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Studies on the preparation of oleo-resinous wood varnish by utilizing Jatropha seed oil

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Abstract

Studies were carried out on the preparation of three different types oil varnishes (short, medium and long oil varnish) depending on the amount of oil used. The seed was characterized in terms of the seed index consist of weight (523.91g) and volume (736ml) of 1000 seed, percentage moisture content (5.39%) and percentage oil yield (48.085%). The physical and chemical properties of Jatropha seed oil were evaluated and results for specific gravity (0.944), density (0.7315g/ml), pH (5.4), acid value (2.41 mg KOH/g) and percentage free fatty acid (1.025mg KOH/g) was recorded. The oil varnishes were prepared by boiling Jatropha seed oil in an open cooking pot and mixing it with drying salt (Zinc Sulphate) and resin (Rosin) and finally thinning it by solvent (Xylene). The cooking temperature was maintained at 240°C for an hour. The short oil varnish dries on the time of preparation and the production failed. It is suggested that this happened due to the proportion of oil to resin. The characteristics of both medium and long oil varnish measured and expressed in pH (9.68 and 9.01), density (0.585g/ml and 0.628 g/ml) and drying time (14 and 23 minutes) respectively.

Keywords: Jatropha seed, Rosin, Seed index, Varnishes

Introduction

Jatropha is a shrub belonging to the *Euphorbiaceae* family. It is cultivated in central and South America, South East Asia, India and Africa (Gubitz et al., 1999). Jatropha can grow well under such adverse climate because of its low moisture demands, fertility requirements and tolerance to high temperatures (Kaushik et al., 2007). In the past, Jatropha oil was used for lighting lamps (Gubitz et al., 1998). Today, rural communities continue to use it for its medicinal value and for local soap production. India and many countries in Africa use the Jatropha plant as a living hedge to keep out grazing livestock.

The Jatropha plant is widely distributed in Ethiopia, existing in many low-lying areas of the country (North Shewa, Wello, Benishangul-Gumuz, Gambela, Welayita, Bale and others). Large volumes of residue are expected to be available from the biofuel processing industry over the coming years (Yisehak et al., 2009).

Chemical properties of oil are amongst the most important properties that determines the present condition of the oil. The fatty acid component of Jatropha oil usually contains oleic acid (41.5-48.8%), linoleic acid (34.6-44.4%), palmitic acid (10.5-13.0%) and stearic acid (2.3-2.8%). Higher iodine value of Jatropha is caused by high content of unsaturated fatty acid such as oleic acid and linoleic (Shalini, 2013).The iodine values of Jatrophaplace them in the semi-drying oil group and suggest their use in production of alkyd resin, shoe polish, varnishes etc. (Akintayo, 2004).

An excellent varnish can be made from the Jatropha oil. This can also be used as a base to make natural shoe polish. Jatropha oil has semi drying properties, the varnish and paints from Jatropha would be more durable as the oil itself has semi drying properties (Khan & Islam, 2006).

The term " varnish " is used to designate any solution which, when spread by means of a brush, in a thin layer over the surface of an object, or applied thereto in a rational manner by any other suitable means, dries (either by simple evaporation of the solvent, as is the case with spirit varnishes, or by the combined evaporation of the solvent, and the more or less complete oxidation of the residue) to an adherent, smooth, uniform, lustrous, elastic, shining film, unaffected by air or moisture (Ach. Livache, 1899).

There are many types of formulation of varnish. They fall into two broad categories under today's system of categorization. The simplest type of varnish is classified as spirit varnish. The spirit varnishes were composed of resins and gums dissolved typically in spirits of wine (alcohol) much the same as we prepare today's shellac. In fact, in the 18th and early 19th centuries our modern day shellac would be consider a spirit varnish. The second category is Oleo-resinous varnishes. These varnishes are a solution of resins, gums and a curing oil such as linseed oil, walnut oil or poppy seed oil. These varnishes cure by a process of chemical changes as well as solvent evaporation and form complex tough films made up of a mixture of resins and oxidized oils (Mussey& Robert, 1987).

Varnish makers express the oil to resin ratio in terms of oil length, which is defined as the number of gallons of oil used for 100 lbs. of the resin in the varnish. Oleo-resinous varnishes are categorized according to their

oil length as long-oil, medium-oil and short- oil varnishes (K. Hultzsch& J. Prakt., 1941).

Materials and Methods

I.   Seed preparation and characterization

The Jatropha seed was obtained from Melkasa agricultural research center, located at a latitude of 8° 24' north, longitude of 39° 21' east and an altitude of 1,550 meters. It is situated at about 107 km from Addis Ababa and 17 km from Adama on the way to Asella and characterized as follows.

a) Seed Index

Weight and volume occupied by 1000 seeds was determined (Adebowale*et al*., 2006). First the 1000 seeds were counted randomly, weighted and the value was recorded. Then these seeds were inserted in a measuring cylinder to measure the volume occupied by them and the value was recorded.

b) Moisture Content Determination

About 6 g of seeds was weighed in a petri dish and kept in an oven maintain at 110°C for 4 hrs. Then the sample was cooled and the loss in weight was recorded in each case (Vogel, 1975). The percentage moisture content in the Jatropha seed was calculated using equation 1. (B.S. Nayak&K.N. Patel, 2010).

$$\%m_X = \left[\frac{(m2 - m1) - (m3 - m1)}{m2 - m1}\right] \times 100 \quad \text{Eq. (1)}$$

Where: m_1= the empty container weight

m_2 = empty container + sample weight before drying

m_3 = empty container + sample weight after drying

II.   Jatropha seed oil extraction

- The Jatropha seeds were cleaned manually to separate good condition seeds from the infected seeds and unwanted impurities.

Fig. 1 Cleaned Jatropha seed

- Then it was first weighed and then de-hulled in order to separate it from the husk.

Fig. 2The husk and the de-hulled Jatropha seed

- Then the de-hulled seeds dried in an oven at 105°C for 30 minutes. After drying the seeds were ground into powder using a grinder prior to oil extraction.

Fig. 3 The dried and grinded Jatropha seed

The oil of Jatropha seeds were extracted by using the Soxhlet extractor from the prepared seedpowder. 50 g of ground seed was placed in the thimble, which was inserted in the center of the Soxhlet apparatus. 250ml of the solvent (hexane) was poured into the flask. The set up was damped and heated on a heating mantle. The extraction process was carried out in six hours and it was done in correspondence to the temperature of the solvent used (n-hexane at $60^{o}C$). (J.C.Attah. *et al.,* 1990). The extraction was done repeatedly in order to get sufficient amount of oil for the varnish production.

Fig.4 Soxhlet extractor

Then the solvent and the oil was separated using rotary evaporator and the solvent is recovered (Emil. *et al*., 2009).

Fig. 5 Rotary evaporator

After extraction the percentage of oil produced was calculated. The percentage of oil content can be calculated using equation 2.

$$\% \ of \ oil = \frac{Wt \ of \ oil \ obtained \ in \ gm}{wt \ of \ seed \ taken \ in \ gm} \times 100 \qquad \text{Eq. (2)}$$

III. Jatropha seed oil characterization

a. Specific gravity

The baker was washed, dried and weighted. Then it was filled with water and weighed. Then again the bottle was emptied, dried and filled with the extracted Jatropha seed oil and weighed, (Ogunwole, 2012). Then the specific gravity of the oil was calculated using equation 3.

$$Specific gravity = \frac{Weight\ of\ oil\ sample}{weight\ of\ equal\ volume\ of\ water} \quad \text{Eq. (3)}$$

b. Density

Using the above procedure the density of the oil was also calculated using equation 4.

$$Density = \frac{weight\ of\ oil\ sample}{volume\ of\ water} \quad \text{Eq. (4)}$$

c. pH

The pH meter was inserted into the Jatropha seed oil and the pH reading was recorded.

d. Acid value,

The free fatty acid content of the Jatropha seed oil was determined using acid base titration technique. Jatropha seed oil was weighted into a 250 cm^3 conical flask and add then, heat the resulting mixture on a water bath under reflux to dissolve the oil.

The solution formed will be allowed to cool and titrated against potassium hydroxide solution using phenolphthalein indicator (AOAC, 1975.) and the acid value can be calculated using equation 5.

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$$Acid\ Value = \frac{V \times N \times 56.1}{w} \quad \text{Eq. (5)}$$

Where:

V= ml of 0.25M KOH consumed by sample

N = Concentration of KOH

W = weight in grams of the sample

56.1= molecular mass of KOH

e. Percentage free fatty acid

Percentage free fatty acids (FFAs) were calculated as a factor of acid value as (AOAC. 1975).

$$Free\ fatty\ acid = \frac{Acid\ value}{2} \times 100 \quad \text{Eq. (6)}$$

IV.   Degumming the Jatropha seed oil

The extracted oil was filtered and then equal volume of water as the oil was boiled and added to the oil. The mixture was stirred for 5 minutes and waited until the gum and the oil separated. Then the oil was decanted and inserted to the centrifuge for further purification. (Albert, 1987).

Fig. 6 Oil degumming

V.   Varnish production procedure

The degummed oil (3.03ml for Short oil varnish, 9.46ml for Medium oil varnish and 22.71ml for Long oil varnish) was first poured in cooking pot, placed on the stove, and boiled until the temperature reaches 210 ^{o}C and then 0.2g of Zinc sulphate was added as a drying salt and stirred continuously for 5 minutes. After the oil and the drying salt was mixed, 4.536g of rosin was added and the temperature raised to 240°C and stirred continuously until the mixture became homogeneous for about an hour. When the mixing process for varnish was completed, the cooking pot was removed from the stove and kept open and cooled to 150°C.Then 100ml xylene at 150 ^{o}C was mixed to the mixture for the purpose of thinning. This was done three times separately for the production of the three different types of varnishes.

VI.   Varnish characterization

a.   Density

The density of the varnish was determined by weighing 20ml of sample varnish in beaker and dividing the mass of varnish by the volume at the room temperature.

b. pH

The pH meter was inserted into the sample of varnish and the pH reading was recorded**.**

c. Drying time

The drying time was measured by coating the sample varnish on the piece of wood and wait until it dry and the time of drying was recorded.

Results and Discussion

a. Seed characterization and oil yield

The results concerning seed index, in terms of weight and volume of 1000 seeds, the moisture content and the oil yield of the seed are given below in table 1.

Table 1: Seed characterization and oil yield

Characterization of seeds		Value
Seed index	Wight of 1000 seeds	523.91 g
	Volume of 1000 seeds	736 ml
Moisture content		5.3939 %
Oil yield		48.085%

The physical parameters of the seed affect chemicals that are contained either in pulp or kernel that directly. The weight and volume of seed directly relate to the hardness of seeds that directly affects process of analysis (Saya*et al*., 2015).

The moisture content is the amount of water in the seed and is usually expressed as a percentage. It can be expressed on either a wet weight basis or on a dry weight basis (Michael *et al*., 2007). The moisture content of the Jatropha seed was determined on dry basis.

The measured weight and volume of 1000 seeds, the moisture content and the oil yield of the seed respectively are comparable with the values that reported by (B.S. Nayak&K.N. Patel, 2010 ; Archana*et al.*, 2011) which are 540.51g, 730.00ml, 5.8% and 46.31 % respectively.

b. Oil characterization

The Jatropha seed oil extracted using soxhlet apparatus was characterized in terms of specific gravity, density, pH, acid value and percentage free fatty acid and the results are listed below in table 2.

Table 2: Oil characterization

Characteristics	Result	Standard value
Specific gravity	0.944	0.9186
Density (g/ml)	0.7315	-
pH	5.4	-
Acid value (mg KOH/g)	2.41	1.0–38.2
Percentage free fatty acid (%)	1.205	-

Source: for the standard (http://www.hindawi.com/journals/jpe/2013/956479/tab2/)

The measured value of specific gravity and density that indicate the physical characteristics of the oil respectively are 0.944 which is closest to the standard value 0.9186 and 0.7315 g/ml that is comparable with the value reported by Emil A. *et al*, (0.90317 g/ml).Such value variation across species and locations might be attributed to the environmental and geological conditions of varied regions.

The pH is the degree of the acidity of the oil. The pH value for Jatrophaoil was found to be 5.4 and is near to the value reported by Zaharaddeen*et al*. (2013) which is 5.2.

c. Oil Degumming

An acid value is indication of the age and quality of the oil or fat. The acid value was determined to be 2.41 mg KOH/g which implies low fatty acid content. The result obtained is within standard. The percentage free fatty acid value indicates the deteriorating condition and edibility of the oil (A.I. Aigbodion, & F.E. Okieiman, 2004). Low value (1.205 %) is obtained for the free fatty acid as indicated in table 4.2 and is in the range that reported by W.M.J. Achten*et al*, (2008) which is 0.18-3.40 %.

In most plants, seed oil contains phosphatides in the form of lecithin. A large part of those phosphates was removed by water degumming. It was observed that once these phosphatides were removed in the form of lecithin, no further appearances of gums or waxes in the oil took place and this

resulted in the production of oil with a good color and without taste or smell. The oil remains fit for storage and transportation for a long time (2–3 years) (Albert, J., 1987), therefore degumming is very important process.

d. Varnish production

Three types of oil varnishes, short, medium and long oil varnishes, with different amount of oil and similar amount of drying salt, resin and solvent was separately made. As stated in the literature the short oil varnish was dried on the cooking pot due to

its high drying capacity and it was removed also by cracking with the help of spoon and water. The rest two the medium and the long one were show better appearance than the short oil varnish and the long oil is better than the medium one.

e. Varnish characterization

Density, pH and drying time was measured and the color was observed for both the

Medium oil varnish and Long oil varnish and the results are listed below in the table.

Table 3: Varnish characterization

Characteristics	Medium oil varnish	Long oil varnish
Density(g/ml)	0.585	0.6285
pH	9.68	9.01
Drying time(minute)	14	23
Color	Brown	Brown

The drying time and the color of both varnishes are comparable to the alkyd varnish available in the market which is 30-50 minutes. This value difference is due to the difference in resin, solvent, drying salt

used and operating temperature. The stickiness is lower than the alkyd varnish and it is suggested this also have its own effect on the time of drying. In both drying time and color the long oil varnish shows better result.

Conclusion

This project shows the capacity of the Jatropha seed oil for the production of varnish in different oil proportions. The experiment indicates the production of varnish is highly affected by the operating temperature and type and composition of raw materials. From the laboratory work it is concluded that the long oil varnish has better performance than the others i.e. short oil and medium oil varnish.

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Control of Permanent Magnet Synchronous Motor Using Space Vector Modulation

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Abstract

Recently, developments in power electronics and semiconductor technology have lead improvements in power electronic systems. Pulse Width Modulation variable speed drives are increasingly applied in many new industrial applications that require superior performance. Hence, different circuit configurations namely voltage source inverters have become popular and considerable interest by researcher are given on them. Variable voltage and frequency supply to A.C drives is invariably obtained from a three-phase voltage source inverter. A number of Pulse width modulation (PWM) schemes are used to obtain variable voltage and frequency supply. The most widely used PWM schemes for threephase voltage source inverters are carrier-based Sinusoidal PWM and Space Vector PWM (SVPWM). There is an increasing trend of using SVPWM because of their easier digital realization and better dc bus utilization. In this paper simulation of SVPWM are applied for performance analysis of Permanent Magnet Synchronous Motor (PMSM) using voltage source inverter. The THD and speed torque analysis for PMSM are simulated using MATLAB/Simulink. This paper focuses on step by step development of SVPWM implemented on PMSM. The model of a three-phase voltage source inverter is discussed based on space vector theory. Simulation results are obtained using MATLAB/Simulink environment for effectiveness of the study.

Key words- Permanent magnet synchronous motor, voltage source inverter, space vector modulation

I. INTRODUCTION

Pulse Width Modulation variable speed drives are increasingly applied in many new industrial applications that require superior performance. Recently, developments in power electronics and semiconductor technology have lead improvements in power electronic systems. Hence, different circuit configurations namely multilevel inverters have become popular and considerable interest by researcher are given on them [4],[5]. Variable voltage and frequency supply to A.C drives is invariably obtained from a three-phase voltage source inverter [1]. A number of Pulse width modulation (PWM) schemes are used to obtain variable voltage and frequency supply. The most widely used PWM schemes for three-phase voltage source inverters are carrier-based sinusoidal PWM[3] and space vector PWM (SVPWM)[2], [6]. There is an increasing trend of using SVPWM because of their easier digital realization and better dc bus utilization [7].

This paper focuses on step by step development of SVPWM implemented on PMSM. The model of a three-phase voltage source inverter is discussed based on space vector theory. Simulation results are obtained using MATLAB/Simulink environment for effectiveness of the study.

II. PWM IN INVERTERS

Output voltage from an inverter can also be adjusted by exercising a control within the inverter itself. The most efficient method of doing this is by pulse-width modulation control used within an inverter. In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components. This is the most popular method of controlling the output voltage and this method is termed as Pulse-Width Modulation (PWM) Control.

PWM techniques are characterized by constant amplitude pulses. The width of these pulses is however modulated to obtain inverter output voltage control and to reduce its harmonic content. The different PWM techniques are as under:

(a) Single-pulse modulation
(b) Multiple pulse modulations
(c) Sinusoidal PWM

A. SPWM for Full Bridge VSI

This is an extension of the one introduced for single-phase VSIs. In this case and in order to produce 120^0 out-of-phase load voltages, three modulating signals that are 120^0 out of phase are used. Fig.1 shows the ideal waveforms of three-phase VSI SPWM. In order to use a single carrier signal and preserve the features of the PWM technique, the normalized carrier frequency mf should be an odd multiple of 3. Thus, all phase voltages (V_{an}, V_{bn}, and V_{cn}) are identical but 120^0 out of phase without even harmonics, moreover, harmonics at frequencies a multiple of 3 are identical in amplitude and phase in all phases.
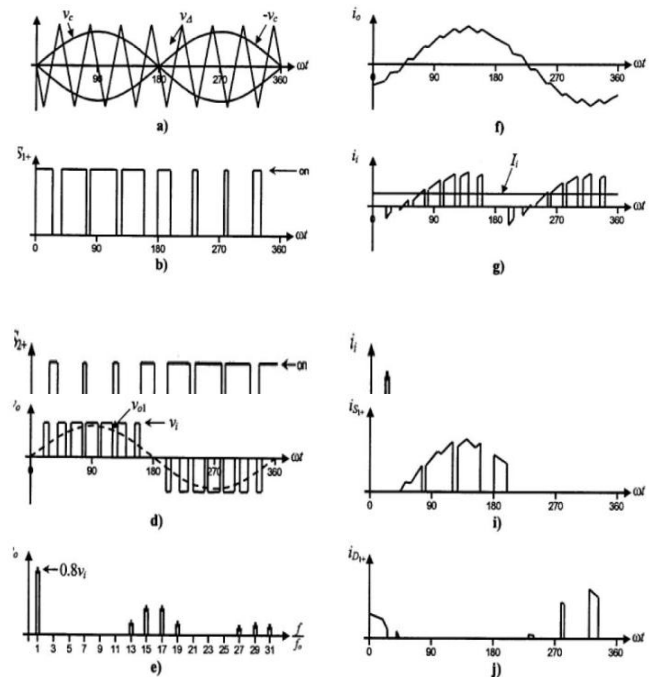
Fig.1: The full-bridge VSI. Ideal wave forms for SPWM (ma =0.8, mf = 0. 8): (a) ac output voltage(b)switch S1+state;(c)switchS2+state;(d)ac outputvoltage;(e)acoutputvoltagespectrum;(f)acout putcurrent;(g)dccurrent;(h) dc current spectrum;(i)switchS1+current;(j)diodeD1+current carrier
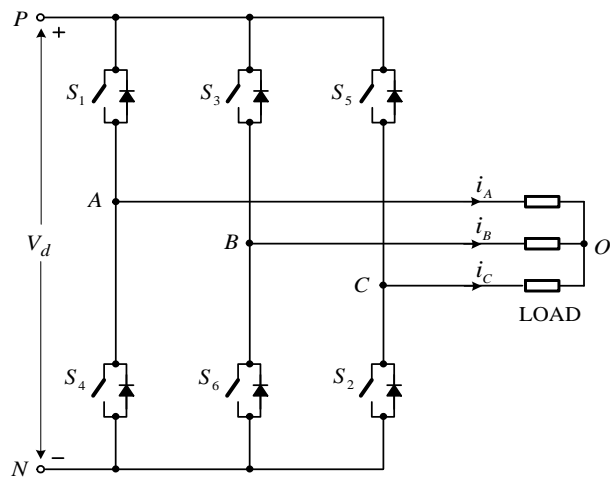
Fig2: Topology of three phase inverter

The topology of a three-leg voltage source inverter is shown in Fig. 2. Because of the

constraint that the input lines must never be shorted and the output current must always be continuous a voltage source inverter can assume only eight distinct topologies. These topologies are shown on Fig.3. Six out of these eight topologies produce a nonzero output voltage and are known as non-zero switching states and the remaining two topologies produce zero output voltage and are known as zero switching states. The switching states given table I

B. Space Vectors Modulation for Full Bridge VSI

Space vector modulation or three-leg VSI is based on the representation of the three phase quantities as vectors in a two-dimensional ($\alpha\beta$) plane. This is illustrated here for the sake of completeness.
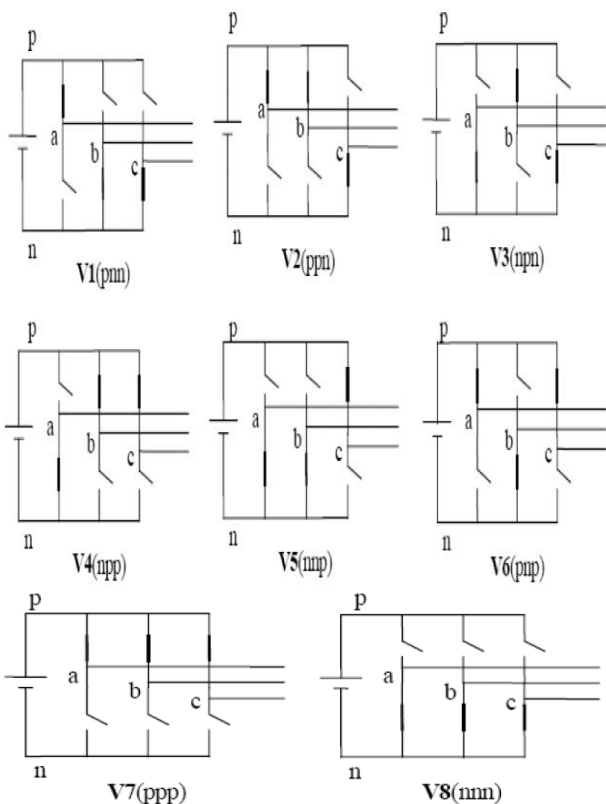
Fig3:Eight switching state topologies of a voltage source inverter

TABLE I
SWITCHING STATES

Switching State	Leg A			Leg B			Leg C		
	S_1	S_4	V_{AN}	S_3	S_6	V_{BN}	S_5	S_2	V_{CN}
P	On	Off	V_d	On	Off	V_d	On	Off	V_d
O	Off	On	0	Off	On	0	Off	On	0

The effective voltage vector generated by this topology is represented as V1(pnn) in Fig. 4 Here the notation (pnn) refers to the three legs/phases a,b,c being either connected to the positive dc rail (p) or to the negative dc rail (n). Thus (pnn) corresponds to phase a being connected to the positive dc rail and phases b and c being connected to the negative dc rail.
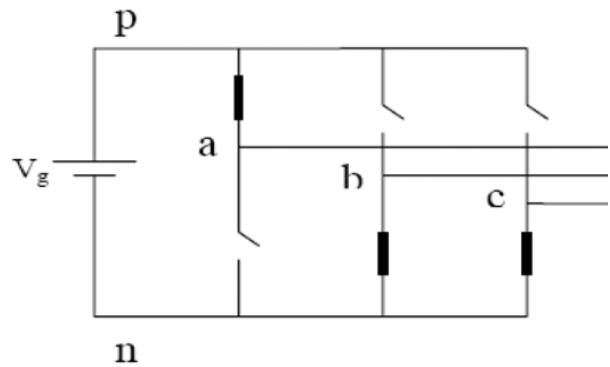
Fig 4: Topology 1-V1 (pnn) of a voltage source inverter.

$V_{ab} = V_g$
$V_{bc} = 0$
$V_{ca} = -V_g$
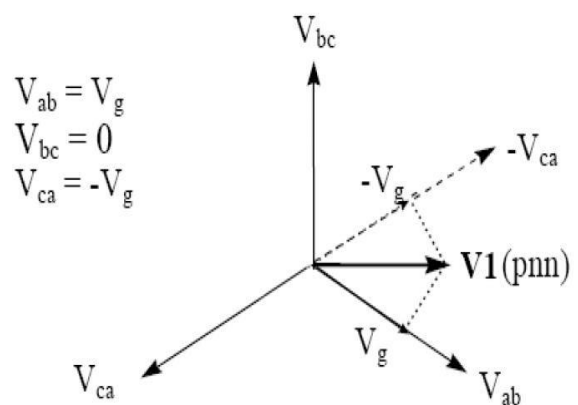
Fig5: Representation of topology1 in the α-β, plane

TABLE II
SWITCHING STATES

Switching State (Three Phases)	On-state Switch
[PPP]	S_1, S_3, S_5
[OOO]	S_4, S_6, S_2
[POO]	S_1, S_6, S_2
[PPO]	S_1, S_3, S_2
[OPO]	S_4, S_3, S_2
[OPP]	S_4, S_3, S_5
[OOP]	S_4, S_6, S_5
[POP]	S_1, S_6, S_5

TABLE III
EIGHT INVERTER VOLTAGE VECTORS

Voltage Vectors	Switching Vectors			Line to neutral voltage			Line to line voltage		
	a	b	c	V_{an}	V_{bn}	V_{cn}	V_{ab}	V_{bc}	V_{ca}
V_0	0	0	0	0	0	0	0	0	0
V_1	1	0	0	2/3	-1/3	-1/3	1	0	-1
V_2	1	1	0	1/3	1/3	-2/3	0	1	-1
V_3	0	1	0	-1/3	2/3	-1/3	-1	1	0
V_4	0	1	1	-2/3	1/3	1/3	-1	0	1
V_5	0	0	1	-1/3	-1/3	2/3	0	-1	1
V_6	1	0	1	1/3	-2/3	1/3	1	-1	0
V_7	1	1	1	0	0	0	0	0	0

(Note that the respective voltage should be multiplied by V_{dc})

Three phase voltages

$$v_{AO}(t) + v_{BO}(t) + v_{CO}(t) = 0 \quad (1)$$

Two phase voltages

$$\begin{bmatrix} v_\alpha(t) \\ v_\beta(t) \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \cos 0 & \cos \frac{2\pi}{3} & \cos \frac{4\pi}{3} \\ \sin 0 & \sin \frac{2\pi}{3} & \sin \frac{4\pi}{3} \end{bmatrix} \begin{bmatrix} v_{AO}(t) \\ v_{BO}(t) \\ v_{CO}(t) \end{bmatrix} \quad (2)$$

Space vector representation

$$\vec{V}(t) = v_\alpha(t) + j v_\beta(t) \quad (3)$$

$$(2) \rightarrow (3)$$

$$\vec{V}(t) = \frac{2}{3}\left[v_{AO}(t) e^{j0} + v_{BO}(t) e^{j2\pi/3} + v_{CO}(t) e^{j4\pi/3} \right] \quad (4)$$

where

$$e^{jx} = \cos x + j \sin x \quad (5)$$

III. PERMANENT MAGNET SYNCHRONOUS MACHINES

The Permanent Magnet Synchronous Machine (PMSM) Is Primarily Associated With High-performance Applications and Is Normally Fed by a Voltage Source Inverter (VSI). The machine is of the Synchronous Type and the Rotor Field Is Created by Permanent Magnets attached To the Rotor. The Material of the Permanent Magnets can differ but the Best materials Are of Rare Earth Type, Such As Samarium-Cobalt (Sm-Co) Or Neodymium-Iron-Boron (Nefeb). The Nefeb Magnets Combine a High Flux Density with a Large Coercive force. Unfortunately, they are still quite expensive but the price has dropped during the last decade. The advantage of using permanent magnets in the rotor circuit is that the design of the machine is simplified and that there are virtually no losses in the rotor circuit since the rotor is (ideally) free of currents. The stator winding can be wound in several ways. Machines with trapezoidal wound stator windings are called brushless dc machines and should be fed by

trapezoidal currents to produce a smooth torque. Another winding method is to wind the stator sinusoidal. The combination of a sinusoidal wound stator and a permanent magnet rotor design is the basis of the permanent magnet synchronous machine. The distribution of the magnets in the rotor can vary significantly.

Methods for controlling PMSM drives, connected to different types of converters, have been developed both for steady state operation and high performance servo control. This paper discusses the control of the PMSM but a small discussion of the steady state behavior of the machine can be found the most advanced type of control of electrical machines is known as vector control. The term vector control includes many different control methods but they all use different types of feedback mechanisms for improved control

Torque ripple produced by a PMSM comes from two different sources. The first ones were known as cogging torque. Cogging torque is generated by the interaction of the rotor magnetic flux and angular variations in the stator magnetic reluctance. Different methods for reducing cogging torque exist and they mostly rely on changes in the design of the machine. One usual design method is known as skewing, which can be done on both the rotor and stator. Skewing can reduce the cogging torque very effectively manufacturing procedure is complicated, which increases the price of the machine. The other method for reducing torque ripple in an existing machine is to use control schemes that reduce torque ripple. The basic goal of these control schemes is to control the currents that the ripple is

cancelled out (this is known as harmonic injection).Vector control offers superior performance when compared to scalar control. Vector control eliminates almost all the disadvantages of scalar control. The main idea of vector control is to control not only the magnitude and frequency of the supply voltages but also the angle. With other words said the magnitude and angles of the space vectors is controlled.

IV. SIMULATION OF PMSM USING SVM
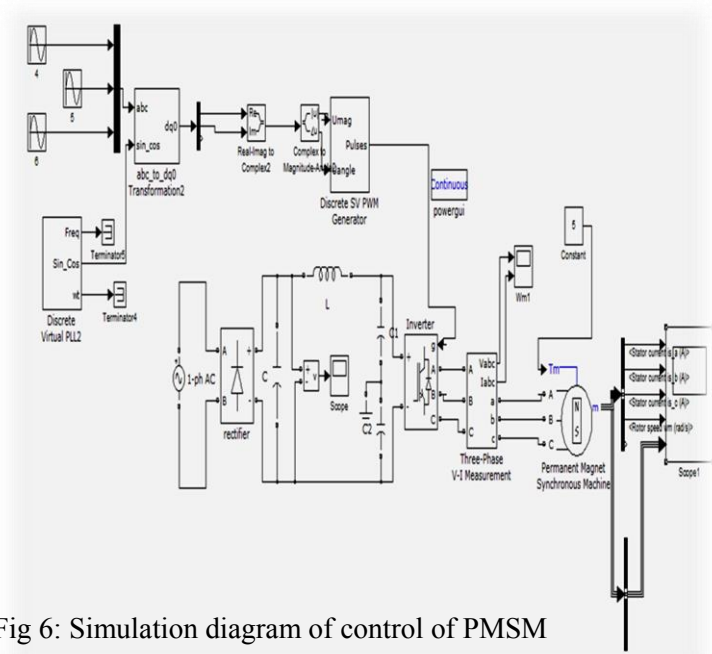
Fig 6: Simulation diagram of control of PMSM
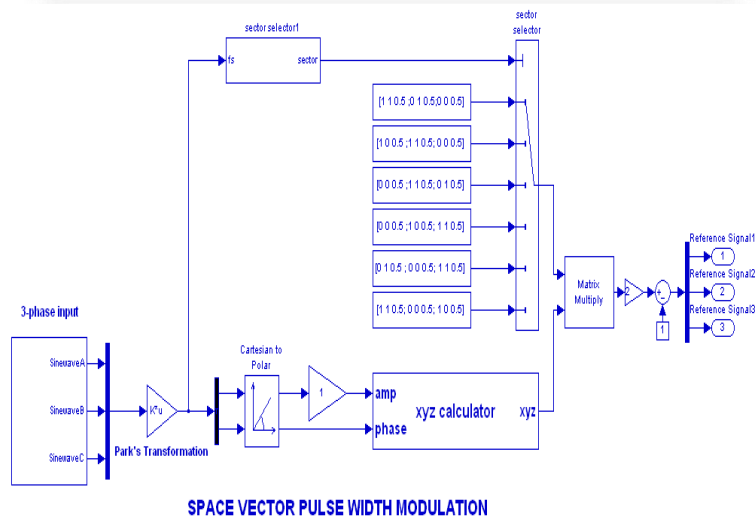
Fig.7: SVM Simulink model of PMSM control

Fig. 6 shows the simulation diagram of control of permanent magnet synchronous motor using space vector modulation. From single phase AC source three phase voltages is obtained through three phase voltage Source inverter. The firing pulse for three phase inverter is controlled by discrete SVPWM by magnitude and angle control of input signal. Fig.7 shows the space vector modulation simulink model of PMSM control.
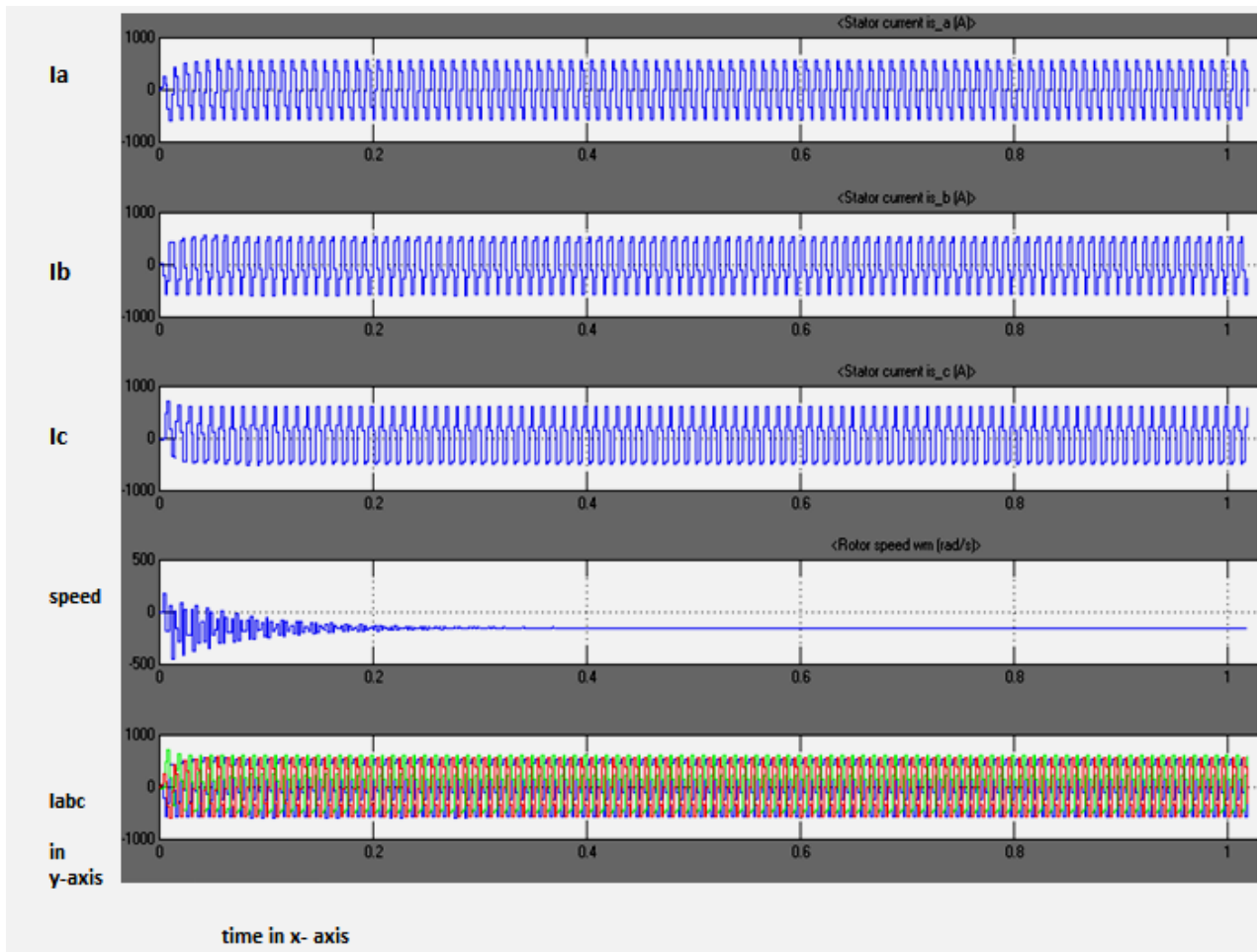
Fig.8: Output waveforms of PMSM using SVM

Fig.8 shows the output of PMSM using space vector modulation control. The output of three phase inverter is feed to sinusoidal PMSM whose stator current ,rotor current, speed and torque are analyzed. In a space-vector PWM inverter, which is widely used, the voltage utilization factor can be increased to 0.906, normalized to that of the six step operation.
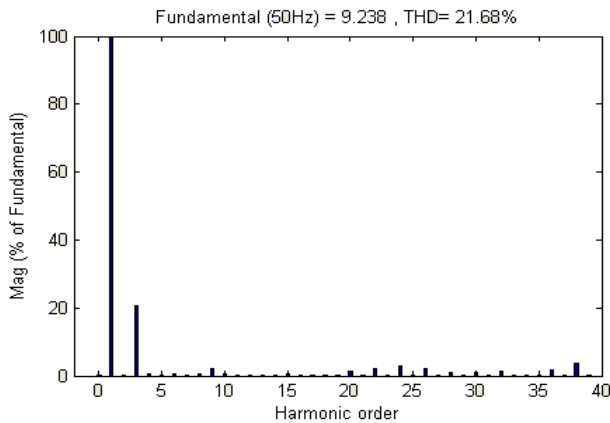
Fig.9: Control of PMSM using SVM harmonic spectrum

The control of permanent magnet synchronous motor using space vector modulation harmonic spectrum is shown in Fig.9. The switching frequency is 2 KHz with fundamental frequency 50 Hz. The harmonic order is 21.68%.The output voltage is about 600 V. Speed of the motor varies from 1600 to 3000 RPM with torque variation of 5 to 6 Nm by controlling SVPWM firing pulses.

V. CONCLUSION

The control of permanent magnet synchronous motor using space vector modulation, three phase AC waveform is obtained from single phase AC supply. The output voltage is about 600 V with Minimum THD. Sinusoidal – PMSM motor is connected and its performance characteristics are analyzed. Speed of the motor varies from 1600 to 3000 RPM with torque variation of 5 to 6 Nm by controlling SVPWM firing pulses.

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Study on Nylon 66 - Thermal, Mechanical and Rheological Properties

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Abstract

In the present investigation, the properties of Nylon 66 with respect to structural modifications by altering the Process variables and Annealing conditions are studied. Polymers have lower glass transition temperature, melting point and thermal stabilities as compared to ceramics and metal polymers. Noteworthy applications of polymers are electronic, optoelectronic areas, tissue engineering, microelectronic membranes and aerospace applications. Nylon 66 is also called as poly hexamethylene diamine adipamide. The specimens are prepared by injection molding by changing the process variables. The process variables which were altered during molding are temperature, injection pressure, flow rate, cycle time. The specimens were annealed at two conditions: 80^0C and 100^0C for 2hrs. Both annealed and unannealed specimens tested for mechanical, thermal and rheological properties. It was observed that the mechanical properties Tensile strength, Flexural strength, Hardness are increased for annealed samples and decreased for Impact strength. Thermal properties Heat Deflection Temperature, VICAT softening points are increased for annealed samples. Rheological property the Melt Flow Index values are shown decreasing trend. The objective of the present work is to enhance the maximum properties of nylon 66 by annealing process. Annealing process increases the crystallinity of material and important conclusions are drawn.
Key words - Crystallinity, Annealing, Molding parameters, Structural changes, Nylon 66.

1. Introduction

Polymers are high molecular weight compounds, formed by combining small or low molecular weight units. The process by which a monomer combines with the identical or different monomers to form polymers is known as polymerization. Polymers are fascinating, indispensable macromolecules without which the existence of nucleic acid, cells and finally life is not possible. The applications of polymers are in electronic, optoelectronic areas, tissue engineering [1-4], microelectronic membranes and aerospace applications [5-10]

Nylon 66 is a semi crystalline polymer, has a good mechanical strength and thermal stability and also an important engineering thermo plastic. Nylon 66 is made from adipic acid and hexa methylene diamine. It is called as poly hexa methylene diamine adipamide. It's a polyamide. The generic name for a group of synthesis fibers was the first of the "miracle" yarns made entirely from chemical ingredients through the process of polymerization. Nylon 66 polymer chips can be extruded through spinnerets in to fiber filament or molded and formed into a variety of finished engineered structures. Nylon offers strength and

durability unattainable for protection against shell fragments. It is used as aircraft tire reinforcement. Today as the global leader in Nylon polymer, Dupont offers a wide range of Nylon 66 polymer types for use in industrial, textile, furnishing, floors covering applications. Nylon thermoplastics and can be repeatedly melted and molded again and again. Nylon 66 is one of the polymer in nylon family. It has dense structure with small pores and is evenly spaced. This means that nylon 66 is difficult to dye but once dyed it has superior fading from sun light, ozone and to nitrous oxide. The properties of crystalline materials such as polyethylene, poly propylene, nylon, acetal are affected by the amount of amorphous material, the amount and nature of the crystalline phase, and the orientation. The properties are strongly affected by the molding conditions and post molding treatments. When a polymer is melted, the molecules are separated to the extent that they are no longer in an ordered structure, large molecular segments vibrate and rotate to give a totally disordered structure. When the plastic is cooled a point is reached where the forces of attraction are strong enough to prevent this free movement. The molecular configuration is the same throughout the intermolecular distance for this phenomenon and should be same throughout the polymer. This distance is controlled by the temperature. At a given temperature the effect is extreme and the material starts to crystallise. This is the crystallisation temperature. This is

usually 10^0 (or) more below the equilibrium melting point.

Structure of Nylon 66:
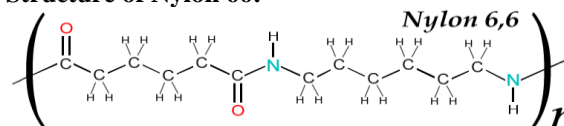
The properties of crystalline materials such as polyethylene, poly propylene, nylon, acetal are affected by the amount of amorphous material, the amount and nature of the crystalline phase, and the orientation. The properties will be strongly affected by the molding conditions and post molding treatments. The heat of fusion of nylon 66 is 56 Btu/Lb.

Crystalline or ordered structure occupies much less space. The sharp decrease in volume is indicative of the onset and amount of crystallisation. Amorphous materials do not have any volume change caused by crystallization. All crystalline polymers show greater shrinkage than amorphous ones in going from a hot liquid to a room temperature solid. The amount of crystallinity varies with molding conditions. It is more difficult to maintain tolerances in highly crystalline materials. The amount of rigidity depends on the amount of crystallinity. So that the crystalline state has a more compact structure.

Annealing is heating the samples and allowing it to cool slowly in order to remove internal stresses and toughen it and reduce brittleness. It is heat treatment, in which the micro structure and the properties of a material are altered. It

refers to heat treatment in which a cold worked material is softened by allowing it to recrystallize.

2. Literature

Dar Jonglin et al., [1] prepared Microporous Nylon-66 polymeric membranes by immersion–precipitation from a ternary system of water/formic acid/Nylon 66. During the course of precipitation, the sequence of liquid–liquid demixing and crystallization of membranes with morphologies were obtained. Using a low voltage field emission scanning electron microscope (FESEM) at very high resolutions, membrane morphologies were studied. Nylon-66 got crystallized into 'α' structure in all the prepared membranes. Deconvolution of the diffraction peaks gave the Crystallinities of the membranes. The results indicate that membranes prepared by a well-dissolved casting dope had a somewhat higher crystallinity than those prepared by incipient dopes with respect to crystallization. The observations were confirmed by Fourier transform infrared spectroscopy and DSC thermo analyses.

Fabiola Navarro-Pardo et al., [2] studied Electrospun one dimensional (1D) and two dimensional (2D) carbon based polymer nanocomposites and determined the effect provided by the structured nanofillers on crystallinity and thermo-mechanical properties of the nanofibres. The nanomaterials such as pristine carbon nanotubes, oxidisedcarbon nanotubes, reduced graphene oxide and graphene oxide were studied. The morphology was studied by scanning electron microscopy and the crystallinity properties were investigated by differential scanning calorimetry and X-ray diffraction. The results suggest that functionalisation favours interfacial bonding and dispersion of the nanomaterials within the polymer matrix. As a consequence the number of nucleating sites increases which in turn decreases the crystal size in the nanocomposites.

Lingyu Li et al., [4] studied on multi-walled carbon nanotubes (MWNTs) which were modified with poly hexamethyleneadipamide (Nylon 66) through a controlled polymer solution crystallization method. A "nanohybrid shish kebab" (NHSK) structure was found wherein the MWNT resembled the shish while Nylon 66 lamellar crystals formed the kebabs. These Nylon 66-functionalized MWNTs were used as precursors to prepare polymer/MWNT nanocomposites.

J.H. Magill et al., [6] studied the chain folding is a central feature of the self organizational aspects of polymer in the solid state , yet the ability of a polymer chain to organize in to a folded morphology depends upon its length. The shorter chains to fold with relative case in dilute solution crystallization but in the melt where

topological constraints are encountered. Crystallisation is less in the higher molecular weight fractions. Polymer morphology and properties demonstrate this point clearly according to the experimental evidence obtained from several sources.

N.K. Pramanik et al., [7] irradiated Nylon 66 by an optimum dose of e-beam in presence of polyurethane as impact modifier in combination with triallylisocyanurate as cross-linker. The results showed a superior performance by nylon 66. The hardness, tensile strength, flexural modulus and impact strength were obtained on radiation processing of nylon 66 by e-beam. There was an increase in cross-linking with dose of e-beam. Irradiated nylon 66 showed better dimensional stability than those achieved with pristine nylon 66.

ZhiqiCai et al., [8] used a liquid crystalline epoxy resin (LCER), 3,3',5,5' - Tetramethylbiphenyl-4,4' -diylbis(4-(oxiran-2-ylmethoxy)benzoate) (M1) and blended it with nylon 66 (M2) at high temperatures to improve the thermal properties. The effects of M1 on chemical modification and crystallite morphology of M2 were investigated by rheometry, thermo gravimetric analysis (TGA), dynamic differential scanning calorimetry (DSC) and polarized optical microscopy (POM). TGA results showed that the initial decomposition temperature of M2 increased by about 8 °C by adding 7% wt M1, indicating the improvement of thermal stability. DSC results illustrated that the melting point of composites decreased by 12 °C compared to M2 as the content of M1 increased, showing the improvement of processing property. POM measurements confirmed that dimension of nylon-66 spherulites and crystallization region decreased because of the addition of liquid crystalline epoxy M1.

Yuan-Chih Chu et al., [9] used surface modification method and made polyacryloamidoxime (PAAmF) to form on the surface of polyacrylonitrile fibers (PANF). By doing this, the characteristics of PAAmF with different modification times were monitored by Fourier transform infrared (FTIR) spectroscopy. Scanning electronic microscopy (SEM) revealed that the surface of PAAmF/PANF was rougher than that of the pristine PANF. Using the reduction method, nano-sized silver nanoclusters were grown on the surface of PANF. Silver nanoclusters were identified by X-ray diffraction (XRD) and SEM microscopy.

3. Materials and Methods

Nylon 66 granules are obtained from SRF Manufacturers Company. Nylon 66 material is hygroscopic in nature. The nylon granules are pre dried at two conditions of temperature, one is at 80^0C and the other is at

100^0C in hot air ovens for 2 hrs. Nylon 66 samples are prepared by injection molding.

Nylon 66 is synthesised by poly condensation of hexa methylene diamine and adipic acid. These are combined with water in a rector .This produces nylon salt. The nylon salt is then sent to an evaporator where excess water is removed. The nylon salt goes in to a reactor vessel where a continuous polymerisation process takes place. This process makes molten nylon 66.The molten nylon 66 undergoes a spinning process where the nylon 66 is extruded and sent through a spinneret , which is a small metal plate with fine holes .The nylon 66 is then air cooled to form filaments .The part CO-NH will stick together becoming nylon 66.

$$n[HOOC\text{-}(CH_2)_4\text{-}COOH] + n[H_2N\text{-}(CH_2)_6\text{-}NH_2] \rightarrow$$

$$[\text{-}OC\text{-}(CH_2)_4\text{-}CO\text{-}NH\text{-}(CH_2)_6\text{-}NH\text{-}]n + 2n\ H_2O$$
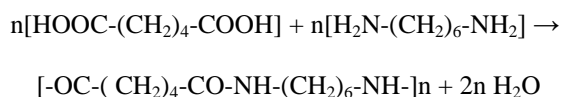
4. Experimental Procedure

The pre drying of polymer is done at 80^0C and 100^0C. The pre dried material is fed to the machine hopper manually or by using hopped loader system. Plasticization of the material is done in the heated cylinder. Then the plasticized molten material is injected at a high pressure through a nozzle into the mold cavity of required shape. Then the material is cooled in the closed mold till the material is solidified. Then the mold is opened and material gets ejected. The cooling

of the specimens is done at two conditions, one is natural cooling and the other is annealing. Table I shows the treatment of specimens.

5. Results and Discussion

Selection of plastics materials for a variety of applications is often based on mechanical performance such as tensile strength, elongation, flexural strength, impact strength, modulus of elasticity etc. Hence, their mechanical properties are primarily dependent on the testing conditions. The mechanical properties (Fig.1) such as tensile strength, flexural strength, hardness have increased due to increase in crystallinity for the annealed specimens. Whereas the impact strength got decreased as crystallinity increased.

Thermal properties play a vital role in evaluating the product performance as well as predicting the processibility characteristics in plastics for specific applications. These properties are of great importance to the process engineers and designers in designing the machines and tool for shaping of plastics. The thermal properties (Fig.2), heat deflection temperature and VICAT softening point have increased for annealed specimens. Therefore, the annealed specimens (2&4) have higher thermal stability than unannealed specimens (1&3).

The study of deformation and flow properties of plastic materials as a result of an applied stress

or strain can be studied under rheological properties. Rheological properties provide ideas about the process ability of plastic materials, molecular architecture, and morphology chain branching, anisotropic micro structural development temperature dependence of properties and degradation. The rheological property, melt flow index of the specimens gave a decreasing trend which is solely attributed to the increase in crystallinity which decreases the molecular mobility and increases hardness.

Table 1 : Specimens at specific dried conditions

Specimens	Pre dried at 80^0C	Pre dried at 100^0C
1	Naturally cooled	-
2	Annealed	-
3	-	Naturally cooled
4	-	Annealed

Figure.1 Mechanical Properties
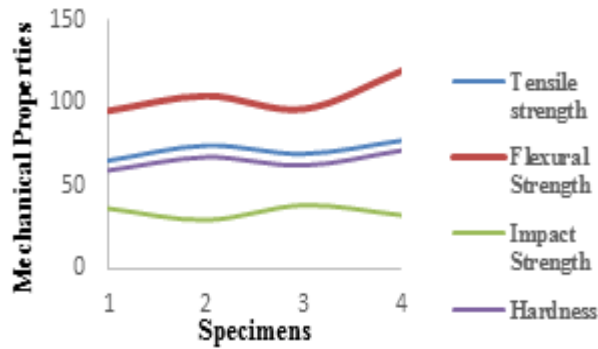
Figure.1 Mechanical Properties
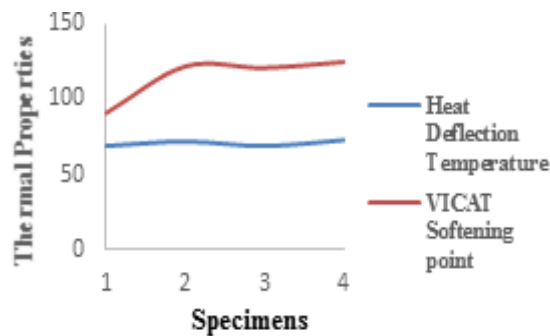
Figure.2 Thermal Properties
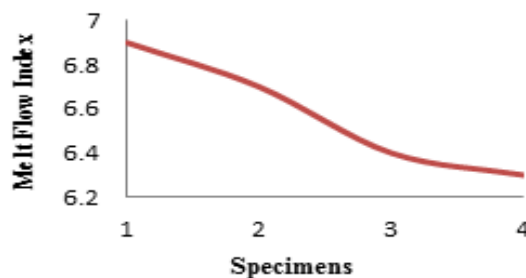
Figure 3: Rheological Property

DSC Thermograms
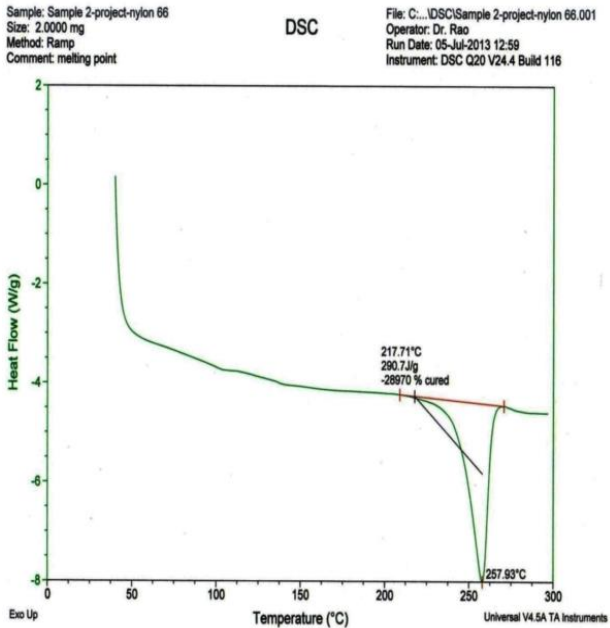
Figure 4: Unannealed Specimen 1
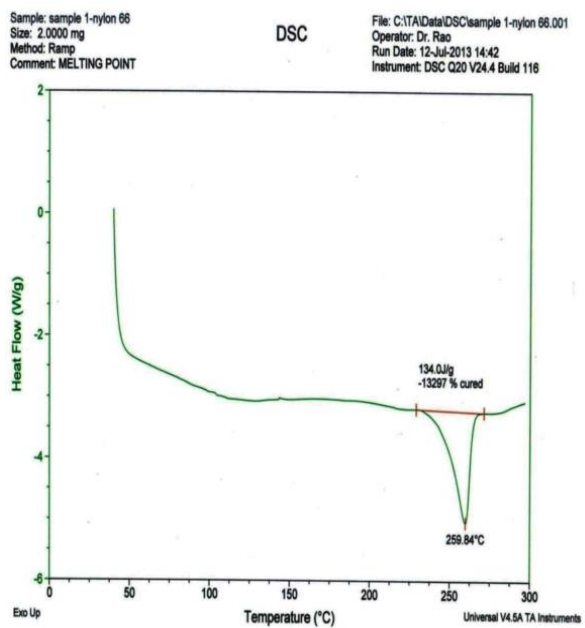
Figure 5: Annealed Specimen 2
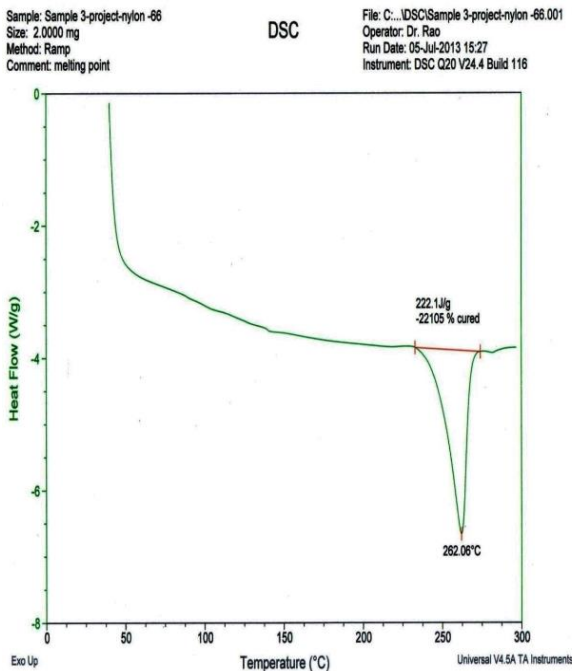
Figure 6: Unannealed Specimen 3
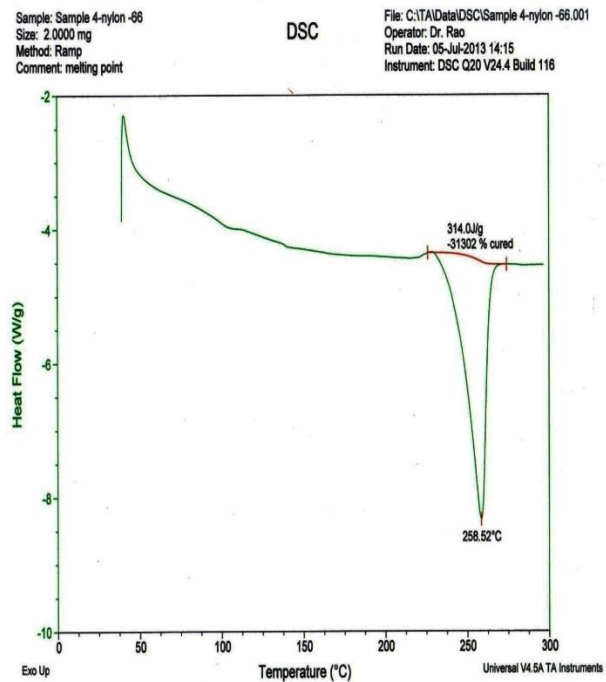
Figure 7: Annealed Specimen 4

SEM images for specimens of magnification at 20 micron meter
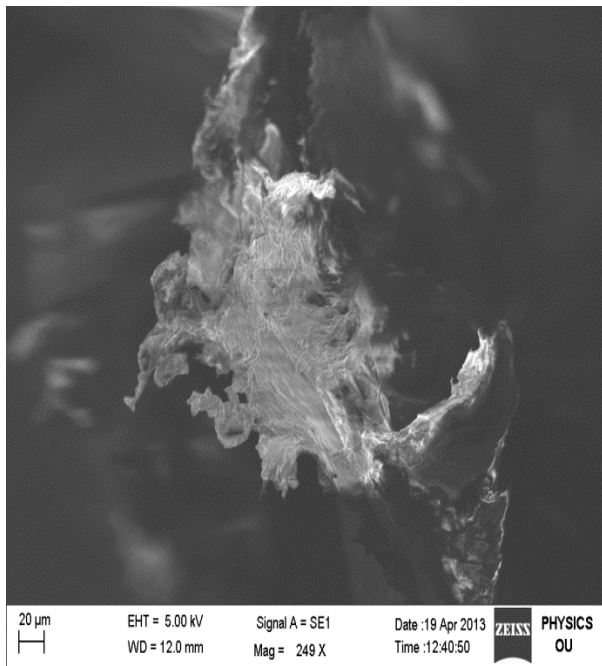
Figure 8:Unannealed specimen 1
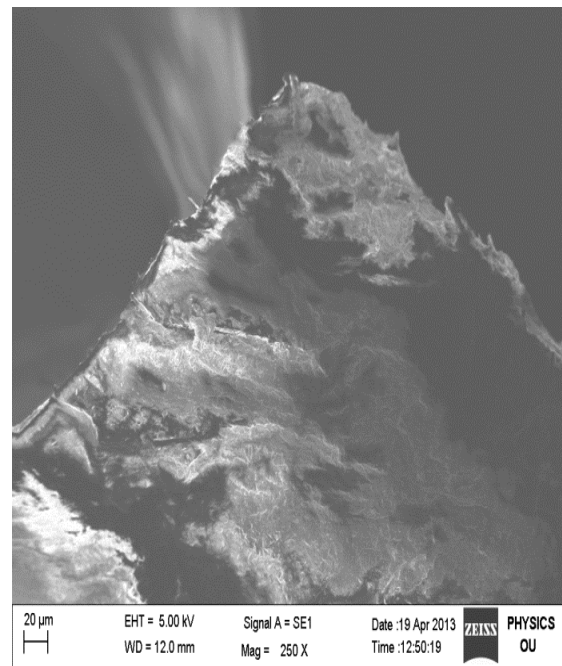
Figure 9: Annealed specimen 2
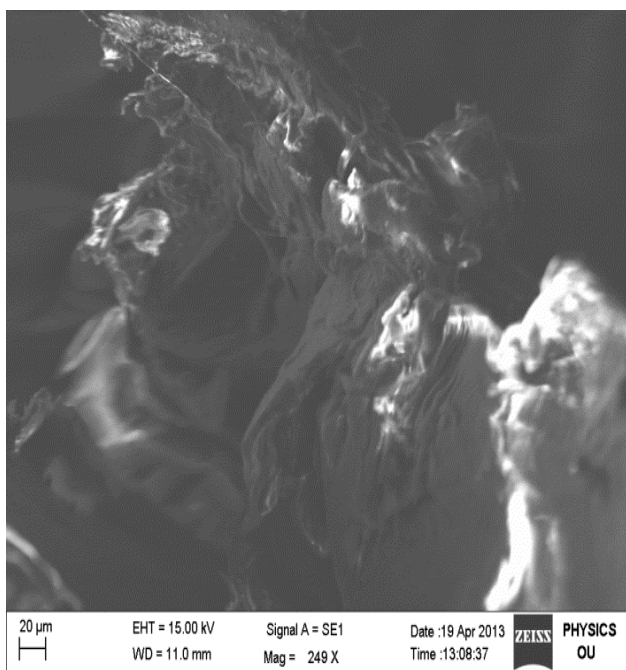
Figure 10:Unannealed specimen 3
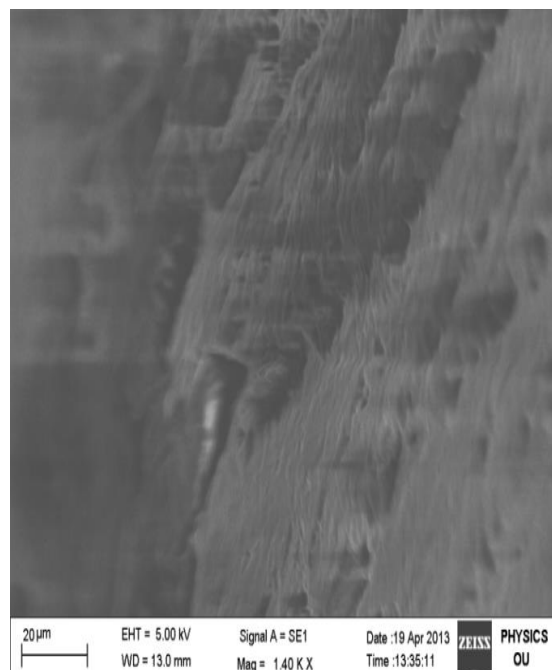
Figure 11: Annealed specimen 4

From the above DSC thermograms (Figure 4-7), the observation shows that higher energies are absorbed by the annealed specimens. It confirms the higher crystallinity due to annealing process.

Heat energy is required to be quickly put in to plastic material during processing. But this is difficult since plastics are poor conductors of heat and have limited thermal stability. Now this clearly shows that annealed specimens have higher thermal stability than unannealed specimens.

The melting point of unannealed specimen 1 was found to be 257.93^0C and that of

annealed specimen 2 was found to be 259.84^0C. The melting point of unannealed specimen 3 was found to be 262.06^0C and that of annealed specimen 4 was found to be 258.52^0C. The above said pre dried operating conditions (Table 1) had also made great effect on the specimens.

From the above SEM images, Fig.9 and Fig.11 (annealed) show that the molecular packing is very much organised when compared to Fig.8 and Fig.10 (unannealed). Thus, the mechanical, thermal and rheological properties for annealed specimens are improved

6.Conclusions

- It was observed that the mechanical properties such as Tensile strength, Flexural strength, Hardness has increased for annealed samples due to the increase of crystallinity and decrease of segmental mobility of the molecule.
- The Impact strength has decreased for annealed specimens due to increase in crystallinity. As the impact strength is inversely proportional to the crystallinity.

- Thermal properties such as Heat Deflection Temperature, VICAT softening point has increased for annealed samples due to increase in crystallinity. As a result the material can show more thermal stability and increased continuous service temperature add more life at ambient condition.
- Rheological property such as the Melt Flow Index values have shown decreasing trend. This may be attributed to the increasing crystallinity, decreasing

the molecular mobility and increased hardness of the specimen.

- From DSC thermo grams the higher heat energy is absorbed by the annealed specimens .It confirms the higher crystallinity due to annealing

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Synthesis of Magnetic Nano Composite Adsorbent by Co-precipitation Method for wastewater treatment

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Abstract

Nowadays there is a continuously increasing worldwide concern for the development of wastewater treatment technologies. In this study a new, cost effective, easily available, and eco-friendly Magnetic Nano Composite adsorbents were developed as an alternative for the removal of Cationic dyes from waste water. The study also investigate the potential use of activated carbon (CWAC) prepared from chat (khat) waste by chemical method of activation with concentrated sulfuric acid in 1:1 ratio and iron oxide nanoparticle through co-precipitation from ferric nitrate to form Magnetic Nano Composite. The synthesized adsorbents were characterized using advanced techniques: XRD, SEM, FT-IR and pH_{PZC}. Batch adsorption experiments were conducted for the adsorption studies and the effect of adsorbent dose, initial concentration, agitation time and pH were studied. The results analysis showed that the adsorption capacities of CWAC and MCWAC were increased with increasing adsorbent dosage, the optimum dosage and percent removal of MB were 0.4g; 94.5% and 0.1g; 93.8% for CWAC and MCWAC respectively. The sorption of MB dye at optimum pH 6 has 93.93 % removal with CWAC adsorbent while 92.9% obtained at pH 4 for MCWAC. Langmuir and Freundlich adsorption isotherm were used to explain the phenomena of adsorption. The Langmuir isotherm describes the experimental data better than Freundlich isotherm and the reaction followed pseudo second order kinetics

Keywords: Nanocomposite, Adsorption, Activated carbon, Cationic dye, adsorbent

1. INTRODUCTION

Nowadays there is a continuously increasing worldwide concern for the development of wastewater treatment technologies. The disposal of industrial effluents without proper treatment is a big challenge and has caused harm to the aquatic environment.

Among the different pollutants of aquatic ecosystem, dyes are a major group of chemicals (Mohd, *et al*., 2013; Sivamaniand Leena, 2009). The removal of dyes from water can be done using physical and/or chemical methods, such as coagulation and flocculation, membrane separation,

electrochemical removal, and photochemical degradation (Vikas, *et al*., 2013). However, for the developing countries, these methods are still too expensive to be used widely so that, an efficient, cost effective and environment friendly method like adsorption should be used. Now days the most widely used adsorbent for the removal of pollutants from water is activated carbon. Activated carbon (AC) is the carbonaceous material which plays an important role in adsorption process (Deshuai, *et al.,* 2013). Although, the commercially available activated carbon is expensive and may not be economical, its preparation and effective utilization from natural plant materials have attracted worldwide attention (Zhantao, *et al*., 2015).

However, active carbon is generally difficult to separate from aqueous solutions. One approach to solve this problem has been to incorporate magnetic particles. Because of their high adsorption capacity and easily to separate after adsorption, in recent year, many researchers and scientists are concentrating on modified agricultural waste adsorbent with magnetic nanoparticles for magnetic separation (Lina, *et al.,* 2012). The main objectives of this study was to synthesis Magnetic Nano Composite adsorbents by Co-precipitation methods and investigate the potential of the nano-composite in removing cationic dyes from waste water.

2. MATERIALS AND METHODS
2.1. Preparation of Chat Waste Activated Carbon (CWAC)

The CWAC was prepared by modifying the method of (Santhi, *et al*., 2011). The CW used for the preparation of the AC was collected around Dilla town. It was thoroughly washed with tape water to remove dirt's and left to dry in sun light. The dried material was then milled using food milling machine and sieved by manually shaking stainless steel mesh screens with the opening of standard 250 μm. For the production of AC the dried CW

powder treated with 98% H_2SO_4 in 1:1 ratio and kept overnight at room temperature. The acid treated sample washed several times with distilled water until it attains pH 7 and finally soaked in 2% $NaHCO_3$ solution overnight. The soaked sample washed with distilled water until pH 7 and dried at 110 ^0C for six hours in oven. The dried carbon then transferred to the muffle furnace and calcined at 400 ^0C for one hour. After one hour the sample was removed from the

furnace, cooled in dessicator, crushed in to powder, sieved and sealed in plastic bag and

preserved in desiccator.

2.2. THE SYNTHESIS OF NANO-COMPOSITE

The Magnetic Chat Waste Activated Carbon (MCWAC) nano composite was prepared by modifying the method reported by (Mutasim, 2015). A 30.455 g of anhydrous $Fe(NO_3)_3.9H_2O$ was completely dissolved in 150 mL distilled water to prepare aqueous solution "A". Further 5.533 g of potassium iodide dissolved in 50.0 mL of distilled water to prepare aqueous solution "B", solutions "A" and "B" were mixed in 500 mL Pyrex beaker at room temperature, stirred and allowed to reach equilibrium for one hour. After one hour the iodine precipitate was filtered out using whattman filter paper № 1. After adding 15 g of

CWAC to the filtrate the suspensions were stirred at 200 rpm for one hour using magnetic stirrer and heated to 80 ^{0}C using a hot plate magnetic stirrer on adding 25% ammonia solution drop-wise with continuous stirring until complete precipitation achieved at pH 10-11. The set up then left to settle at ambient temperature overnight, filtered, washed several times with distilled water, and dried at 250 ^{0}C in muffle furnace. The dried composite were cooled and its magnetic properties was verified using a permanent magnet. The samples were kept in air tight PVC based containers and stored in a desiccator.

2.3. Adsorbate Preparation

Cationic basic dye, methylene blue (MB) obtained from research laboratory was used as the adsorbate in this study, and used without any purification. The stock solution was prepared by dissolving 1 g of dye in 1L distilled water. MB dye chemical formula,

$C_{16}H_{18}N_3ClS$ and its molecular weight of 319.85. The pH of initial dye solution can be adjusted by the drop wise addition of 0.1 M HCland 0.1 M NaOH and measured using a pH meter. All chemicals used were of analytical reagent grade.

2.4. Adsorption studies

For both adsorbents the batch adsorption studies were conducted in 250 mL Erlenmeyer flasks containing adsorbent dose of (0.01-0.5g) and 100 mL dye solutions

with various initial concentrations. The flasks were agitated in a shaker at 200 rpm and 25±2°C and samples were taken at different time intervals until the equilibrium

reached. The experimental data was analyzed for equilibrium and kinetic studies where the effects of initial concentration of MB (10, 20, 30, 40 and 50 mg/L), agitation time (10-50 min), pH of the solution (2–10).The samples withdrawn were centrifuged for 10 min at 3000 rpm. The dye concentrationbefore and after adsorption were determined using UV–Vis spectrophotometer (Shimadzu UV-2000, Japan) at wavelength 663 nm. All experiments were performedin duplicates. MB uptake at time t, q_t(mg/g),and at equilibrium, q_e (mg/g), was calculated by the following equation:

$$q_e = [(C_o - C_e) \ V/M] \ x \ 100 \ \text{---------} \ (1)$$

$$q_t = [(C_o - C_t) \ V/M] \ x \ 100 \text{--------} \ (2)$$

Where C_o, C_e and C_t (mg/L) are the initial, equilibrium and concentration at time t of dye, respectively, V (L) is the volume of the solution, and M (g) is the mass of adsorbent used. The percentage removal of MB was calculated as:

$$\% \ RMB = [(C_o - C_e) \ / \ C_o] \ x \ 100 \ \text{---------} \ (3)$$

3. RESULTS AND DISCUSSIONS
3.1. Fourier Transform Infrared (FT-IR) Spectra

The FT-IR in the range of 4000–400 cm^{-1} was used to identify the functional groups on CWAC and MCWAC. The peaks at 3400 cm^{-1}, 2850-2920 $cm^{-1}$for CWAC associated to hydroxyl and aliphatic($-CH_2$-) groups respectively (Roshanak,*et al*., 2013), peaks at 1650, 1540, 1450, 1420,1250 and 1160 cm^{-1} which may be assigned to the unsaturated groups like alkene, amide, CH deformation, OH deformation, aromaticity and OH stretch, respectively (Solomon, *et al*., 2010). For MCWAC wave numbers assigned to the spinel structures were in the ranges of 800-400 cm^{-1}. Fe-O stretching of magnetite observed at 578 and 628 cm^{-1} (Ayman, *et al.,* 2014). The appearance of broad bands at 3450 and 1630 are attributed to OH and COOH stretching and indicated the functionalization of magnetite nanoparticles with the carboxylic or hydroxyl groups (Ramesh, *et al*., 2014).
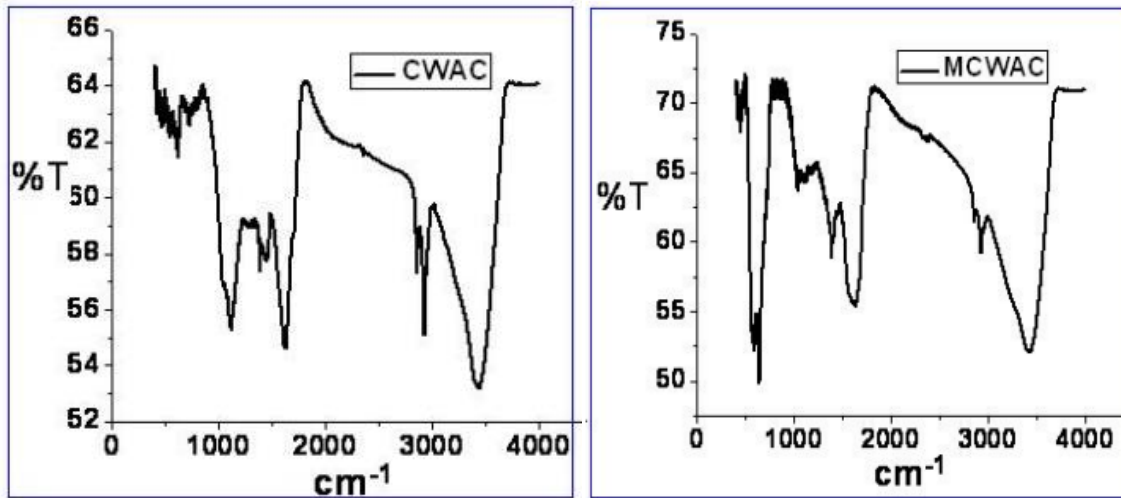
Figure: 1 The FT-IR spectra's of CWAC and MCWAC

3.2. PH AT POINT OF ZERO CHARGE (PH$_{PZC}$)

The pH$_{PZC}$ corresponds to the pH value at which the surface of the solid is considered to be neutral (Doke, *et al.,* 2013). The pH$_{PZC}$ is the point where the curve pH$_i$ vs pH$_f$ intersects the straight line corresponding to pH $_{initial}$ = pH $_{final}$ (Sunil and Arti, 2012). The pH$_{PZC}$ result indicated the surface of MCWAC was more acidic (pH$_{PZC}$ = 3.53) than CWAC (pH$_{PZC}$ = 5.46). The lower pH$_{PZC}$ value made MCWAC to be more suitable for the removal of MB from water (Irfan, *et al.,* 2015). The lower pH$_{PZC}$ value of the composite was likely caused by surface coverage with magnetite and the oxidation of carbon surfaces due to the ferric nitrate added at the initial stage of magnetizing process (David, *et al.,* 2014).
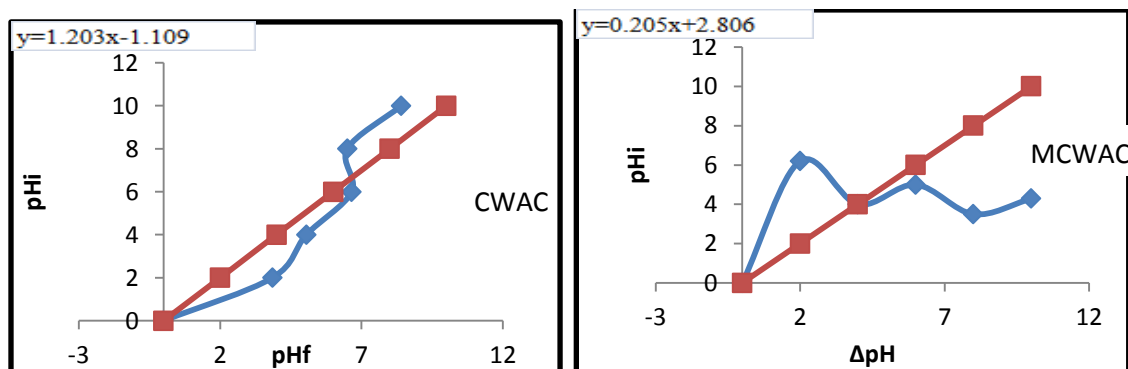
Figure: 2 the pH$_{PZC}$ of CWAC and MCWAC

At pH values below pH_{ZPC}, the MCWAC surface is positively charged while at pH above pH_{PZC} the surface is negatively charged (Gamal, *et al.,* 2014). At lower pH values (pH < pH_{PZC}) the surface of MCWAC undergoes surface protonation due to the frequent interaction and accumulation of H^+ ions from the bulk, which have the tendency to surround the surface. However; at alkaline pH, the surface was found to be negatively charged. The trend in pH_{ZPC} values obtained for both the CWAC and MCWAC in this work is in close agreement with (Irfan*et al*., 2015).

3.3. X-RAY DIFFRACTION PEAKS (XRD)

The characteristic peaks on the pattern of MCWAC at 2θ values 30.205º, 35.515º, 57.215º, 62.945º were corresponding to (220), (311), (511) and (440) crystal planes having a characteristic cubic spinel structure of Fe_3O_4 (JCPDS file PDF no.65-3107). In addition the peaks at 2θ value of 30.2^o, 35.5^o and 62.9^o corresponded to (220), (311) and (511) planes which emphasized the presence of magnetite Fe_3O_4 with a spinal cubic crystal system and using Sheeree's equation the average crystalline size of MIONPs calculated and found 12.77 nm. A similar work was reported by (Kakavandi, *et al*., 2013).The XRD pattern of CWAC showed amorphous in the 2θ range (10° -30°) and crystalline phase which is typical of the graphite at 2θ values 45° , 65° , 77° corresponded to (101), (004) and (110) graphite planes associated with crystalline state. The additional peaks observed in MCWAC patterns at higher 2θ might due to the mixed phases of Fe3O4 & that of CWAC.
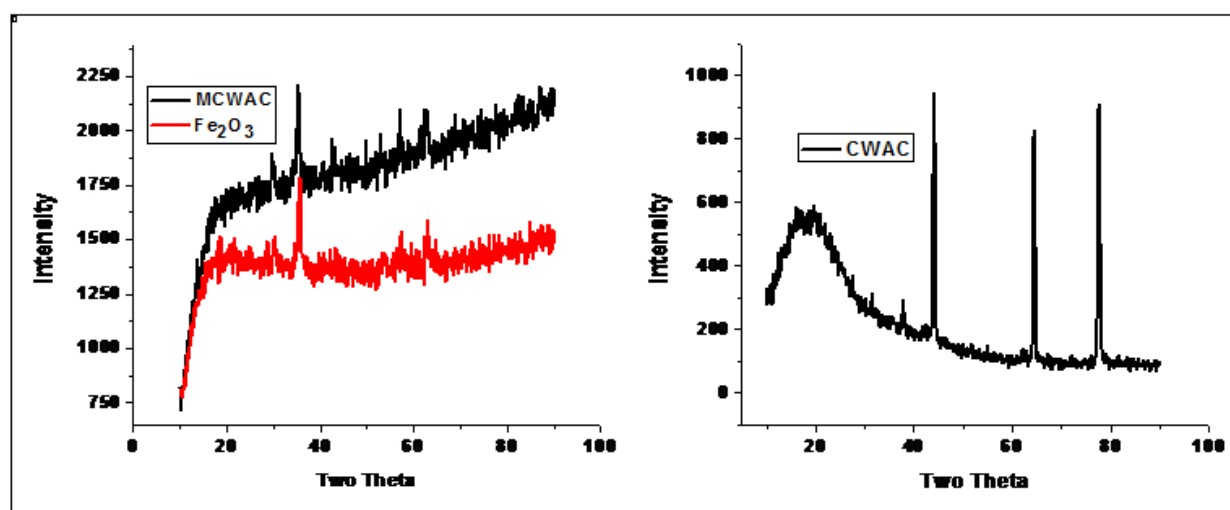
Figure 3: the XRD spectrum of MCWAC, Fe_3O_4 NPs and CWAC.

3.4. THE SCANNING ELECTRON MICROSCOPY (SEM)

The morphology, porosity and texture of MIONPs, CWAC and MCWAC samples were investigated using scanning SEM at 20 Kev. Figure 4a illustrates the SEM images of CWAC at 10000 and 20000 times showed regular shape, grain and pores network with different sizes.
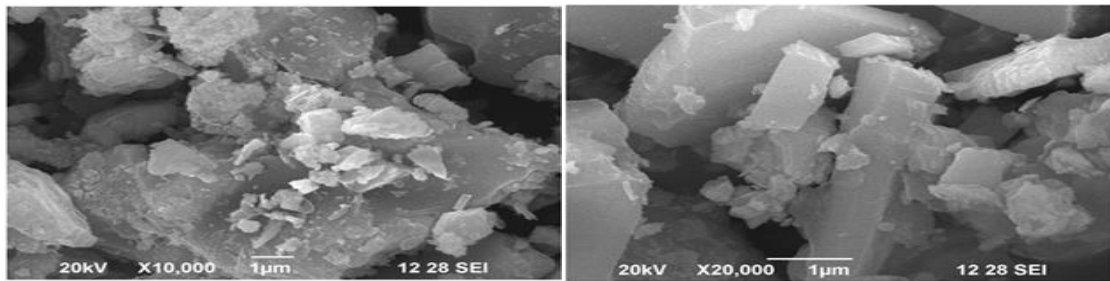
Figure 4a: SEM images of CWAC at different magnifications.

The surface of the Nano composite was found as rough and porous in nature (Figure 4b) in that the Nano composite have improved adsorption capacity. The electron micrograph of the composite sample showed deposition of iron oxide on the surface of the grains of activated carbon and inside the porous structure during the co-precipitation reaction.
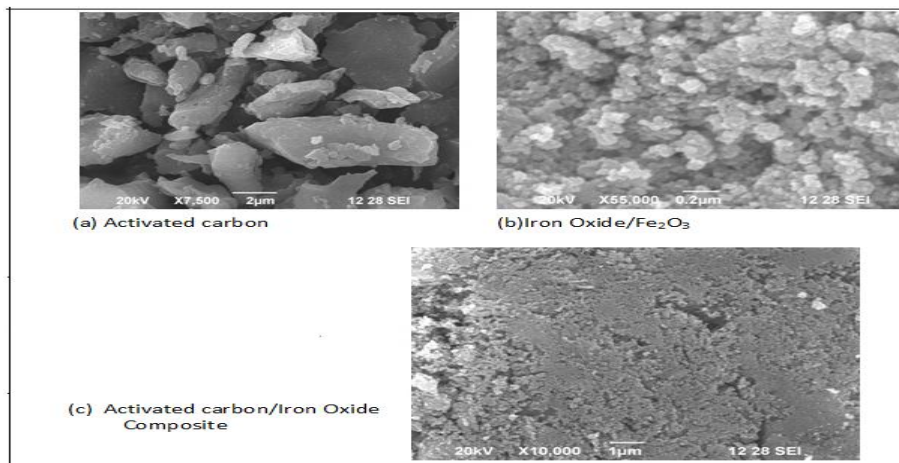
Figure 4b: SEM image of CWAC, Fe_3O_4 NPs and MCWAC.

3.5. Batch adsorption experiments

3.5.1. Effect of initial concentration and agitation time on adsorption.

The amount of MB adsorbed onto the CWAC and MCWAC increases with time and it reaches a constant value beyond

which no more MB removed from solution (Figure 6 and 7). At higher initial concentration, the number of interacting adsorbate molecules is higher. However, after certain period of time equilibrium was established between the rate of adsorption and rate of desorption and there was no further net adsorption. At equilibrium the adsorption capacity of CWAC increases from 2.05 mg/g to 11.11 mg/g for initial dye concentration of 10mg/L and 50 mg/L. Similarly the adsorption capacity of

MCWAC shows an increment from 7.76 mg/g to 47.05 mg/g for 10 mg/L and 50 mg/L of MB concentration respectively. This is because the mass transfer driving force would become larger as the initial concentration increased (Bello, 2010). It is evident that both CWAC and MCWAC were efficient in adsorbing the MB dye from aqueous solution however; the modified carbon showed higher adsorption capacity which is more than four times efficient than CWAC.
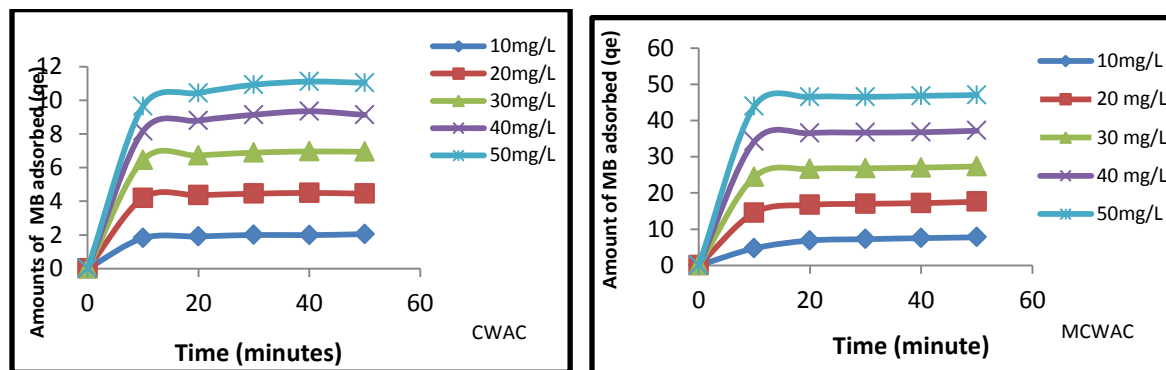
Figure 6: Effect of contact time and dye initial concentration on adsorption of MB dye on CWACadsorbent dose 0.1 g/100 mL, pH 4 and agitation speed, 200 rpm.

3.5.2. Effect of pH on MB adsorption

Generally, the trend in dye removal efficiency by an adsorbent can be explained on the basis of (pH_{ZPC}) of the adsorbents and

the nature of the dye molecules either anionic or cationic groups (Irfan,*et al*., 2015).
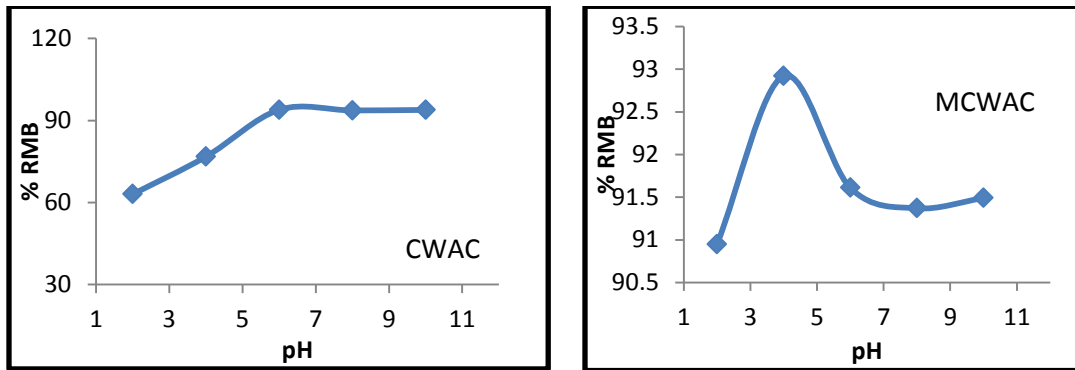
Figure 7: Effect of pH on %RMB (adsorbent dose 0.4 g/100 mL, CWAC and MCWAC MB dye concentration, 40 mg/L and 200 rpm).

The dye adsorption were examined in the pH range of 2–10 and the results indicated that %RMB over CWAC increased from 63.05 to 93.88 upon changing the pH from 2 to 10 and the optimum pH observed at pH 6, where % RMB = 93.93. Likewise the maximum % RMB over MCWAC was recorded at pH 4, where % RMB= 92.92. These substantial increases in the %RMB can be well described on the basis of pH_{PZC}. Below pH_{PZC}, the surface of MCWAC and CWAC becomes positively charged which results in a competition between the H^+ ions and $[C_{16}H_{18}N_3S]^+$ to reach the surface. Eventually, the active sites on the adsorbents surface surrounded mostly by the H^+ ions and to some extent by $[C_{16}H_{18}N_3S]^+$. The H^+ ions will limit the interaction between $[C_{16}H_{18}N_3S]^+$ and the surface of the MCWAC and CWAC creating a repulsive force that hinders the contact of $[C_{16}H_{18}N_3S]^+$ to the surface and contribute to the small amount of MB adsorbed (Nashaat and Rings red, 2011). On the other hand at (pH > pHzpc) there was deprotonation on MCWAC and CWAC surfaces and the surface becoming negatively charged with high attractive properties leads to an increase in the surface diffusion as a result of high electrostatic attractions between $[C_{16}H_{18}N_3S]^+$ and the negatively charged surfaces of the adsorbents (Fangwen,*et al.,* 2009). The result indicated that the removal of MB dye was based on the surface charge density of CWAC and MCWAC adsorbents.

3.5.3. Effect of adsorbent dosage

The percentage of dye adsorption increased with increasing adsorbent dosage. The reason behind is that, as the adsorbent dosage increases, the surface area of the

adsorbent will be increased and more adsorption sites were available to adsorb the dye from aqueous solution (Solomon, *et al.,* 2014). At optimum conditions the % RMB over CWAC increased from 82.6 to 94.5% with an increase in adsorbent dosage from 0.1g to 0.4 g at pH 6, the % RMB over MCWAC increases from 92 to 93.8 with an

increased in adsorbent dosage from 0.02 to 0.1 at pH 4. Moreover; a 0.1 g of MCWAC have the same removal capacity with a 0.4 g CWAC, the reason behind might be the MCWAC have more adsorption sites on the surfaces of iron oxide nano particles& activated carbon in the composite.
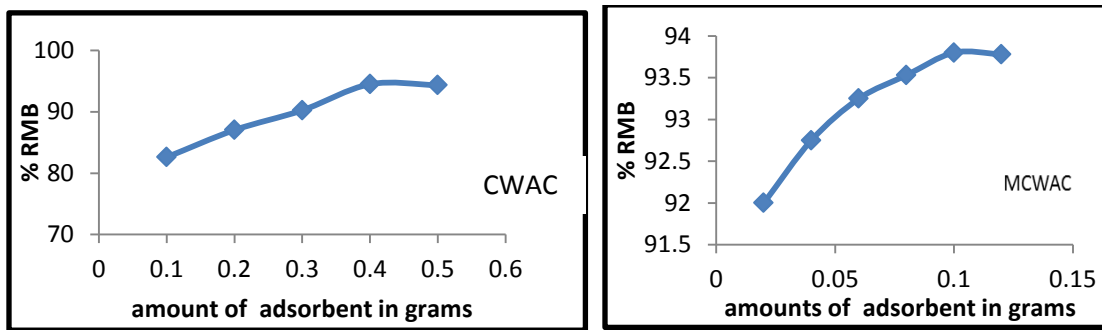
Figure 9: Effect of adsorbent dosage at constantMB concentration (40 mg/L) CWAC, pH= 6 and MCWAC, pH= 4 agitation speed, 200 rpm.

3.6. Adsorption Isotherms
3.6.1. The Langmuir isotherm model

Adsorption Isotherms is based on the formation of homogeneous monolayer coverage on the adsorbent surface (Karti, *et al.,* 2014).The linear form of Langmuir equation can be expressed as:

$$1/q_e = 1/C_e Q_m K_L + 1/Q_m \quad ....(4)$$

Where K_L (L/mg) is a direct measure of the intensity of the sorption, Q_m (mg/g) is a constant reflecting the maximum adsorption capacity. For both CWAC and MCWAC adsorbents the plots of $1/q_e$ versus $1/C_e$ were

linear showing the applicability of Langmuir adsorption isotherm. Q_m and K_L were calculated from slope and intercept of the plot $1/q_e$ vs $1/C_e$.
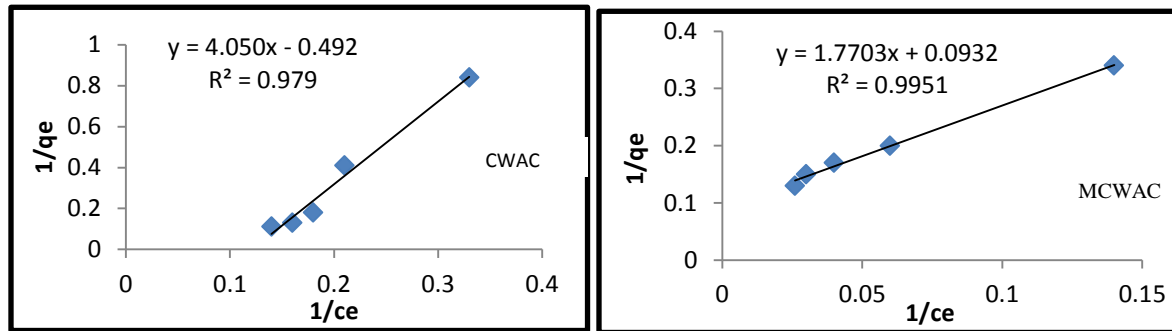
Figure 10: Langmuir adsorption isotherm of MB on to CWAC and MCWAC at room temperature.

For concentration ranges of 10-50 mg/L, the Q_m values were 2.033 and 10.75 for CWAC and MCWAC respectively and the calculated K_L values were 0.121 and 0.053 for CWAC and MCWAC respectively indicated that the adsorption efficiency of the two adsorbents were good. In addition the correlation coefficient $R^2 = 0.979$ and $R^2 = 0.995$ for CWAC and MCWAC respectively showed the linearity of the model where the R_L values for CWAC

decreases from 0.452 to 0.142 for the initial concentration of MB dye from 10 mg/L to 50 mg/L. A similar trend was observed for MCWAC in which the R_L values decreases from 0.656 to 0.276 for the initial concentration of MB. This confirmed that the adsorption process is favorable at higher dye concentration and the Langmuir isotherm model indicates the homogeneous nature of both CWAC and MCWAC surfaces (Doke, 2013).

3.6.2 The Freundlich adsorption isotherm

It is an empirical equation used for non-ideal sorption (Haza and Hussein, 2015) assuming the adsorbent has a heterogeneous surface composed of adsorption sites with different adsorption potentials.

$$Log\ q_e = Log\ K_F + 1/n\ Log\ C_e\ \text{----------- (5)}$$

Where q_e (mg/g) and C_e (mg/L) are defined as the amount of dye adsorbed per unit weight of adsorbent and equilibrium liquid phase concentration respectively.

Table 1 The Langmuir and Freundlich parameters for the removal of MB.

CWAC						MCWAC					
Langmuir			Freundlich			Freundlich			Langmuir		
Q_m	K_L	R^2	K_F	n	R^2	Q_m	K_L	R^2	K_F	n	R^2
2.033	0.121	0.979	0.069	0.402	0.962	10.75	0.053	0.995	0.977	0.544	0.996

The values of 1/n and K_F were calculated from the slope and intercept respectively. Moreover, the applicability of the linear form of Freundlich model for adsorption of MB over CWAC and MCWAC confirmed by the high correlation coefficient R^2 suggested that Freundlich models provide good model of the sorption system but the value 1/n is greater than one indicating that the model is not best fitted.
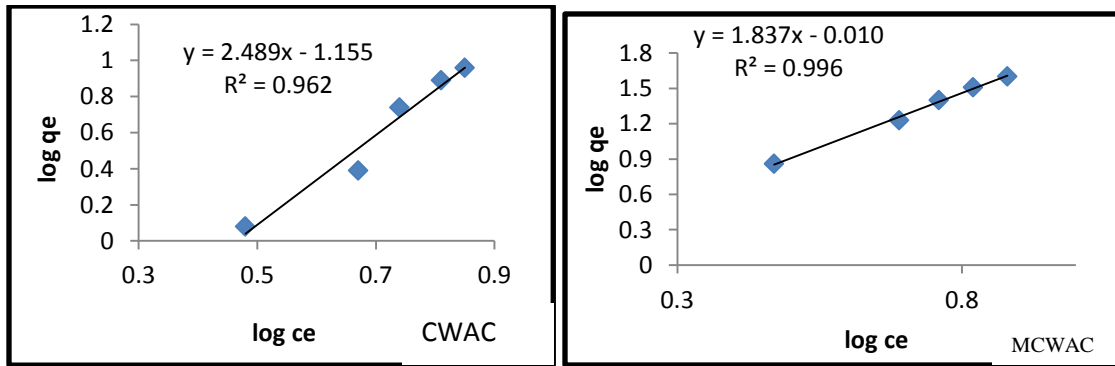
Figure 11: Freundlich adsorption isotherm for MB on to CWAC and MCWAC.

3.7. Kinetics of Adsorption

3.7.1. The pseudo second-order kinetics

The adsorption mechanism over a complete range of the contact time is explained by the pseudo second order kinetic model (Mahdavinia, *et al*., 2012).

$$t/q_t = 1/k_2(q_{e, exp})^2 \ + \ t/q_{e, cal} \ \text{------------} (6)$$

Where q_e (exp) is the amount of adsorbate adsorbed per unit mass of adsorbent at equilibrium (mg/g), q_t is the amount of adsorbate adsorbed at contact time t (mg/g), k_2 is the pseudo-second order rate constant (min^{-1}). q_e exp and k_2 were determined from the slope and intercept respectively.
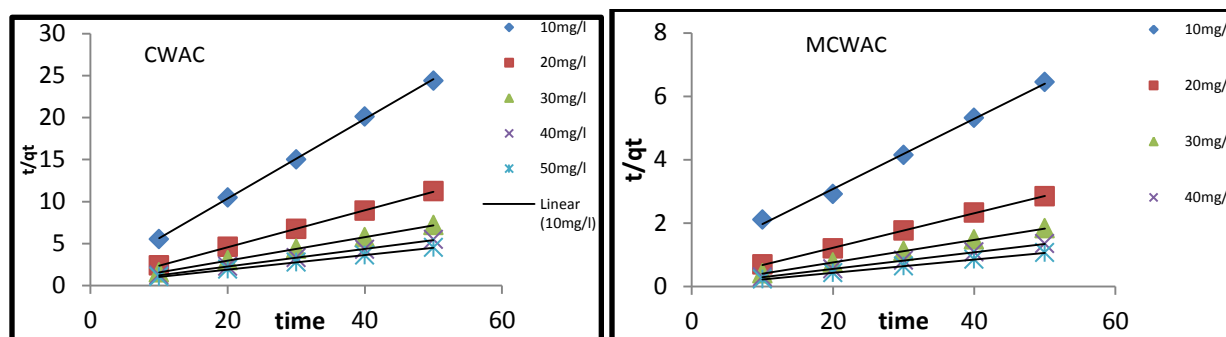
Figure 12: Pseudo second-order kinetics of MB adsorption onto CWAC and MCWAC adsorbent.

The correlation coefficient values, R^2 for the second-order kinetic model were larger than 0.987. Moreover, the calculated $q_{e, cal}$ values agreed with the experimental $q_{e, exp}$ values indicated that the adsorption of MB on CWAC and MCWAC were more appropriately followed the pseudo-second ordermodel.

Table 2: Results of kinetic plots for the adsorption of MB onto CWAC and MCWAC obtained at different initial MB concentration.

	Pseudo First Order (PFO)							
	CWAC				MCWAC			
Co mg/l	$q_{e_{exp}}$ Mg/g	$q_{e_{cal}}$ mg/g	K_2/min	R^2	$q_{e_{exp}}$ mg/g	$q_{e_{cal}}$ mg/g	K_2 min^{-1}	R^2
10	1.75	1.67	0.12	0.872	7.2	1.297	0.107	0.003
20	3.83	0.58	0.045	0.715	17	0.629	0.059	0.054
30	6.13	1.084	0.083	0.794	25.12	0.8	0.083	0.963
40	8.37	2.11	0.24	0.676	33.23	0.469	0.094	0.636
50	10.73	1.967	0.22	0.739	42.4	0.199	0.095	0.637

Table 3: Results of kinetic plots for the adsorption of MB onto CWAC and MCWAC obtained at different initial MB concentration.

	Pseudo Second Order (PSO)							
	CWAC				MCWAC			
Co mg/l	$q_{e_{exp}}$ Mg/g	$q_{e_{cal}}$ mg/g	K_2/min	R^2	$q_{e_{exp}}$ mg/g	$q_{e_{cal}}$ mg/g	K_2 min^{-1}	R^2
10	2	2.1	0.369	0.999	7.2	8.92	0.023	0.995
20	4	4.5	0.4	0.999	17	18.2	0.027	0.999
30	6.13	7.11	0.18	0.999	25.12	27.6	0.046	0.999
40	8.37	9.48	0.094	0.998	32.23	37.6	0.040	0.999
50	11	11.6	0.048	0.999	42.4	47.4	0.037	0.999

4. CONCLUSIONS

The activated carbon prepared from chat waste by chemical method of activation using 98% H_2SO_4 as an activator and modified with Fe_3O_4 to form magnetized chat waste nano composite has better removal efficiency at lower dose. The pH pzc study indicates the surface charge density of CWAC drastically decreased from 5.46 to 3.53, as a result of surface oxidation and Fe_3O_4 impregnation, which is crucial for the significantly higher uptake of cationic dye (MB) from the aqueous system. The SEM studies revealed the better morphology of the modified adsorbent by magnetic iron oxide.

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PREDIT the Compressive Strength & Quality   of Portland Pozzolana Cement

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Abstract

The objective of current work is to study physical and chemical parameters of commercially available cements and enhance the quality of selected feeble quality cement. The chief quality parameter chosen here is analysis of compressive strength of 1,3,7 and 28 days. Commercially available cements from market were procured and analyzed for physical and chemical parameters, as per Bureau of Indian Standard norms. A maximum of 50 different brands of cement samples were procured for analysis, with in a period of six months. Chemical constituents studied include Loss on Ignition, Insoluble Residue, and Sulphur Anhydride, where as physical constituents studied include D_{10}, and D_{50} particles. The data generated is analyzed using JMP software, to find the significant parameter responsible for quality of cement. An equation predicting the compressive strength of cement had been established and the percentage error was justified within the norms. A range of D_{10} and D_{50} particles have been identified, which are responsible for quality of cement and important conclusions are drawn.

Keywords -- *Cement quality, particle characterization, particle size distribution, cement quality prediction,Chemical constituents.*

1. INTRODUCTION

Ordinary Portland Cement (OPC) is commonly used as a best means of cementing material for construction, with different grades including 33, 43 and 53 grades, available in the market as per Bureau of Indian Standards [1]. OPC consists of calcium silicates, aluminates, and iron. Calcium carbonate is first dissociated at around $900^{o}C$ to produce calcium oxide and carbon dioxide, further it is heated at around $1400^{o}C$ and made to react with silica, alumina and iron, to form small pebbles called clinker, which is then grinded to approximately 100 micrometer size to produce OPC cement. An amount of approximately 5% gypsum is added to retard setting time, which serves as a buffer time during construction.

Portland Pozzolana Cement (PPC) is produced by mixing a maximum of 35% [2] of fly ash in

OPC cement. Fly ash is produced at thermal power stations as a waste material, when huge volumes of coal are burnt in boilers. The flu gas is made to pass through electrostatic precipitators, and the fine dust (fly ash) is collected. Fly ash consists of silica, calcium oxide, and traces of alumina as well as iron, which is cementing compatible material. The present line of work is to replace fly ash with granite waste, in OPC cement. Earlier fly ash was considered as waste and was used for land filling, similarly granite waste, is presently used in land filling.

Grounded flyash blended with ordinary Portland cement found to yield good compressive strength in comparison to blending of ordinary fly ash [3], it has also been reported in the literature that the porosity of cement mixture decreases upon addition of classified fly ash. The compressive strength of cement can be enhanced to high strength cement (HSC)by adding 30-40 % of ultra fine cement to Normal Use Portland Cement (NUPC)[4] The compressive strength of cement depends on the kind of medium and its temperature provided for cooling [5] Fine particle distribution has been found to have high early strength, where as high surface area found to have relative higher strengths in all

days of curing [6]. Compressive strength of cement can be increased by a selected portion of particles and adjusting with – 32, and -20 micron particles to which modifies the surface area of the cement intern the compressive strength of cement [7] The quality of cement can also be increased by selecting a particular particle size distribution in Pozzolana Portland Cement, by using fly ash upto 35% [8].

2. MATERIALS AND METHODS

A. Materials

Cement Samples: 50different brands of cement samples were procured from market and are subject to complete testing of physical properties like D10, D50 and D90 particless and were estimated using **Rosin**- **Rammler and Kozeny Caraman** equations.

Chemical analysis of samples include Insoluble Residue, Sulfur Anhydride, Loss on Ignition has been done as per the norms of Beuro of Indian Standards.

B *Aggregates*

Aggregates are prepared with reference to the BIS standards by mixing laboratory grade sand (supplied by Tamilanadu minerals Ltd, Innore, Chennai) cement and water, in the ratio of 3:1 (sand: cement-granite mix -mass

basis), water is added based on the normal consistency. These composites are thoroughly mixed in pony mixer for 2 minutes, poured into standard mould of 7.5 x 7.5 x 7.5 cm, then subjected to compression in vibrating machine for 2 minutes, and then kept in humidity chamber for 24 hours, maintaining 27 degree centigrade. The specimens are then taken out and cured for 1, 3, 7, and 28 days in curing chambers of same temperature.

C. Laboratory Test

1. Compressive Strength: Specimen cubes are subjected to compressive strength test in the standard compressive strength machine, supplied by AIMIL, New Delhi.

2. All the blended samples were analyzed as per Bureau of Indian Standard norms

3. DEVELOPMENT OF THEORETICAL MODEL

Different cement samples were tested physically and chemically and it is tried to develop the equations for 1day, 3 days, 7 days and 28 days strengths and setting times of the samples.

JMP software was used to develop the equation. JMP is statistical discovery software, to perform simple and complex statistical analyses. It dynamically links statistics with graph's to interactively explore, understand, and visualize data. To establish the relation, some samples were excluded those having large deviation amongst all. JMP provides a comprehensive set of statistical tools as well as Design of Experiments and Statistical Quality Control in a single package

The equations are developed for compressive strength of 1,3,7 and 28 days for the physical parameters D10, D50 and D90 particles, and chemical parameters LOI, IR, SO_3.

A) Procedure

In JMP software at first, all the results were enrolled and a least square model was used to fit the data with a suitable R^2 value. R^2 indicates sum of the squares of residuals. A residual is a difference between actual and predicted value. For a best fit R^2 should be closed to 1. The data was compiled and the R^2 value was found to be close to 1.

The significant properties for different day's strengths and setting times were determined based on leverage plots. A plot that compares residuals from these models is called a leverage plot. If the probability value (p) from

a leverage plot was greater than 0.05 then the property said to be not significant. This same significance can also be decided by the solid straight line in the graph. The property was not significant if the line was horizontal.

4. RESULTS AND DISCUSSION

The compressive strength is increasing as the number of days of curing increases, in line with the established research [9,10]

Table 1: Experimental results of physical and chemical analysis of different samples

Code	LOI (%)	SO3 (%)	IR (%)	D10	D50	D90	Compressive Strength			
							1 Day	3 Day	7 Day	28 Day
1	2.4	1.1	30.4	2.8	17	59	11.3	28.3	37.9	53.38
2	1.6	1.79	27	2.95	19	63	9.65	29.02	37.69	60.73
3	1	2.95	33.5	2.9	17.5	58	10.74	28.82	47.09	66.52
4	2	1.99	23.8	2.5	15	50	10.41	34.23	47.9	65.73
5	2	2.34	27	2.9	17.5	55	8.92	25.98	35.79	60.6
6	4.1	2.15	18.2	2.5	14	46	11.36	41.75	50	67.62
7	3.2	1.57	38.9	2.2	14	45	20.6	34.91	48.72	71.16
8	1.4	2.90	31.3	2.2	13	44	13.9	31.66	42.01	56.22
9	1.5	1.78	31.5	2.8	14	45.2	17.46	34.23	44.52	60.56
10	2.5	2.02	34.5	2.8	14	45	11.46	25.1	35.86	46.95
11	2.3	1.82	34.9	2.8	15	45	18.25	32.68	42.35	53.45
12	3	0.45	21.5	2.9	17	50	17.25	35.79	48.58	54.87
13	3	2.98	19.6	2.5	14	45	17.15	35.65	45.26	54.06
14	2.9	1.99	23.3	3.1	20.1	65	8.83	22.32	32	47.58
15	1.2	2.06	23	4	23	75	14.91	33.22	49.19	62.75

16	3	1.92	36.1	3.2	22	69	12.17	26.38	34.78	49.93
17	2.2	2.92	23.1	3.2	22	69	11.77	26.38	35.76	52.4
18	1.5	2.54	30.6	2.5	12.5	43	15.52	33.89	46.48	61.23
19	1.5	1.78	18.2	2.9	17.5	60	17.05	38.49	49.83	61.71
20	2.6	1.7	30	2.9	17	58	10.1	28.55	33.15	46.89
21	2.3	2.7	24.4	3	17.5	63	9.33	27.06	38.49	55.82
22	2.9	1.5	19	2.9	17.5	62	12.07	33.49	43.1	55.05
23	2.2	1.9	26.9	2.95	16.5	50	17.86	32.2	41.74	61.57
24	3	2.3	20.1	2.9	17.5	60	16.54	33.26	40.79	52.23
25	2.9	2.0	24	3.9	22.5	74	7.74	24.69	30.65	46.48
26	1.2	2.0	28	3.9	22	70	7.66	23	26.85	45.6
27	1.5	1.5	20.6	3.9	22.5	74	10.83	25.84	33.02	45.87
28	2.4	1.9	24.8	3.2	20.1	64	10.18	26.45	31.86	48.72
29	1.8	2.5	22.5	3.9	22.5	74	9.87	31.46	42.08	58.32
30	2.3	1.8	31.9	3.5	19	63	10.59	24.66	34.18	51.5
31	2.7	2.7	27	2.5	15	46	10.26	24.27	32.86	52.8
32	2	2.3	31.5	2.5	16	55	15.63	31.12	42.14	57.4
33	1.4	1.5	19.77	2.5	14	45.2	16.13	37.59	46.20	54.8
34	2.1	2.0	28.1	2.5	18	55	15.79	30.96	41.22	61.6
35	3	2.3	23	2.9	18	59	9.75	26.86	39.92	55.8
36	2.3	1.6	24.4	2.8	18.5	5.7	8.80	24.46	37.67	48.3
37	1.8	2.0	30.9	3.2	20	63	11.13	27.49	34.23	49.5
38	2.3	2.1	27.2	3	18	59	11.37	27.18	36.21	50.3
39	2	2.7	22.8	3	18	62	8.52	23.52	32.69	60.6
40	2.3	1.65	19	3	17.5	54	14.51	27.87	37.88	50.3
41	3	2	21.7	2.9	17.4	57	10.86	25.41	33.62	53.4
42	1.9	1.84	23.4	3.9	22.5	73	9.70	19.88	31.56	54.1

43	2.4	2.11	15	3.8	54	73	15.83	30.24	38.70	57.6
44	2.5	2	15.5	3.1	17.5	62	23.43	41.54	51.49	62.5
45	2.9	2.12	27.5	33	20	63.1	19.00	27.90	39.71	60.5
46	1.9	1.84	31.3	4	24	75	13.29	28.14	39.11	54.9
47	3.2	2.1	22.1	5	30	91	8.47	22.39	34.57	55.6
48	2.1	2.5	24.6	4	22.5	75	9.51	25.84	32.58	47.8
49	1.8	2	7.4	3.2	20	63	10.11	22.32	30.51	55.3
50	2.4	2	23.4	4	22.5	23	10.17	25.91	37.89	55.5

strength for 1 Day

The data has been compiled JMP software, and the actual by predicted plot and it is shown in figure 1.
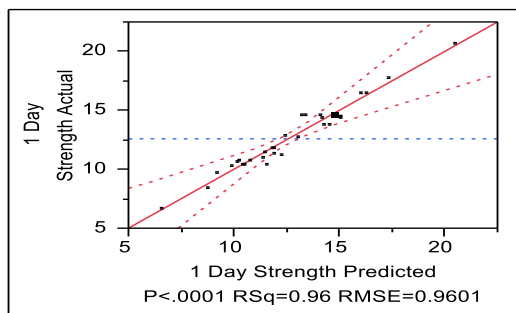
Figure1: Actual vs Predicted compressive

The above actual by predicted plot was plotted for Experimental 1 Day Strength results versus Predicted results. The 45° Line from the passing from the origin shows where the actual and predicted responses are equal. The horizontal dashed line indicates the mean. Based on the 'actual by predicted plot' samples with large deviation from the ideal value were excluded and as a result an increment in R^2 value was found. The above figure showing an R^2 Value of 0.96 which makes the regression line looks like a best fit.

Similar kinds of results were obtained for 3, 7 and 28 days compressive strength. Both physical and chemical parameters were analyzed individually as well as inter interaction among physical and chemical constituents. The results indicates Insoluble residue to be significant parameter for all day strengths. Whereas D_{10} particles are significant for 1 day strength, and D_{50} particles are significant for 28 day strength. These results are correlated to 1 day strength and equation obtains is given by equation. The empirical equation for 1 day strength was developed from the above terms & their corresponding coefficients generated in JMP

software. Here the estimates are the coefficients. And the equation was given by

$$1 \text{ Day Strength} = (-2.70682) + (LOI*-0.233302) + (IR*-0.075632) + (SO_3*0.6512243) + (D_{50}*-0.220633) + (D_{10}*19.274218) + ((LOI-2.12469)*(LOI-2.12469)*-0.143687) + ((IR-25.5197)*(IR-25.5197)*0.0312818) + ((SO_3-1.96091)*(SO_3-1.96091)*2.0541681) + ((D_{90}- 23.3858)*(D_{50}-23.3858)*0.0368872) + (((D_{10}-1.03388)*(D_{50}-1.03388)*11434.598) + ((LOI-2.12469)*(IR-25.5197)*0.2072964) + ((LOI-2.12469)*(SO3-1.96091)*3.8933798) + ((LOI-2.12469)*(D_{10}-23.3858)*0.2406089) + ((LOI-2.12469)*(D_{50}-1.03388)*33.409833) + ((IR-25.5197)*(SO3-1.96091)*-0.207013) + ((IR-25.5197)*(D_{90}-23.3858)*-0.066458) + ((IR-25.5197)*(D_{10}-1.03388)*0.1314536) + ((SO3-1.96091)*(D_{50}-23.3858)*-0.470204) + ((SO3-1.96091)*(D_{50}-1.03388)*-237.9762) + ((D_{10}-23.3858)*(D_{10}-1.03388)*55.174802)$$

similar kind of equations were developed using JMP software for 3,7 and 28 days strength. The actual values and values obtained from the equation were compared, and the error found to be maximum of 18 %.
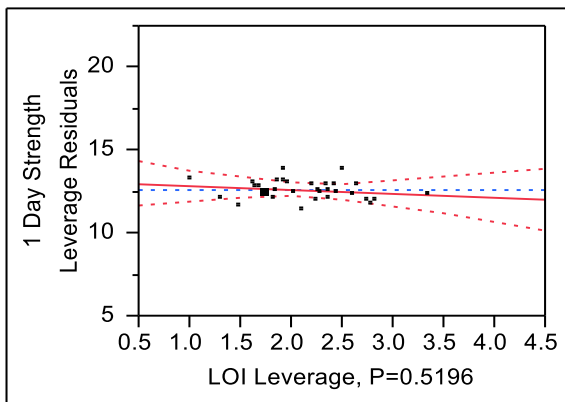
Figure 2: LOI Leverage vs compressive strength for 1 day LR

The above leverage plot plotted for Loss On Ignition for 1 Day Strength. Here the P value was observed as 0.5196. This probability value was very far from 0.05.

Hence it can be concluded that the LOI is not a significant property.

The Solid Straight line also seems horizontal. Hence this can be said that LOI was not a significant property for 1 Day strength of cement.

From Parameter estimate table the coefficient of LOI was found -0.233302. Hence the sign of the coefficient was negative. It is clear that for high strengths less Loss on Ignition can be recommended. (1)
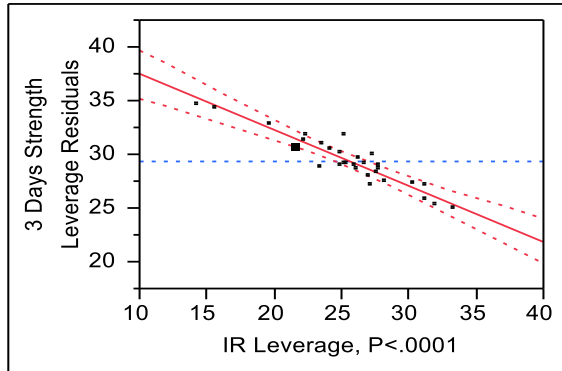
Figure 3: **IR Leverage vs compressive strength for 3 days LR**

Figure. 3 was showing a leverage plot for Insoluble Residue percent in cement. The P (Probability value) from the above plot was found less than 0.0001, as it is less than 0.05, this implies that the Parameter insoluble residue is a significant property.

5. Conclusion

A selected range of D_{10}, D_{50}, and D_{90} particles are found to have good quality. D_{50}, and D_{90} particles are found to be significant in maintaining good compressive strength.

The solid straight line is also observed as very slant and it is clearly saying that this property was a significant property.

From parameter estimates the coefficient was examined as -0.518653. Due to negative sign of coefficient it can be said that as the Insoluble Residue increase strength will decreases.

Similar kind of graphs were generated for all the days of compressive strength including 1,3,7 and 28 days. It has been found that D_{10}, D_{50}, and IR values found to be significant in attaining good quality.

Insoluble Residue and D_{10}, and D_{50} particles are found to be significant in cement quality development. An equation is developed, which will predict the compressive strength of cement based on physical and chemical constituents.

Technology University,Dept.of Chemical Engineering in providing Computer facilities.

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'2

Experimental investigation on the Effect of Straight Jatropha Oil on the Life of Lubricating Oil of Small Diesel Engine Used in Farm Irrigation

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Abstract

Current demand of transport fuel requires exploring every possible plant resource of engine fuel which can deliver satisfactory performance, emission, combustion and engine durability. Straight vegetable oil (SVO) is an alternative fuel of petroleum diesel, and mainly used to reduce the environmental impact of emission without modifying engines. Until now, much of the primary research has focused on process technologies to produce straight vegetable oil as a fuel from different sources such as palm, sunflower, rapeseed and jatrophacurcas. There have also been studies looking at the impact of the use of SVO on exhaust emission, engine performance, and fuel economy and fuel system compatibility. There is limited data on the effect of SVO use on engine lubricant which is necessary to investigate usability of different fuels and their impact on engine hardware and lubricant properties due to oil contamination in combustion engines which may affect the critical components and functions of lubrication necessary to maintain engine performance and useful service life of the engine. This research work presents experimental investigation of the effect of Jatropha straight vegetable oil (JSVO) fuel on the engine lubricant properties and hardware. An endurance test were made according to IS:10000 (Part IX)-1980 for a total 75 hours on two brand new identical Robin DY23-2D air cooled single cylinder diesel engines with two types of fuel (JSVO and diesel fuel) while the engines use the same engine oil SAE 30 according to the manufacturer recommendation. The engine oil samples were drawn at interval of 25 hours and tested with ASTM standard test methods D93, D189, D445, D482, D947, D2270, D2709 and D4052. The test results from the engine oil sample were analyzed for the basic lubricating oil properties (kinematic viscosity, viscosity index, density, carbon residue, water and sediment, total acid number, flash-point and Ash content) and it is found that the variation in these properties not much with JSVO when compared to diesel and the viscosity of oil with JSVO is within the range prescribed for lubrication oil SAE 30. So it can be conclude that usage of JSVO doesn't affect much the lubrication oil and it's possible to use JSVO as a fuel. From the analysis of the wear it is observed that the wear of the parts in combustion chamber are higher for JSVO which is due to high carbon deposits.

Keywords: *Jatropha Straight Vegetable oil, lubrication properties, lubrication characteristic, wear.*

1. INTRODUCTION

Diesel engines are widely used in the transport, electricity generation, agriculture and shaft power etc. These sectors are heavy consumers of petroleum oils which can be partially or totally replaced by vegetable oils and their derivatives which are derived from agriculture and thus of renewable origin. Many studies have been done involving vegetable oils as a primary source of energy. Particularly, during the early 1980's, studies were completed that tested the possibility of using unmodified vegetable oils as a replacement for diesel fuel and there is no question that vegetable oil can be placed in the tank of a diesel powered vehicle and the engine will continue to run and deliver acceptable performance.

Despite the success when diesel engines are operated on vegetable oil for short term performance tests, the real measure of success when using vegetable oil as a diesel fuel extender or replacement depends primarily on the performance of vegetable oils in engines over a long period of time. The viscosity and chemical property differences between SVO and the diesel fuel for which direct inject diesel engines are designed, lead to several issues and the unburned fuel buildup can infiltrate the engine lubrication oil, potentially leading to the engine wear.

The major causes of engine malfunction due to lubricant quality are deposit formation, contamination, oil thickening, oil consumption, ring sticking, corrosion and wear. The environment in which it operates affects lubricant stability. Such factors as temperature, oxidation potential and contamination with water, unburned fuel fragments and corrosive acids limit the useful life of a lubricant. This is the area where additives have made a major contribution in improving the performance characteristics and extending the useful life of lubricants (Wiils,J.G 1980).

During cold start-up and stop-and go regimes in an internal combustion, the non-vaporized fuel condensed on the liner is scrapped by the piston rings and reaches the oil pan where it dilutes the lubricating oil. Some limited engine oil dilution by diesel engine fuel is acceptable and it happens in all diesel engines. But when the engine is fueled by biodiesel, biodiesel blends or SVO, engine oil dilution rates and their effects can be different than those from regular diesel fuel Gili et al (Baranscu,R.AandJ.J Lusco1980). This

study was conducted to compare the wear, carbon deposit and lubrication oil properties of diesel fuelled with JSVO fuelled engine, during the endurance test of 75 hours.1.2 Statement of the problem

Straight vegetable oil (SVO) has been a recurring subject of study as a fuel for compression ignition engines. Rudolph Diesel developed the diesel cycle engine with peanut oil as the original fuel. More recent studies have examined the suitability of various agriculturally derived fuel oils as alternatives to petroleum products. SVO studies generate interest because of the potential benefits, compared to petroleum derived fuels, such as low cost, local production, and carbon-neutrality. Studies have considered a wide range of assessments of fuel quality, including combustion efficiency and emissions.

However, during any engine operation an amount of fuel will always penetrate into the sump and some limited engine oil dilution by diesel engine fuel is acceptable but when the engine is fueled by alternative fuels then engine oil dilution rate and it effects can be different than those from the regular diesel fuel. Hence, using JSVO as a fuel may affect engine oil performance, which is a very important factor regarding engine wear, frictional power loss, engine oil life and durability. Therefore, this research work investigates experimentally the actual impact of JSVO on engine lubricant and engine hardware by conducting a 75 hours test on two new Robin D23-DY engines.

2. MATERIALS AND METHODS

Measuring this experimental based research work, which aims to find the effect of usage of JSVO as a fuel on hardware and lubricating oil properties of a small scale diesel engine which is used for farm irrigation, was conducted. Two brand new engines of exactly same specification, one for diesel and another for JSVO, were used in this work. This chapter gives the details about various materials and standard equipment used and step by step procedure followed in achieving the objectives set.

2.1. Materials

The materials used in this work are listed in the following table

Table 1:List of materials

S/n	Item	QTY	Remark
1	DY23-2D Engines	2	Engine available in workshop
2	Jatropha SVO	23 lit	Available in the workshop. Which was produced by mechanical pressing
3	SAE 30 Engine oil	4 liter	From local market. (Including initial 25 operating hours.)
4	Diesel fuel	35 liter	From local market (Including initial 25 operating hours.)
6	Secondary fuel tank	1	Available in the work shop
7	Control valves	2	Available in the work shop

Characterizations of JSVO and various samples of lubricant were tested in the laboratory of Ethiopian Petroleum Supply Enterprise using ASTM standard. .

Table 2: list of materials used for disassemble and wear measurement

S/n	Name	specification	Remark
1	Open and Box end wrench	10 to 19 mm	
2	Socket wrench	Set	
3	Hammer	2 pcs	small (Ball pin and plastic)
4	Screw drivers	2 pcs	Flat and Philips
5	Torque wrench	<50 Nm	
6	Digital Varner caliper	< 200mm	
7	Micrometers	0 – 100 mm	0-25,25-50,50-75&75-100
8	Bore and telescopic gauge	Set	
9	Filler gauge	0 - 100 mm	

Figure 1: Tools and measuring instruments for wear

2.3. Methodology

The methodology adapted in this work includes the steps as follows:

Preparation of experimental set up, characterization of JSVO, characterization of samples of lubricant, disassembling of the engines, wear measurement of engine parts

2,3.1 Experimental set up

Two new Robin DY23-2D engines one for diesel and another for JSVO were used to fulfill the set objectives. The experimental test was conducted for period of 75 hours for JSVO and diesel. The first engine was run with diesel and the second one was run with JSVO. Sample was taken after 25 hours. The lubricating oil samples were collected from both the engines and various properties were tested. A number of factors affect lubricating oil such as viscosity, TAN. Density, flashpoint, ash and Carbon residue etc. were tested on the lubricating oil samples to assess the comparative condition of engine oil drawn from diesel and JSVO.

The long-term endurance test was carried out according to Indian Standards Code (IS:10000 (Part IX)-1980 Methods of tests for internal combustion engines) and the two similar engines were subjected to similar loading cycles and operating conditions. The engines were run for 25 hours before the endurance test according to the

manufacturer recommendation for new engines and the oil was drained from the two engines and refilled with new oil SAE 30 while the recommended oil change interval by the manufacturer is 100 hrs. During the test, each engine was run for 8 cycles (each of 4 hr. continuous running) at rated speed as per IS: 10000, Part IX, 1980. The test cycle is specified in Table 6. At 69 operating hours the engine running with JSVO makes a knocking sound and minor engine adjustments were made.

The engine was disassembled after completing this long-term endurance test and was physically examined for carbon deposit and wear of various moving components. Lubricating oil samples were drawn from the oil sump after every 25 hours from these engines and a large number of tests were carried out in order to assess the effect of fuel on the lubricating oil residual useful life. The Schematic diagram

and overall pictorial of experimental setup is   shown in figure 20 and 21 below.

→	JSVO Fuel line to fuel filter	Diesel→	Fuel line to fuel filter
▪▪▪▪▶	JSVO Return line to fuel tank	▪▪▪▪▶	Diesel Return line to fuel tank
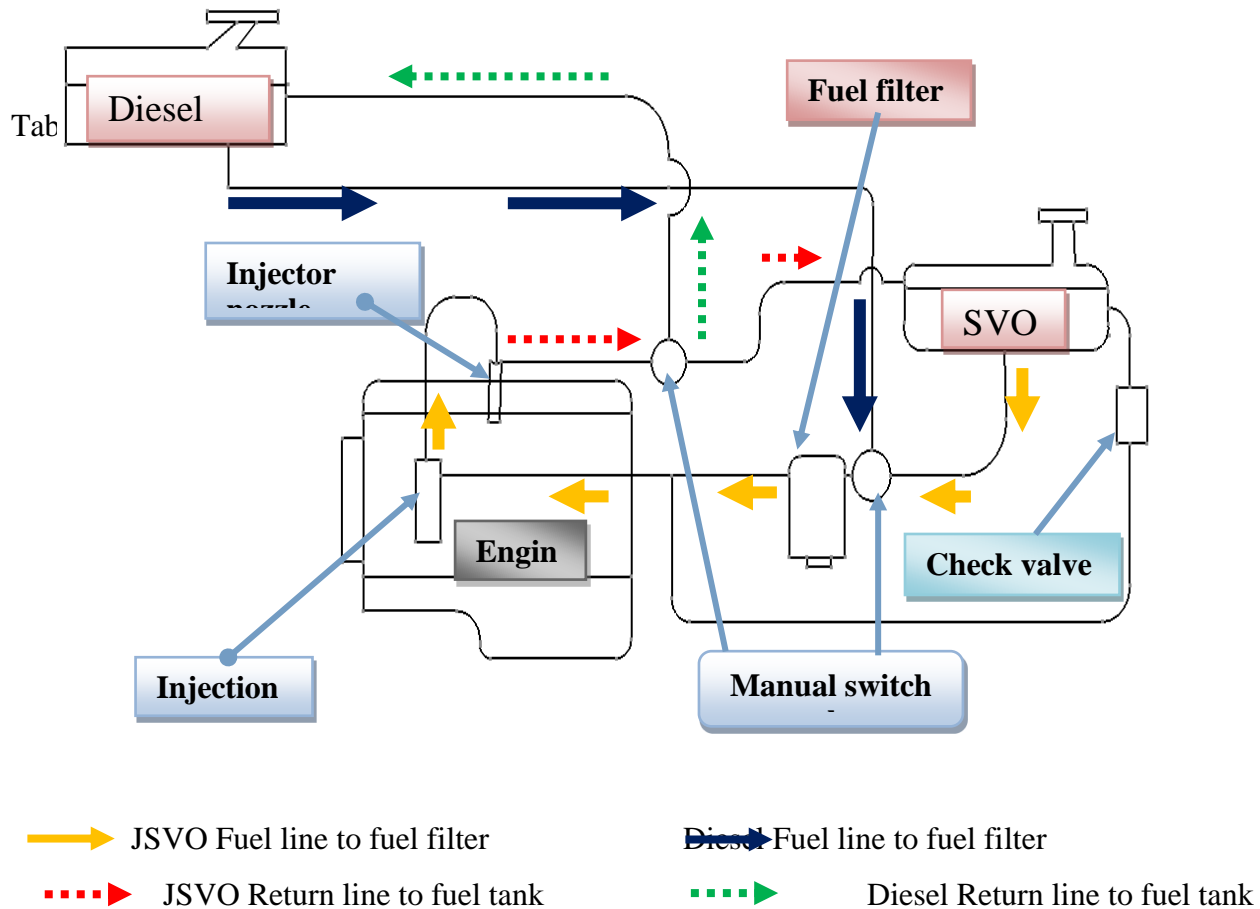
Figure 2: Schematic diagram of experimental setup for dual fueling.

Figure 3: Overall picture of experimental setup for dual fueling and diesel engine

3. Results and discussion

3.1 ENGINE OIL ANALYSIS

Oil analysis studies proved to be a powerful tool to estimate the condition of the engines, and moving parts as well. These tests provide valuable and relevant information on the effect of JSVO on the lubricating oil system.

Comparative studies on various samples of lubricating oil indicated that the density of JSVO fuelled engine increases +72 % with the usage of lubricating oil when it compared to diesel fuelled engine. The flash point testing result also indicate a similar level of lowering for JSVO and diesel lubricating oil but the flash point of JSVO fuelled engine lubricating oil decreases at higher level again after 50 operating hours of the engine in comparison to Diesel fuelled engine. The test results from density and flash point clearly indicate that the fuel dilution is higher in JSVO

fuelled engine. The higher kinematic viscosity @40°C and 100°C indicates that, even if the fuel dilution is high for JSVO the large molecular sizes of the triglycerides contained in SVO fuel allows the kinematic viscosity to remain higher than diesel engine. The highest amount of ash content in JSVO fuelled engine indicates that the increment rate of engine wear is increasing with increasing operating hours of the engine. However, the change in lubrication properties from JSVO is not much when it compares to mineral diesel engine and the viscosity of lubrication oil from JSVO fuelled engine is within the standard range which is described by "SAE viscosity grade comparison" for SAE 30 oil. Therefore, it can be concluded that JSVO can be used as substitute of mineral diesel in CI engines.

3.2 ENGINE PHYSICAL WEAR

In the long-term endurance test, the effect of use of JSVO as a fuel on various engine parts was evaluated. Physical wear measurement of vital engine parts indicates increased wear of cylinder, piston ring, and piston and exhaust valve of JSVO engine

while wear of Gudgeon Pin, Pin Bore and Small End Bush of Connecting Rod and rocker arm are similar. However use of JSVO as fuel results a higher possibility of physical wear, especially around the combustion chamber which is due to the

high amount of carbon deposit accumulation and contamination of oil lubrication mechanism at the cylinder walls. Wear of these components leads to loss of performance, increased maintenance costs, lower fuel efficiency, and shorter lube oil service life.

Therefore, it can be concluded that usage of JSVO is possible if the problems associated with accumulation of carbon deposit in the combustion chamber are solved where the high wear rate of the engine parts are recorded.

3.3 CARBON DEPOSIT

After completion of endurance test, visual inspection was done for deposit assessment. The inspection of engine vital parts indicated JSVO has higher amount of carbon deposits which is 165% higher on the cylinder head and 135 % higher on the piston head compared to mineral diesel. The high amount of carbon deposit on the combustion chamber leads to overheating of the engine while the carbon deposit on the valve produced hard particles lodged between the valve and guide. This causes the timing of the port openings and closings to vary, causing incomplete combustion in the cylinder it may also result in a permanent power loss. Therefore, it can be concluded that JSVO can be used as substitution if the amount of carbon deposit are minimized.

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Production and Characterization of Oat - Wheat Based Composite Bread

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Abstract

In this study the proximate composition and rheological properties of oat and wheat flour were investigated. The oat flour contained considerable amounts of protein (16.92%), total carbohydrates (64.65%) ash (1.80%), crude fiber (4.92%), moisture (5.61%) and fat (6.10%). The wheat flour also contained protein (13.56%), total carbohydrates (73.51%), ash (0.6%), crude fiber (0.32%), moisture (11.35%) and fat (0.98%). Based on these results, oat flour is nutritious and has a potential for use as composite flour in food formulations. Effects of oat flour supplementation (5%, 10%, and 15% of oat flour) on nutritional properties of the composite bread were investigated. The crude fiber, fat and protein are increased as the addition of oat flour increased. The farinograph water absorption values of the composite flour (5%, 10%, and 15% of oat flour) were 58.3%, 59.0% and 64.2% while the dough stability values were 8.5, 5.2 and 3.4 minutes; respectively. The dough development times were also 2.4, 3.0, and 4.3 minutes and that of the farinograph quality number were 99, 65 and 58 Brabender units; respectively. According to the results of wet gluten, falling number, and sedimentation values were decreased with the increase of oat flour supplementation (p<0.05) while color grade and oil absorption increased. The loaf volume of the composite flour bread were 340.6 cm³(100% wheat flour), 323.5 cm³ (5% oat flour), 298.4 cm³(10% oat flour), 250.3 cm³ (15% oat flour) and 210.9 cm³(100% oat flour). Loaf volume was significantly decreased with increase in level of incorporation of oat flour whereas loaf weight at 5%, 10% and 15% level of oat incorporation was significantly lower as compared to 100% oat supplementation (p<0.05). Results of this research suggested that supplementation of oat flour up to 10% results in bread with acceptable qualities. The sensory evaluation results were also suggested that the 10% oat flour supplemented bread was acceptable by the panelists.

Key words: *Composite bread, Farinograph values, Flour supplementation, Oat flake, Wetgluten*

INTRODUCTION

Cereal grains like wheat, corn, rice, barley, sorghum, etc. provide 68% of the total world food supplies. Wheat is mainly used as a dietary staple, averaging two-thirds of total consumption (Anjum *et al.,* 2005). Owing to shortage of wheat, several developing countries have devised programs to assess the feasibility of alternate sources for substituting or blending with wheat flour (Abdel-Kader, 2000).

Most developing countries including Ethiopia rely on importation to get wheat or wheat flour needed for making bread, rolls, biscuits and other pastry products. For this reason, most developing countries are interested in the possibility of replacing the wheat needed for making baked goods, wholly or partly with flour obtained from home grown products. Africa is becoming increasingly food insecure. In 2011 Africa imported some $7.7 billion worth of cereals and cereal products, equivalent to nearly $10 per person (FAO, 2011). Most of the imports are wheat and flour for bread making. Importation of cereals is having a devastating effect on the economies of many African countries like Ethiopia. It uses valuable foreign exchange, which would be much better applied for economic development. It also inhibits local agricultural development (Stanley *et al.*, 2004). To combat this problem, as long ago as the 1960s, the FAO launched a "Composite Flour Program". The objective was to seek new possibilities for the use of raw materials other than wheat in the production of bread, biscuits (cookies), pastas, and similar flour based foods (De Ruiter, 1978).

Knowledge of functional and rheological properties of un-conventional and/or novel food ingredients is imperative to incorporate successfully in existing food formulations. Blending non wheat flours with Wheat flour might result in technological difficulties and impairment of baking quality. For the purpose, determining potential use of composite flour blends in food formulations, informations regarding functional and rheological properties of blends are essential (Akubor *et al.*, 2003).

Studying the possibilities of increasing oat utilization as an important food is the basis of this research which tries to find alternative ways in which oat can be more accepted not only as a traditionally processed food but also as a value added product in Ethiopia. Therefore, this study is initiated to study the possibility of incorporating oat flour in bread formulation and so as to harness its potential both in economic and nutritional terms.

MATERIALS AND METHODS

Materials

Two types of food grains (wheat and oat) were used in the study. The wheat variety SH 2002 was purchased from (Kality Food Share Company) KFSC and oat grain was purchased from local market whereas yeast, sugar, salt, oil as a shortening, etc were obtained from the KFSC. The wheat flour was used as a base material for the preparation of composite flours with oat flour. The cleaning of oat and wheat grains was performed manually to remove damaged seeds, dust particles, seeds of other grains/crops and other impurities such as metals and weeds. The samples were then packed in polypropylene bags and stored at room temperature for further analysis.

The composite flour was blended using laboratory beating (mixing) machine (Model: R100C, CAT). The straight grade wheat flour was blended with varying levels of oat flour. 5%, 10% and 15% oat flour was used in the composite flour with wheat flour.

Methods

Thousand Kernels Weight: The Thousand Kernels Weight of the wheat samples was determined by counting thousand kernels from the sound and cleaned wheat. The counted thousand kernels were weighed on the precision balance to better describe wheat kernel composition and potential flour extraction.

Wet gluten determination: Wet gluten content was determined by washing the composite flour samples with a 2% salt solution to remove the starch and other solubles from the sample. The residue remaining after washing is the wet gluten. Wet gluten content results are expressed as a percentage.

$$\text{wet gluten}(\%) = \frac{\text{weight offinally washed gluten}}{\text{amount of flour used}(10\text{gm})} * 100$$

Rheological characteristics: Rheological characteristics of composite flour samples such as water absorption, stability, dough development, degree of softening and faringograph quality number of the composite flours were measured using the Brabender Farinograph (C. W. Brabender, Duisburg, Germany) according to the standard method of ICC No 115/1 for the determination of the quality characteristics of composite flour samples. The instrument automatically determines the amount of flour to be poured into the mixer of the farinograph based on the

moisture content of the flour. The farinograph is equipped with a 300 g capacity mixer. Mixing was carried out for 20 minutes. Immediately when the mixing starts, the computer automatically starts to plot the graph. The speed of the torque was adjusted to be 63 min^{-1}.

Color grade: The color analyzer (model Satake Color Grader Series IV, Germany,2005 uses ultra violet light to determine the absorbance of emitted lights. The color grade value of the flour samples was measured to make sure the brightness of the flours. 30 g of flour sample was placed in a beaker containing 50 ml distilled water and made in to a paste by continuously stirring it with a glass rod for 45 seconds. The paste was then poured in to the sample cell and the sample cell containing the paste was inserted in to the carriage of the instrument. The result was displayed with in90 seconds.

Falling Number: The samples were evaluated for falling number using the Hagberg falling number apparatus (model 1500, Sweden, 2005) according to the ICC standard No 107/1 for the determination of the amylase activity of cereal and flour.

Oil absorption capacity: Oil absorption was determined by the method of Rosario and Flores (1981). One gram sample was mixed with 10mL oil (refined groundnut oil) for 30 sec in a mixer. The samples were then allowed to stand for 30 min at 30 ^{0}C in a water bath and centrifuged at 3000rpm for 20 min. the volume of supernatant was recorded to calculate the amount of oil absorption capacity.

Sedimentation value: Sedimentation value were determined by AACC method 56-60.01

Bread preparation: The three blend formulations the wheat flour and the oat flour would be baked using the straight dough method (Federation of bakers, 2002). The baking formula was 62% wheat flour or the blend, 0.3 % yeast, 0.2% bread improver, 0.5 % salt and 37.0 % water. All ingredients were mixed in a dough mixer (model: B15mixer) for 15 minutes. The dough was fermented in a bowl covered with polyethylene plastic for 30 minutes at room temperature. It was then knocked back and molded. The dough pieces were then allowed to ferment for 60 minutes in a proofing room of temperature 35 ^{0}C and relative humidity of 80 %. The fermented dough was baked at 250 ^{0}C for 20 minutes (Toufeili *et al.,* 1999; the federation of baking, 2002; Edema *et al.,* 2005; Olaoye *et al.,* 2006).

Proximate composition analysis: Moisture content, total ash, crude fat, crude protein and crude fiber of the flour (wheat and oat) and bread samples were determined by AOAC (2000). Total carbohydrates of the samples including crude fiber were determined by subtraction. The minerals content was determined by flame atomic Absorption spectrometry and flame photometry generally according to the AOAC (2000).

Bread quality: The loaves were packed in polyethylene bags and analyzed for volume (cm^3), weight (g) and specific volume (g/cm^3). Bread volume was measured by rapeseed displacement method (AACC, 2000) and the volume was divided by bread weight to calculate the specific volume.

$$\text{Specific volume} = \frac{\text{Loaf volume}}{\text{Loaf weight}}$$

Sensory quality evaluation of bread products: The subjective evaluation of bread products were carried out for the external sensory characteristics. Breads were evaluated for color, appearance, flavor, taste, mouth feel, and overall acceptability by taste panel using 5-Point Hedonic Score System (Meilgaard et al., 2007) with following individual scores: 5 = Excellent, 4 = Very Good, 3 = Good, 2 = Fair, 1 = Poor, to find out the most suitable product for commercialization.

RESULTS AND DISCUSSION

Proximate composition and total kernel weight of raw materials: The results regarding total kernel weight (TKW) Table 2 shows that the wheat grain is non significantly higher than to that of the oat grain. This shows generally speaking,

Experimental design and data analysis: Data were reported as mean values and standard deviation. Comparisons among means were performed by one-way ANOVA. The Student's t was used to test for comparison of the means among different products. Significance was accepted at probabilities of less than 0.05. All statistical analyses performed used JMP version 5 (SAS Institute Inc., USA, 2002). All measurements were performed in duplicate.

wheat with a higher TKW can be expected to have a greater potential flour extraction.

The oat flour yielded higher contents of protein, fat, ash and crude fiber as compared to wheat flour sample. The

wheat flour had higher moisture content. These results of proximate composition are comparable with the results found by Salehifar (2007).As it is reported by Ahmed (2001),the chemical composition of wheat flour, for moisture, ash, crude protein, crude fat, crude fibers ranged from 9.38 to 10.43%, 1.32 to 1.85%, 10.13 to 14.74%, 1.96 to 2.52% and 2.31 to 2.99% ;respectively (Ahmad, 2001). It has been reported that chemical composition is dependent upon genetics, the growing environment, the processing of the seed, and the method employed for analysis (Daun *et al*., 2003).

Higher levels of crude fiber and ash are associated with whole oat flour and presence of oat bran particles. The results of chemical composition of oat flour are comparable with the results found by Asif (2009) who reported 5.86 % fat, 15.83 % protein, 4.00 % total dietary fiber, 5.00% moisture and 0.98% ash content.

Table 1: Proximate composition of raw materials (per 100 gram)

Flour	Moisture	Crude Protein	Crude Fat	Ash	Crude Fiber	Total Carbohydrates
Wheat	11.35 ± 0.49^a	13.56 ± 0.79^a	0.98 ± 0.03^a	0.6 ± 0.14^a	0.32 ± 0.17^a	73.51 ± 0.72^a
Oat	5.61 ± 0.86^b	16.92 ± 1.30^a	6.10 ± 0.14^b	1.80 ± 1.13^a	4.92 ± 1.30^b	64.65 ± 2.33^b

All values are means of triplicate ± standard deviation
a-b Means with the same superscript letters within a column are not significantly different (p>0.05)   Values except moisture are expressed in dry weight basis (DWB).
of = oat flour wf = wheat flour
*% Carbohydrates is by difference, i.e. 100 – (crude protein + crude fat + ash + moisture)

The analysis results of major minerals for oat and wheat flour is shown on table 2 and the result indicates that there is a significant difference of all compositions, except for that of Calcium content (table 2). The mineral content of flour as such is not related to quality of a final product, but it does affect the appearance of flour and the product. The minerals are concentrated on the outer part of wheat grain, which is removed during milling. Flour that contains higher proportion of minerals will have more ash content and it will be darker in color and it may also contain more fine bran particles. Bran has been shown to have detrimental effect on the quality of bakery products.

Table 2: Mineral composition of raw material (mg/100 g) and TKW

Flour (Grain for TKW)	K	Ca	Mg	TKW*
Oat	143.02 ± 7.35^b	21.99 ± 6.93^a	258.67 ± 9.47^a	29.83 ± 1.16^a
Wheat	420.04 ± 4.79^a	23.10 ± 1.41^a	20.00 ± 7.07^b	32.85 ± 1.13^a

All values are means of triplicate $\pm$ standard deviation
[a-b] Means with the same superscript letters within a column are not significantly different (p>0.05)   TKW* Total kernel weight

Wet gluten determination: Wet gluten content results are expressed as a percentage on a 14 percent moisture basis (wet base); for example, 35 percent wet gluten is for high protein, strong gluten wheat and 23 percent wet gluten is for low protein, weak gluten wheat. The statistical result shows that there is a significant decrease of wet gluten from 30.3% (for control) to 22.9% (for 15% oat flour supplementation) (table 3).

Baking standards require that the wheat flour used for bread making to contain at least 25% of wet gluten (Anna *et al.,* 2005).In this study, an average of 26.1% of gluten was washed from the mixes containing 10% of oat flour. It may be thus, concluded that an appreciable amount of gluten in the flour enriched with 10% of oat flour may be sufficient to obtain good-quality baking products. As shown in table 2, the wet gluten decreases as the amount of supplementation increases. This phenomenon has been seen on the loaf volume (extensibility of the dough).

Table 3: Wet gluten values

Composite flour	Wet gluten (%)
Control (100% wheat flour)	30.3 ± 0.28^a
5% oat flour + 95% wheat flour	28.3 ± 0.14^b
10% oat flour + 90% wheat flour	26.1 ± 0.14^c
15% oat flour + 85% wheat flour	22.9 ± 0.14^d

All values are means of triplicate $\pm$ standard deviation
[a-d] Means with the same superscript letters within a column are not significantly different (p>0.05)
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Farinograph Measurement: The results for water absorption indicated variations among the treatments due to different level of supplementation; ranged from 58.2% to 64.2%. Highest value for water absorption (64.2%) was noted in bread with 15% oat flour followed by 10% oat flour supplementation (59.0%) and 5% oat flour supplementation (58.3%) while lowest water absorption (58.2%) was recorded for control wheat flour (table 4). Farinograph characteristics and absorption increased with increasing the oat flour proportion in the formula Appolonia, (1990). Oat β-glucan played an important role in increasing water absorption and bread

moisture. In general, dietary fibre increases water absorption and mixing tolerance. Rossel *et al*., (2001) expected such a result due to the hydroxyl groups of the fibre structure which allows more water interaction through hydrogen bonding. Oat starch has higher water absorption than other cereals (Rossel *et al*., 2001). This moisture retention property of oats keeps breads fresher for longer periods of time (Gomez *et al*., 1995; Ozboy *et al*., 1997).

Dough development time significantly increased with the substitution of wheat flour with oat flour. The results in Table 4 indicate that the dough development time in composite flours ranged from 2.2 to 4.3 min among different treatments. The highest dough development time (4.3 min) was observed in bread with 15% oat flour followed by 10% (2.0 min) and 5% (2.4 min) while the lowest dough development time (2.2 min) was noted in control wheat flour. This is consistent with Bhatty (1986), who reported little to no difference in mixograph peak time with the substitution of wheat by 5 to 20% hull-less barley flour and Jacobs *et al.* (2008), who showed that a fiber rich barley fraction increased faringograph dough development time compared to the wheat control. For pure wheat flour, dough development time

reflects the total energy amount that is needed to develop the gluten network. In the presence of fibre rich flours, the gluten network formation will be influenced by water availability and mechanical disturbance due to insoluble fibre.

The increase in development time of composite flours found in the present study may be due to decrease in their gluten contents, coarser nature of oat flours added to wheat flours and weakening of protein network due to proteolytic activity during the storage of composite flours.

Dough stability, which indicates the dough strength was also decreased. It is obvious from the results (Table 4) that dough stability time in oat supplemented flours ranged from 3.4 to 8.5 min among different treatments. This probably due to the formation of hydrogen bonds, also gelatinized starch has been shown to be capable of forming a three dimensional network that retains gases and expands during the fermentation and baking of composite bread.

The flour blend (15:85) showed also the lowest farinograph quality number (58) indicating that the flour do not exhibit strong flour characteristics followed by 10 %(65) and 5% (99) and highest farinograph quality number (100) was

noted in control wheat flour. The highest values of stability, dough development and faringraph quality number of the flour indicate that this flour blend is strong flour and is suitable for bread production

(Toufeili *et al.*, 1999). The degree of softening increased with the increasing oat flour level (Table 4). The same result was obtained by Zhang (1998)

Table 4: Faringraph values of blended flours for bread

Parameters	Blended flours ratio (OF:WF)			
	Control wheat flour	5:95	10:90	15:85
Consistency, Farinograph Unit (FU)	451	461	531	739
Water absorption (corrected for 500 FU)	58.8	59.0	60.8	66.0
Water absorption (corrected to 14.0%)	58.2	58.3	59.0	64.2
Stability (min.)	8.5	8.5	5.2	3.4
Development time (min)	2.2	2.4	3.0	4.3
Degree of softening (FU)	30	31	63	124
Degree of softening (ICC),FU	60	69	104	211
Farinograph Quality Number	100	99	65	58

OF – oat flour, WF - wheat flour

Color grade and falling number: The color test on flour sample indicates the whiteness of the flour which is considered as a quality attribute that affects appearance of final product. The color of the flour depends on extraction rate of flour, amount of pigments and flour particle size. The darkness or whiteness of the flour is due to contamination of bran particles. Higher the flour extractions rate, darker the color of the flour and vice versa. The coarse flour generally looks dull and darker than its finer counter part due to the shadow effects of the larger particles (Khatkar, 2009).

The addition of oat flour resulted in a loss of flour brightness, probably due to oat

bran color in the flour (Table 5).The particle size of oat flours was larger than wheat flour and it was also due to using whole oat flour and the presence of bran particles in the flour (Webster, 1986). The brightest color grade value 3.5 was recorded in a control sample. The color grade value significantly increased from 3.5 (control) to 17.21 (15% oat flour supplemented SGF) (Table 5). There was a significant increase in the color grade value with the increase in the level of oat flour supplementation in SGF.

The level of enzyme activity measured by the falling number test affects product quality. Yeast in bread dough, for example, requires sugars to develop

properly and therefore needs some level of enzyme activity in the dough. Too much enzyme activity, however, means that too much sugar and too little starch are present. Since starch provides the supporting structure of bread, too much activity results in sticky dough during processing and poor texture in the finished product. According to Sologuk and Sorenson (2005), a falling number value of 300 seconds or longer indicates a low enzyme activity and very sound wheat quality. As the amount of enzyme activity increases the falling number decreases. Values below 200 seconds (Sologuk and Sorenson,(2005); German, (2006); ICC, (2000) indicates high levels of enzyme activity. If the falling number is too high (>400 sec), enzymes can be added to the flour in various ways to compensate. If the falling number is too low (<200 sec),

enzymes cannot be removed from the flour or wheat, which results in a serious problem that makes the flour unusable (German, 2006).

Table 5 indicated that supplementation (10% and 15% oat flour) had a significant ($p<0.05$) effect on the reduction of falling number by increased enzymatic activity of the flour. The percentage of oat flour on the composite wheat flour significantly ($p<0.05$) decreased a falling number from 200 to 184. Value below 200 seconds indicates that high levels of enzyme activity (Bekele *et al*., 2009). From these results might be concluded that bread quality was significantly affected with the supplementation of oat flour to wheat flour.

Table.5: Color grade and falling number values

Blended flours ratio (OF:WF)	Color grade	Falling number(sec)
0:100 (control)	3.5±0.32[c]	200.0±8.00[a]
5:95	11.87±3.2[b]	198.4±0.45[a]
10:90	15.30±0.86[a]	185.7±0.81[b]
15:85	17.21±0.21[a]	184.0±0.98[b]

OF – oat flour, WF - wheat flour
All values are means of triplicate ± standard deviation
[a-c] Means with the same superscript letters within a column are not significantly different ($p>0.05$)

Functional properties

Oil absorption is another important functional property since it plays an important role in enhancing the mouth feel while retaining the flavor of food products

(Kinsella, 1976). The OAC of oat flour (1.60 ml/g) was higher than that of the wheat flour (0.9ml/g). The result in table 6 showed that oat flour may be a better

flavor retainer than the wheat flour. It has been reported that variations in the presence of non-polar side chains, which might bind the hydrocarbon side chains of oil among the flour, explain differences in the oil binding capacity of the flour (Adebowale and Lawal, 2004). It might be concluded that the lower OAC of wheat flour is due to the lower extent of hydrophobic proteins when compared to oat flour.

Sedimentation value: A useful parameter which can be used to determine the quality of protein in flour is the sedimentation value. Differences in the sedimentation values for blends containing oat flour, was insignificant (Table 6). Increasing the content of this additive led to a decrease in the sedimentation value. When viewed from the perspective of baking technologies, it indicates the deterioration of hydration properties of protein composition (Anna*et al.,* 2005). The sedimentation value of flour depends on the wheat protein composition and is mostly correlated to the protein content, the wheat hardness, and the volume of pan and hearth loaves. Positive correlations were observed between sedimentation volume and gluten strength or loaf volume attributes.

Table 6: Oil absorption and sedimentation values of flours used in the study

Blended flours ratio (OF:WF)	Oil absorption(ml/g)	Sedimentation value(ml)
0:100 (control)	0.90 ± 0.14^b	87 ± 1.41^a
5:95	0.91 ± 0.01^b	85 ± 1.41^a
10:90	0.95 ± 0.35^{ab}	83 ± 1.54^a
15:85	1.0 ± 0.14^{ab}	82 ± 1.46^a
100:0	1.60 ± 0.42^a	46 ± 4.24^b

OF – oat flour, WF - wheat flour
All values are means of triplicate ± standard deviation
[a-b] Means with the same superscript letters within a column are not significantly different (p>0.05)

Bread quality

The simplest bread making procedure is the straight-dough method whereby all the ingredients in bread formulation are mixed to form developed homogenous dough in one-step were used (Sahlström and Bråthen, 1997). Dough formation for straight-dough method require low amount of energy during mixing process to produce a suitable bread quality (Cauvain, 1998b). Subsequently, the resting periods of the dough in this method varied depending on the flour quality, yeast level, dough temperature and the specificity in types of bread produced (Mondal and Datta, 2007). A typical white wheat flour protein content used in this bread making procedure is 12% to obtained an optimum dough development. However, addition of non-wheat flour resulted in lower bread

quality due to lower flour quality and strength (Cauvain, 1998b). Bread properties are very often influenced by flour components (Dowell *et al.,* 2008; Edwards *et al.,* 2007; Perez Borla *et al.,*

2004) and the rheological properties of the dough (Andersson *et al.,* 1994; Armero and Collar, 1997; Bloksma, 1990; Gras *et al.,* 2000; Oliver and Allen, 1992).

Chemical composition of composite bread
Moisture content

The moisture content is one of most important and commonly measured properties of different food products. It is measured for a number of reasons including legal and label requirements, economic importance, food quality, better processing operations and storage stability considerations.

Determining moisture content is an essential first step in analyzing bread quality since this data is used for other tests. Flour millers adjust the moisture in wheat to a standard level before milling. Moisture content of 14 percent is commonly used as a conversion factor for other tests in which the results are affected by moisture content. Moisture is also an indicator of grain storability. Bread with a

high moisture content attracts mold, bacteria, and insects, all of which cause deterioration during storage. Bread with low moisture content is more stable during storage. The statistical results for moisture content of different composite flour bread is presented in Table 7 indicates that the moisture content was not significantly affected by the supplementation levels of oat flour in straight grade flour (SGF).

The statistical results indicated non significant changes in moisture content with the increase in level of supplementation of oat flour in wheat flours. It is obvious from the results that moisture content of the composite flour bread non significantly (p> 0.05) decreased from 27.75% (control) to 25.89% (15% 0at flour supplementation).

Ash content

The ash content is an inorganic residue remaining after the removal of water and organic matter by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals in

a food. Since ash is primarily concentrated in the bran, ash content in flour and bread is an indication of the yield that can be expected during milling. Ash content also indicates milling performance

by indirectly revealing the amount of bran contamination in flour. Ash in bread can obviously seen in affecting the color, imparting a darker color to the bread. Some specialty products requiring particularly white flour call for low ash content while other products, such as whole wheat flour, have high ash content. The analyses of variance regarding ash content of different composite flours breads is given in Table 7 indicated that the ash content differed significantly

Crude fat

Lipids including fats and oils are a major source of energy and provide essential nutrients. In many foods the lipid component plays a major role in determining the overall physical characteristics, such as flavor, texture, mouth-feel and appearance.

The statistical results presented in the Table 7 indicated that the fat content in oat flour supplemented SGF varied significantly due to variation in supplementation levels. The effect of supplementation level on the fat content of different composite flour breads is given in Table 7 .The fat content was significantly increases with the supplementation level. The highest fat content (4.11%) was found in the composite flour bread supplemented

during 5% supplementation, and the rest becomes non significantly different in the composite flour breads. It is evident from the results given in Table 7 that the highest ash content (1.75%) was found in a composite flour bread which was supplemented with 15% oat flour and the lowest (1.3%) was found in the control wheat flour bread. The ash content significantly increased from 1.3% (control) to 1.75% (15% supplementation).

with 15% oat flour and the lowest fat content (0.98%) was found on the 100% wheat flour bread.

Crude fiber

The crude fiber is a measure of the quantity of indigestible cellulose, pentosans, lignins and other components of this type present in foods. The crude fiber has little food value but it gives bulk to the food and also helps to regulate certain physiological functions.

The statistical results regarding crude fiber content of different composite flour breads have been presented in Table 7 .The results indicated that crude fiber content was significantly increased with a 5% supplementation of oat flour. It is evident from the results that crude fiber content of

composite flour breads increased significantly from 0.45% (control) to 2.56% (5%) in the composite flour breads. The increase in level supplementation improved the crude fiber contents, from 0.45% (control) to 4.11% (15% oat flour).

Crude protein

The statistical results regarding protein content of composite flour breads supplemented with different levels of oat flour is presented in Table 7 indicated that treatments (supplementation levels) significantly affected the protein contents of composite flour breads. It is obvious from the results (Table 7) that protein content of composite flour breads increased significantly by increasing the level of oat flour supplementation. It is evident that significantly the highest protein content (19.60%) was found in the SGF supplemented with 15% oat flour followed by the SGF supplemented with 10% oat flour (18.93%). Kim (1977) observed that increasing the protein content of composite flours, diluted the starch and decreased the rate of staling.

Table 7: Proximate composition of composite bread

Composition (%)	Control(100%wf)	5%of+95%wf	10%of+90%wf	15%of+85%wf
Moisture	27.75 ± 2.47^a	26.30 ± 2.67^a	26.01 ± 1.83^a	25.89 ± 1.42^a
Crude protein	13.45 ± 0.63^c	18.60 ± 0.84^b	18.93 ± 5.56^b	19.60 ± 0.84^a
Crude fat	0.98 ± 0.11^c	2.44 ± 0.05^b	2.56 ± 0.08^b	4.00 ± 0.00^a
Ash	1.3 ± 0.14^b	1.53 ± 0.04^a	1.71 ± 0.01^a	1.75 ± 0.07^a
Crude fiber	0.45 ± 0.04^b	2.56 ± 0.08^a	3.21 ± 1.43^a	4.11 ± 0.01^a
Total carbohydrates*	56.52 ± 8.58^a	51.13 ± 2.22^b	50.79 ± 6.44^b	48.76 ± 2.33^b

All values are means of triplicate $\pm$ standard deviation
[a-c] Means with the same superscript letters within a column are not significantly different (p>0.05)
Values except moisture are expressed in dry weight basis (DWB).
of = oat flour wf = wheat flour
*% Carbohydrates is by difference, i.e. 100 – (crude protein + crude fat + ash + moisture)

The supplementation of oat flour in wheat flour significantly improved the nutrient profile of the composite flours breads. The results of the present study are in line with the earlier study conducted by Hussain (2004) in which he has found significant improvement in the proximate composition (ash, fat, crude protein and crude fiber) of oat flour supplemented wheat flours. These results are also supported by the findings of Zaib-un-Nisa (2000), who reported that bread made from composite flour containing 5% oat flour had increase in protein content from 6.50% to 8.52%, fat content from 26.13% to 31.45%, fiber content from 0.15% to 3.78% and ash content from 0.26% to 1.00%.

Mineral composition of composite bread

The statistical results pertaining to the effect of oat flour supplementation with wheat flour on macro minerals contents like potassium (K), calcium (Ca) and magnesium (Mg) of composite flour breads are shown in Table 8 The results indicate that supplementation of oat flour into SGF significantly affected the contents of macro minerals of composite flour breads. The K content of composite flour breads was non significantly decreased from 470.0 mg/100g (100% SGF) to 459.50 mg/100g in 15% oat supplementation (Table 8). The results regarding calcium content of different composite flour breads presented in Table 8revealed that Ca content was found 56 mg/100g in 100% SGF, non significantly decreased to 51 mg/100g in 10% oat flour supplemented SGF and significantly decreased to 23.1mg/100g in 15% oat flour supplementation. The results regarding the magnesium content of different composite flour breads was given in Table 8.The lowest magnesium content (180.6 mg/100g) was found significantly in 100% SGF while 15% oat flour supplemented SGF had significantly the highest Mg content (216.7mg/100g).

Table 8: Mineral composition of composite breads (mg/100 g)

Sample	K	Ca	Mg
control	470.0 ± 7.07^a	56.0 ± 2.82^a	180.6 ± 14.14^b
5% oat flour	468.3 ± 11.73^a	53.6 ± 2.26^a	200.5 ± 2.12^a
10% oat flour	463.3 ± 4.66^a	51.9 ± 2.68^a	207.5 ± 3.53^a
15% oat flour	459.5 ± 3.53^a	23.8 ± 1.13^b	216.7 ± 2.12^a

All values are means of triplicate ± standard deviation
[a-b] Means with the same superscript letters within a column are not significantly different ($p>0.05$)

Physical characteristics of bread

The loaves were packed in polyethylene bags and analyzed for volume, weight and specific volume. The statistical analysis for volume of bread samples prepared from oat flour supplemented in wheat flour is presented in Table 9. The results indicated that volume of breads was affected significantly except in 5% oat flour, by the level of oat flour supplementation.

Table 9: Bread loaf weight, volume and specific volume

Sample	Loaf weight(g)	Loaf volume(cm^3)	Specific volume(g/cm^3)
Wheat flour	86.0 ± 0.32^b	340.6 ± 4.26^a	3.96
5% oat flour	89.1 ± 0.32^b	323.5 ± 3.32^a	3.63
10% oat flour	94.5 ± 1.23^b	298.4 ± 0.98^b	3.16
15% oat flour	98.6 ± 0.92^b	250.3 ± 0.34^c	2.53
Oat flour	101.7 ± 0.39^a	210.9 ± 1.43^d	2.07

All values are means of triplicate ± standard deviation
[a-c] Means with the same superscript letters within a column are not significantly different ($p>0.05$)

Loaf volume was significantly decreased with increase in level of incorporation of oat flour whereas loaf weight at 5%, 10% and 15% level of oat incorporation was significantly lower as compared to 100% oat supplementation. Specific volume was also found to decrease with increase in level of supplementation. This might be due to the dilution of gluten protein. The decrease in loaf volume upon the incorporation of low gluten flour is the expected as indicated by previous investigators (Czuchajowska and Paszczynska, 1996).

However, the incorporation of oat flour or the use of whole grain flour (usually from wheat) or bran all diminish bread quality, particularly loaf volume, of wheat composite breads (Bhatty, 1986; Gill *et al.,* 2002; Lai *et al.,* 1989). This deteriorating effect has been shown to be more than solely the dilution of wheat gluten. Fiber, especially insoluble fiber, may mechanically interfere with gluten network formation (Gill *et al.,* 2002; Salmenkallio-

Marttila *et al.,* 2001) and cause rupture of gas cells (Courtin and Delcour, 2002). Both soluble and insoluble fibers, tightly bind high amounts of water, which may make it less available for the development of the gluten network and may further result in less steam production during baking (Gill *et al.,* 2002). It is therefore crucial to compensate for the high water binding capacity of cereal β-glucans when baking with oat flour in order to obtain good quality of oat or barley enriched wheat bread (Holtekjolen *et al.,* 2008).

The addition of oat products to wheat flour caused diffusion of gluten proteins, which resulted in a loss of dough strength and a decrease in loaf volume (Zhang *et al.*, 1998). The smaller loaf volumes obtained from oat substituted flours might have been caused by poor gas formation and poor gas retention in the dough. Gluten dilution and gums present in the oat flour may have had a strong influence on bread quality.

Sensory quality evaluation of bread

Breads were evaluated for color, appearance, flavor, taste, mouth feel, and overall acceptability by taste panel using 5-Point Hedonic Score System (Meilgaard *et al.,* 2007) with following individual scores: 5 = Excellent, 4 = Very Good, 3 = Good, 2 = Fair, 1 = Poor, to find out the most suitable composition of bread for commercialization. The sensory hedonic mean scores of the bread samples are shown in the following table.

Table 10: Sensory evaluation of bread samples

Product code	Sensory attributes						
	Color	Appearance	Odor	Taste	Mouth feel	Flavor	Overall acceptability
01	3.2 ± 1.95^a	3.4 ± 1.00^a	3.8 ± 1.00^a	4.3 ± 0.52^a	4.3 ± 0.50^a	4.2 ± 0.22^a	4.0 ± 0.93^a
02	2.5 ± 2.00^b	3.2 ± 2.27^a	3.6 ± 0.90^a	4.0 ± 1.99^a	3.2 ± 0.26^b	3.0 ± 2.1^b	3.0 ± 2.10^a
03	2.4 ± 2.07^b	3.2 ± 3.56^a	3.4 ± 1.78^a	3.5 ± 0.48^a	3.0 ± 1.81^b	2.5 ± 3.5^b	2.7 ± 0.80^b
04	2.0 ± 3.2^c	2.5 ± 0.9^b	2.3 ± 3.2^b	1.8 ± 1.8^b	2.0 ± 0.3^c	1.9 ± 9.0^c	1.0 ± 2.8^b

All values are means of triplicates ± SD
[a-c] Means with the same superscript letters within a column are not significantly different ($p>0.05$)
01=control, 02= 5% oat flour + 95% wheat flour, 03= 10% oat flour + 90% wheat flour, 04= 15% oat flour + 85% wheat flour

The 15% oat flour supplemented bread had a significantly softer texture than all other breads. This probably due to the higher levels of fat from oats compared with wheat. Fats have softening properties and act as a lubricant in bread (Rogers, 1988) Also, the dilution of wheat gluten with the addition of oat flour affects bread texture (Pomeranz, 1971). Based on the sensory evaluation, bread made with 5% oat flour + wheat flour and wheat flour was the best quality bread which fulfilled most of the quality attributes. The samples with code 01 and 02 are generally acceptable by consumers while the samples with code 03 and 04 were less acceptable by the panelists.

CONCLUSIONS

The study was aimed at investigating the influence of oat flour supplementation in wheat flour for the production of bread and its effect on sensory attributes and quality characteristics of those products. The results of the present study indicated that oat flour supplementation into straight grade wheat flour improved the chemical constituents of the composite flours. The crude protein and crude fat of the composite bread increases from 13.45% (100% wheat flour) to 19.60 (15% oat flour) and 0.98% (100% wheat flour) to 4.00% (15% oat flour) ; respectively. This reflects the potential use of oat into wheat flour for enhancement of these nutrients/chemical constituents. The improvement in the chemical constituents such as protein, fat, fiber and ash was due to the fact that oat flour had higher content of these constituents.

Mg and K content of bread increased as a result of the addition of oat flour. The decrease in loaf volume of the bread from 340.6 cm^3 (for 100% wheat flour) to 250.3 cm^3 (15% oat flour)can be attributed to low gluten content of the blend of wheat flour and oat flour. The production of oat is abundant in our country. Thus the research work has indicated the utilization of this oat flour by supplementing it with wheat flour.

The sensory evaluation of bread samples has showed that some formulations were highly accepted by panelists and they had overall acceptability. The technology is familiar and can be adopted in the bakeries without the necessity of purchasing novel ingredients or new equipment. The feasibility study also showed that the suggested composite bread production is both technically and financially feasible. Thus, the production of bread from the oat flour supplemented wheat flour can be considered as the economical and nutritive food for developing countries.

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Optimum Disc type and Operating Speed of a Pneumatic Precision Planter for acala type cotton planting

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Abstract

Based on the measured seed physical properties, a systematic selection of an optimum combination of seed metering disc type and ground speed was undertaken for a pneumatic precision planter to be used for acala type cotton seed planting. A static test was performed by employing a recently developed and more effective high-resolution optical pneumatic planter performance evaluation system. The study was conducted on two seed metering discs (22 and 48 hole discs each hole having a diameter of 3.5mm) and the ground speeds considered were 4 km.hr^{-1}, 5 km.hr^{-1}, 6 km.hr^{-1}, 7 km.hr^{-1}, 8 km.hr^{-1}and 9 km.hr^{-1}. A 3kPa vacuum pressure level was optimum to create the pressure difference sufficient to hold the seeds to the plate and allow singulation by the cut-off wiper. Accordingly, for the 22 hole seed metering disc typethe highest ground speed which gave acceptable performance that could lead to the desired plant population was 6 km.hr^{-1}(which exhibited 7.5% missing index, 91.8% quality index and 12% precision index),while 8 km.hr^{-1}forward speed (which exhibited 9% missing index, 89.5% quality index and 15.56% precision index) was found to be the best option for the 48 -hole seed metering disc type. Therefore, as it could save the time and labor required and make the planting operation efficient, using the 48 hole seed metering disc at 8 km.hr^{-1} ground speed is recommended for such acala type cotton seeds. However, further field study under actual field condition is suggested.

Introduction

Cotton is one of the exceptional crops produced and consumed more or less globally. The crop is row planted to get uniform plant distribution and to facilitate mechanization and irrigation. Farmers use different types of row planters that perform metering and placing the cotton seed at certain spacing and depth in the seed bed (ASAE, 1999). However,

Different planters use diverse seed metering mechanisms. High precision disc

inaccurate metering, which causes either excess or missing seed placing in the row, affects the plant population in the field and causes reduction in yield and dry matter should always be avoided. This could be done through proper selection of a suitable planter and its optimum operating conditions.

type pneumatic planters have vacuum seed meters that can plant a wide variety of

crops and seed types by changing seed metering discs and adjusting the vacuum level. Once the seed metering disk and vacuum level is set, the seed metering rate is adjusted by selecting disc with suitable number of holes around its circumference and by varying the disc speed relative to ground speed. Farmers using precision disc type pneumatic planters usually have sets of plates to match each size of seed to be planted. However, there are many factors related to seed and machine conditions determining the accuracy of seed spacing (Srivastava et al., 2006). In this regard, mean particle diameter, geometry and mass of the seeds are among the important factors that dictate the level of vacuum, the diameter of the holes and the peripheral speed of the vacuum plate to be selected.

Testing and evaluation of such planters is undertaken either for the selection of the appropriate seed metering disc, adjusting of the optimal operating parameters like operation speed and spacing of seeds or to observe the performance of a newly developed planter. This leads to the selection of the best seed metering disc and operating conditions or the development of a new planter which will make the farmer profitable through saving time and labor and getting better yield (Liu et al., 2004; Murray et al., 2006). Different

methods have been developed to test the performance of planters or to set optimal planter component setups and operating conditions. Grease or sticky belt stand is the most common method developed earlier for such purpose where the planter unit is positioned and operated over a moving belt covered with an adhesive material (usually grease) so that the seeds that exit from the planter remain at the point where they hit the belt (Kelly and Palmer, 1993; Kaur and Kumar, 2013). The sticky/grease belt is driven by a separate motor to provide the chosen theoretical seed spacing and forward speeds. However, a high-resolution optical pneumatic planter performance evaluation system is a recently developed technology for similar purpose, giving a more reliable result, saves time and by far cleaner than the conventional grease belt evaluation system (Alchanatis et al., 2002).

In this study, a systematic investigation, using a high-resolution optical pneumatic planter performance evaluation system, was undertaken to observe the effect of ground speed and seed metering disc type on the performance of pneumatic precision planter for planting cotton. Then a combination of suitable seed metering disc type and optimum ground speed that could give acceptable plant population in an

efficient manner (by saving time and labor) is recommended.

Materials and Methods

Acala type delinated cotton seed was used for the study. Seed physical properties were measured to determine the suitable disc hole diameter and optimum vacuum pressure to be applied. The average size was determined based on 100 randomly selected seeds. Digital calliper with an accuracy of 0.01 mm was utilized to measure the three principal dimensions, namely length, width and thickness of the seeds (Baümler et al., 2006). Seeds were counted using a seed counter for thousand seed mass measurement and the thousand-seed mass was determined using a digital electronic balance reading to 0.001 g.

The bulk density was measured by pouring the seeds in stainless steel cylinder of known volume and removing excess seed by rolling cylindrical glass rod on the rim of the container without compacting the seed. True density was determined as the ratio of sample mass to the true volume of the seeds using toluene displacement method (Nimkar & Chattopadhyay, 2001; Konak et al., 2002). Then the equivalent sphere diameter was calculated as shown below (Sitkei, 1986):

$$D_e = \left(\frac{6m_s}{\pi \rho_t} \right)^{\frac{1}{3}}$$

Where: D_e is equivalent sphere diameter, m_s and ρ_t are mass in kg and true density in kg/m^3 respectively.

The results of the measured seed physical properties used for the establishment of test setup are presented in Table 1.

Table 1. Physical properties of the cotton seeds used for the study

Length (mm)	Width (mm)	Thickness (mm)	Thousand seed mass (g)	Equivalent sphere dia. (D_e)(mm)	True density (kgm^{-3})	Bulk density (kgm^{-3})
8.058±0.082	4.576±0.0626	4.062±0.060	78.246±0.115	5.025±0.043	1178.43±0.03	628.2±0.1

Values are the mean ± standard deviation. Values with the same letter in a column are not significantly different (p>0.05)

Then the experiment was undertaken using a high-resolution optical pneumatic planter performance evaluation system (Figure 1), developed in Institute of Agricultural Engineering of Agricultural Research Organization-Volcani Center, Israel by Alchanatis et al. (2002).The planter performance evaluation system has a hardware setup along with image processing and statistical analysis special algorithms. The image processing algorithms help to separate the seeds from the background, to determine the seeds location in the image coordinate system and to compute the area of the seeds and to calculate seeds spacing distribution and statistical features. As shown in Figure 1, the system includes a line scan camera (CL512M, DALSA Inc., Ontario Canada) connected to a frame grabber installed on personal computer. The system processes the data obtained by the parameters of the seeds' distribution defined in the ISO 7256/1-1984E standard for regular shape seeds like cotton.

The test was a static test, on a stationary sowing unit. The metering discs tested were driven at a rotary speed simulating the speed of the actual work. In such kinds of planters rotation of the wheels are used as driving mechanism for performing the seed metering operation. The ground speed was synchronized with the disc rotation speed. Simulated vacuum pressure was created by using a compressor and a 3kPa level was applied as suggested in Karayel et al., (2004). A preliminary test undertaken during the experiment was done indicated that this vacuum pressure level was optimum to create the pressure difference sufficient to hold the seeds to the plate and allow singulation by the cut-off wiper.
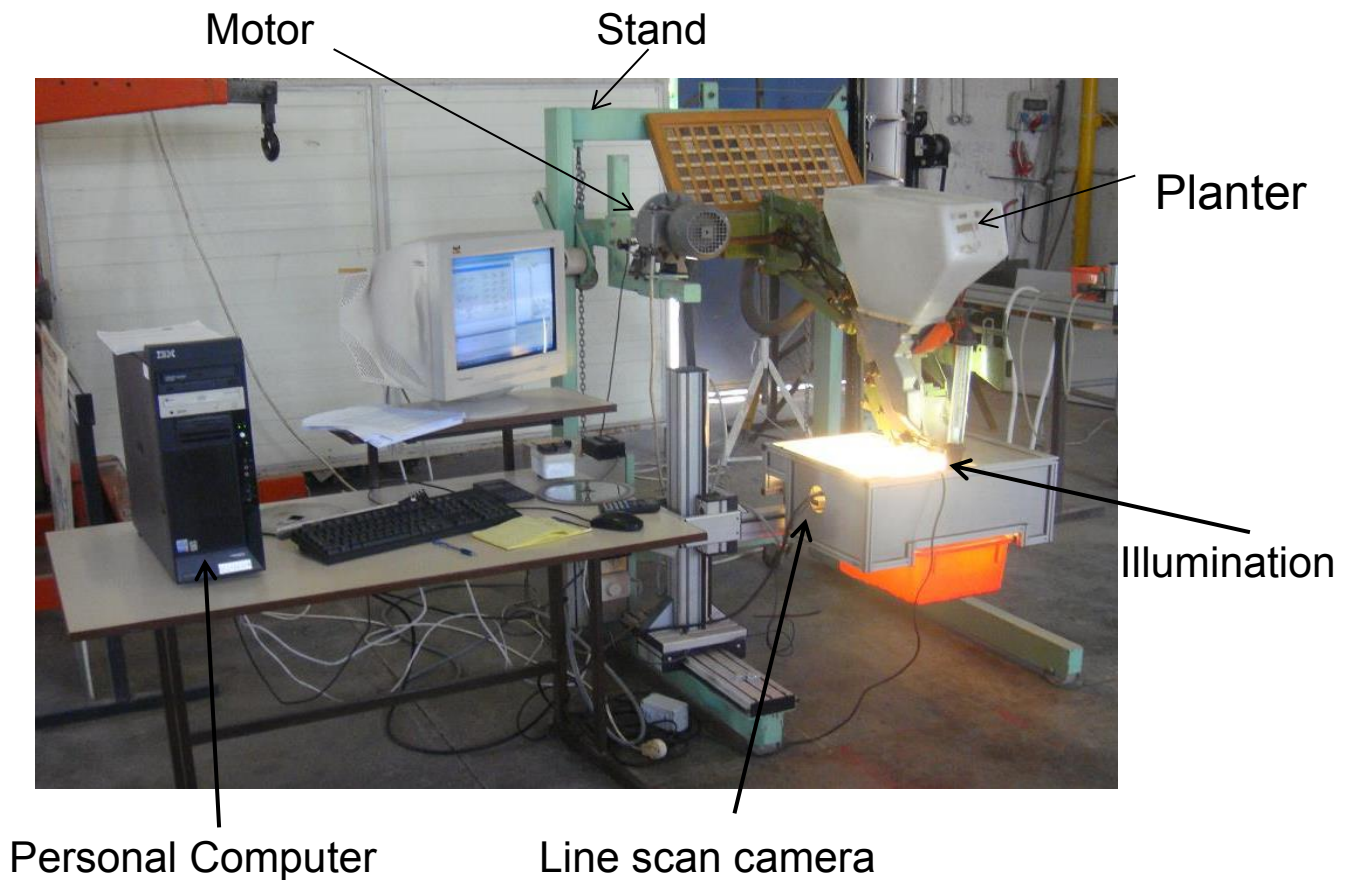
Figure 1. Lay out of the high-resolution optical pneumatic planter performance evaluation system (Source: Own photograph taken at the Institute of Agricultural Engineering of Agricultural Research Organization-Volcani Center, Israel)

The desired spacing of planting was 10 seeds per meter length, which means the seeds are dropped 10 cm apart. The study was conducted on two vertically rotating seed metering discs having equivalent diameters and a row of holes around their circumference. The two seed metering discs were: a seed metering disc with 22 holes (designated as a 22 hole metering disc from now on) and a seed metering disc with 48 holes (designated as a 48 hole metering disc from now on). The diameter of the holes in the discs selected for the study was 3.5mm and it was determined based on the measured physical characteristics of the test seed (Muarry et al., 2006). The ground speeds (V) considered were 4 km.hr^{-1}, 5 km.hr^{-1}, 6 km.hr^{-1}, 7 km.hr^{-1}, 8 km.hr^{-1} and 9 km.hr^{-1}. For every metering disc type and ground speed level 4 replications were done with 1000 seeds each. Statistical analysis and determination of regression equations were done by the Statgraphics Centurion XVI

program(StatPoint Technologies, Inc. 1982–2010).

The planter performance quality parameters were measured, computed and displayed on-line while the seeds are

1. Missing index, M: The ratio of the number of missed the seeds (seeds missed planting) to the total number of seeds used for the experiment expressed in percent. It was estimated using distance measured between seeds dropped spaced at a distance greater than 1.5 times the theoretical (nominal) spacing.

2. Multiple index, D: The percentage of the number seeds planted in multiple to the total number of seeds used for the experiment. Seed spacings less than or equal to half of the theoretical (nominal) spacing were considered as multiple planted.

dropped from the planter. The quality parameters were computed based on the following relations (Kachman and Smith, 1995):

3. Quality index, A: The percentage of the number of seed sown in the desired way to the total number of seeds used for the experiment. It is an indicator of uniformity of seed distribution in the row. Seed spacings more than half but no more than 1.5 times the theoretical (nominal) spacing were considered as planted as desired.

4. Precision index, PREC: It is the coefficient of variation of the spacing between the nearest seeds in a row that were classified as singles after omitting the outliers, i.e., the misses and multiples (Singh et al., 2005).

Results and discussion

For the 22 hole metering disc, the increase in the ground speed significantly (p<0.05) raised the mean missing indices (M) from 1.50 to 33.75% (Talble 1). A similar trend was observed for the mean M of the 48 hole metering disc, however the rate is low and it increased only to 13.5% at 9 km.hr^{-1} forward speed (Table 2). Effect of disc type on M is significant (p<0.05) where the mean M value for the 22 hole metering

disc (14.33±11.43%) was significantly higher than 48 hole metering disc type (6.46±4.24%). The probable reason for higher missing index at higher forward speed is that it causes higher disc rotation speed exceeding the optimum speed required for seed pickup or adhesion to the hole (Sing et al., 2005: Muarry et al., 2006). In both types of seed metering discs the multiple index (D) did not

considerably varied (p>0.05) with the increasing forward speeds. D was not as such dependent with the disc types evaluated also. Hence, when the trends of both M and D are observed together the number of seeds dropped decreased as the ground speed increased and this could cause lower plant population than the recommended and lead to lower amount of harvest. Such effect was more pronounced on the 22 hole metering disc than the 48 hole metering disc. The results clearly indicated that for the 22 hole metering disc forward speeds greater than 6 km/hr and for the 48 hole metering disc forward speeds greater than 8 km.hr^{-1}would result in percent miss indexes above ten and this exceeded the acceptable level of percent miss (Chhinnan et. al, 1975 and Karayel and Ozmerzi, 2001).

Table 2. Performance of 22 hole metering disc

Speed (km.hr^{-1})	Missing Index M (%)	Multiple Index D (%)	Quality Index A (%)
4	1.50±0.58a	1.25±0.50a	96.75±0.5e
5	5.50±0.58b	1.25±0.50a	93.75±1.26d
6	7.50±1.73b	1.25±0.50a	91.75±1.50d
7	14.75±1.50c	1.00±0.00a	84.00±1.83c
8	23.00±2.71d	1.00±0.00a	76.00±2.71b
9	33.75±0.96e	1.00±0.00a	65.50±1.00a

Values are the mean ± standard deviation. Values with the same letter in a column are not significantly different (p>0.05)

Quality indexes (A) of the 22 hole metering disc immediately started to signficantly (p<0.05) decrease with increasing forward speed, whilefor 48 metering disc drop of quality index became significant (p<0.05) as the forward speed went beyond 5 km.hr^{-1} (Tables 1 and 2). This agreed with earlier reportby Nielsen (1995) where increased speed had detrimental effect on the quality index. Effect of disc type on A was also significant (p<0.05). In the 5 ground speed levels tested, the mean A scored by the 48 hole metering disc type was (92.17±4.37%) significantly (p<0.05) higher than that ofthe 22 hole metering disc (84.83±11.29%). Hence, lower values of A in the 22 hole metering disc than the

48 hole metering disc type could indicate the would-be inferior plant population per hectare and less harvest (Kachman and Smith, 1995; Karayel, 2009).

Table 3. Performance of 48 hole metering disc

Speed (km.hr^{-1})	Missing Index M (%)	Multiple Index D (%)	Quality Index A (%)
4	1.50±0.58a	1.25±0.50a	97.25±0.50e
5	2.50±0.58b	1.25±0.50a	96.00±0.82e
6	4.50±0.58c	1.50±0.58a	94.00±0.82d
7	7.75±0.50d	1.00±0.00a	91.50±0.58c
8	9.00±0.82e	1.50±0.58a	89.50±1.29b
9	13.50±0.58f	1.50±0.58a	84.75±0.96a

Values are the mean ± standard deviation. Values with the same letter in a column are not significantly different (p>0.05)

The precision indexes (PREC) of the 22 hole seed metering disc significantly (p<0.05) increased from 8.93% to 17.68% and those of the 48 hole seed metering disc increased from 10.24% to 16.33%. Hence, the percentage of variation in the spacing between the nearest seeds in a row that were classified as singles after omitting the outliers consisting of misses and multiples increased accordingly. This means ground speed increase led to decline in the precision of metering. However, the PREC scores of the two discs at the 5 speed levels were below the upper limit for acceptable PREC in such types of precision planters that extends up to 29% (Kachman and Smith, 1995). The influence of the seed metering disc type on PREC was not appreciably visible (p>0.05).
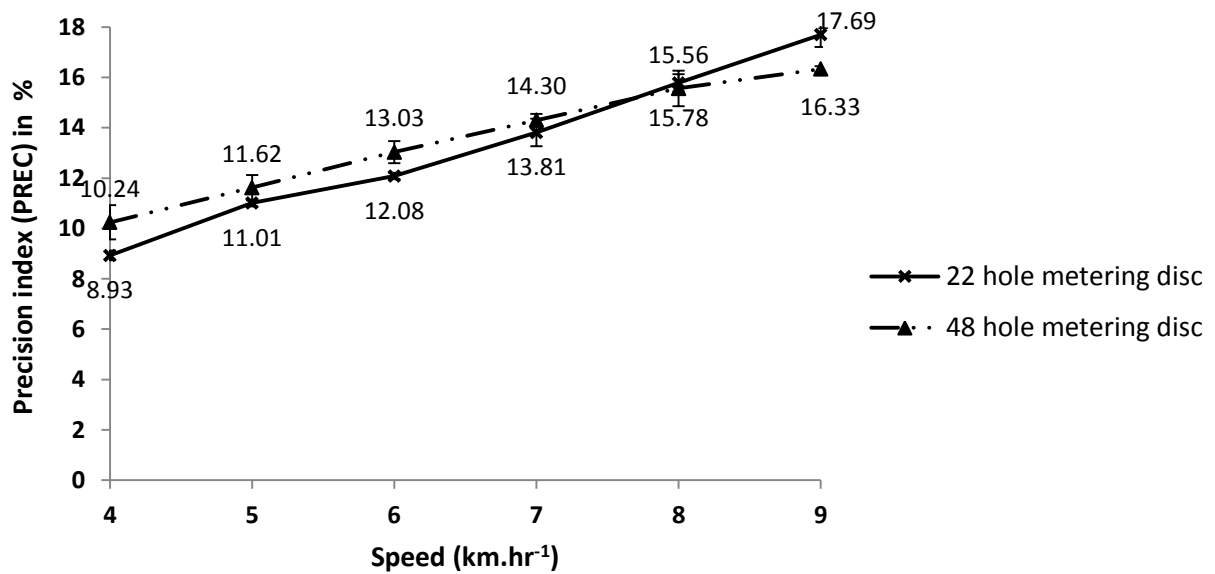
Figure 2. Effect of speed on the precision index (PREC) of the two seed metering disc types

Results of regression analysis made to establish relationships between missing index, quality index and precision index with ground speed are given in Table 4. As it can be observed the coefficients of ground speeds (V) are positive for missing and precision indexes indicating these parameters should be anticipated to increase with ground speed. On the other hand, coefficients of V are negative for quality indexes showing quality index should be anticipated to decrease with ground speed. These relationships corroborated earlier discussions that underline the variations in seed metering performances due to the ground speed increase and seed metering disc type. The R^2 values for all regression equations are greater than 0.91 confirming that the regression equations could be used to predict the effect of ground speed on the performance of pneumatic precision planter fitted the two types of seed metering discs. F test on the coefficients of V for the three planter performance quality indices showed the presence of a highly significant ($p<0.01$) rate of performance deterioration in the 22 hole seed metering disc type than the 48 hole seed metering disc.

Table 4. Regression equations relating missing index, quality index and precision index with ground speed

Parameter	22 hole metering disc			48 hole metering disc		
	Regression equation	R^2	P	Regression equation	R^2	P
Missing index	M=6.314V-26.710	0.927	0.0001	M=2.364V-8.909	0.945	0.0001
Quality index	A=-6.207V+124.971	0.919	0.0001	A=-2.414V+107.86	0.929	0.0001
Precision index	PREC=1.710V+2.096	0.984	0.0001	PREC=1.243V+5.432	0.955	0.0001

V= Ground of speed (km.hr-1) and P=Level of significance

Conclusions

Based on the parameters studied using the high-resolution optical pneumatic planter performance evaluation system with 3kPa suction pressure the 48 hole metering disc performed better than the 22 hole metering disc. The maximum ground speeds that could lead to acceptable plant population in planting the studied acala type cotton seed with the desired spacing for the 22 and 48 hole seed metering discs respectively were 6 km.hr^{-1} and 8 km.hr^{-1}. Therefore, as it could save the time and labor required and make the planting operation efficient, using the 48 hole seed metering disc at 8 km.hr^{-1} ground speed is recommended for such acala type cotton seeds. However, further field study under actual field condition is suggested.

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Biopsychosocial Effects of Domestic Violence against Women: Narratives of Some Survivors in Adama City

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Abstract

The purpose of this study was to investigate the biopsychosocial effects of domestic violence against women with particular reference to domestic violence survivors in Association for Women Sanctuary and Development (AWSAD) Safe House found in Adama City. The study mainly used narrative design of qualitative research where in-depth interview was the major data gathering instrument. From about 24 gender-violence survivors found in the Safe House of AWSAD, only fifteen women who experienced domestic violence were purposefully selected and included in the study. Questionnaires were also administered to 13 key informants from hospital, the Safe House, women and children affairs, and justice offices of East Shoa Zone and Adama City. The data gathered through in-depth interview were analyzed qualitatively with reference to thematic areas of the research questions, while those collected through supplemented the analysis of in-depth interview. The result of the study revealed high pervasiveness of severe biopsychosocial effects of domestic violence on women in the study area. Based on the findings, it was recommended that concerned government bodies, particularly, women and children affairs offices and police should work with other partners like NGOs, research institutes and universities to address problem of domestic violence in a comprehensive manner.

Keywords: Biopsychosocial, effects, domestic, violence, women

Background and Justification

The term 'domestic violence' includes violence by an intimate partner and by other family members, wherever this violence takes place and in whatever form. It refers to any abusive behavior within an intimate relationship that causes physical, psychological or sexual harm to those in the relationship. Such behavior includes: acts of physical aggression – such as slapping, hitting, kicking and beating; psychological abuse – such as intimidation, constant belittling and humiliating; forced intercourse and other forms of sexual coercion (UNICEF, 2000; WHO, 2012).

Domestic violence is a worldwide problem that is not limited to any demographic, geographic or economic boundary. It happens in rural and urban areas, within all age, religious and ethnic groups, and across all socio-economic groups. It can happen between people who are married, in de facto relationships or just dating. Assessment by the World Health

Organization (WHO, 2012) on 10 countries between 2000 and 2003 reported violence on over 24,000 women. The report estimated that each year, about It is one of the leading causes of injury and death to women. It also leads to short and long-term health problems such as mental illness, and problems with sexual and reproductive health. The economic cost of domestic violence on the individual, family, community and country as a whole is considerable. Women in violent relationships often have trouble holding down jobs or accessing enough money to feed their children or provide them with other necessities (Sakhi, 2012).

One of the most common forms of violence against women is that performed by a husband or an intimate male partner. This is in stark contrast to the situation for men, who in general are much more likely to be attacked by a stranger or acquaintance than by someone within their close circle of relationships (WHO, 2012). The fact that women are often emotionally involved with and economically dependent on those who victimize them has major implications for both the dynamics of abuse and the approaches to dealing with it.

Some international reports argue that, there has been a greater understanding of

5,000 women worldwide are murdered by their family members in the name of honor. Intimate partner violence against women is among the highest in the world. the problem of domestic violence, its causes and consequences, and an international consensus has been developed on the need to deal with the issue. However, much has not yet been done on creating women's awareness on domestic violence as a crime. Effective strategies to address domestic violence against women are still being defined as getting rid of attitudes deeply entrenched on men's power over women are not that easy. As a result, women worldwide continue to suffer, with estimates varying from 20 to 50 per cent from country to country (WHO, 2013).

According to WHO report, the highest proportion (45.6%) of women in the continent report either physical and/ or sexual violence by intimate partner. The continent ranked second (37.0%), next to South-East Asian Region (37.7%), in the rate of intimate partner violence prevalence in the world. Thus, domestic violence against women in Africa is more pronounced.

Local researches on domestic violence against women have been done in different

parts of Ethiopia. Studies conducted on "Community attitudes and women's response to intimate partner violence against women" in west Ethiopia by Abeya , Afework and Worku (2012); "Magnitude and Correlates of Intimate Partner Violence against Women and Its Outcome in Southwest Ethiopia," by Deribe, Beyene, Tolla , Memiah & Biadgilign (2001); "Domestic violence and its predictors among married women in reproductive age" in North Western Ethiopia", by Agumasie, Tefera, and Misra (2013), and "Domestic violence against women" in Kersa District of Arsi Zone (eastern Ethiopia) by Shanko, Wolday, Assefa and Aro in 2013 are among the researches related to the present study. They all were cross-sectional studies that reported high prevalence of domestic violence against women. None of them have looked into psychological, social and physical (multifaceted) effects of the problem in depth.

To this end, the present study wanted to investigate the biopsychosocial effects of

Theoretical Framework

The purpose of this study was to explore the physical, psychological and social consequences of domestic violence on women survivors. Thus, the study used the biopsychosocial model to understand the

domestic violence against women in Adama City and its environs with particular emphasis to survivors in the Safe House of Association for Women Sanctuary and Development. As the previous researches, it has considered the prevalence of the problem in the study area. But it is different in that it tried to investigate the magnitude of domestic violence through exploring its biopsychosocial effects on the survivors, as narrated by informants of the study. The present researcher mainly used narrative approach of the qualitative study to look into the problem using an in-depth interview with limited number of survivors in the Safe House of Association for Women Sanctuary and Development (AWSAD). Since only gender violence victims with critical hurt and little or no social support are referred to the AWSAD Safe House from different districts, their cases is believed to represent the severity of domestic violence against women at the study site.

holistic nature of victims' experiences. The biopsychosocial model of health and illness is a framework developed by psychiatrist George Engel in 1970s (Hatal, 2012). It states that biological,

psychological and social factors play a significant role in human functioning in the context of disease or illness. It posits that, health is best understood in terms of a combination of biological, psychological, and social factors rather than purely in biological terms.
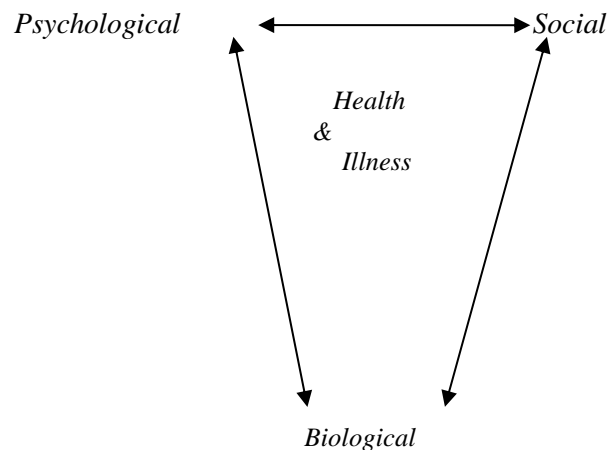
Figure 1: Biopsychosocial (BPS) model of health and illness (slightly adapted from Hatal, 2012).
This figure shows how biological, psychological and sociological factors overlap to determine overall health and illness.

The biopsychosocial BPS framework above shows that health and illness (the middle variables) are consequences of the interplay of biological, psychological, and social factors. It emphasizes health and illness, rather than regarding illness as a deviation from some steady state. The model underlines that, health is what one achieves through attention to biological, psychological, and social needs rather than something that is taken for granted (Taylor, 2009).

According to the model, health and illness are affected by multiple levels of organization, from the societal to the molecular. At the practical level, it is a way of understanding the patient's subjective experience as an essential contributor to accurate diagnosis, health outcomes, and humane care. The model links several dimensions of a person's life: the biological (i.e. genetics, organic causes of disease), the psychological (emotional and behavioral processes), and the social (i.e., a patient's family, friends, and support network), in conceptualizing

health and illness (Catherine, Ellen, Christina, Stephanie, and Nancy, 2012). That is, the biological, psychological, and social factors are all involved in the causes, manifestation, course, and outcome of health and disease. Engel (1980) introduced the biopsychosocial model as an alternative to the biomedical model, which tends to view disease solely in terms of biophysical causes and consequences, overlooking the social and psychological implications of illness (Hatal, 2012).

Sometimes the presence of a biopsychosocial component may cause another. For example, psychosocial factors can cause a biological effect by predisposing the patient to risk factors. A depressed woman may catch liver problem. The depression by itself may not cause liver problems, but the woman may be more likely to have alcohol problems, and therefore liver damage. Similarly, a usually insulted or intimidated woman (experiencing psychological problem) may not be socially active or effective (example at work place). As a result, she may lose job which intensifies social complex and in the long run can develop chronic disease or mental illness due to lack of basic needs. On the other hand, a physically injured or disabled woman (suffering from biological problem) can be

psychologically stressed and socially isolated. Therefore, the biopsychosocial components may have reciprocal relationship in the context of health and illness. A change in one component can cause changes on the other component. This power of influence among the components has been indicated by the arrows in the model above.

In this paper, data gathering, organizing and analysis was guided by the biopsychosocial model. The result of the research can be a foundation for a portfolio of programs and/ or research that seek to implement a new integrated intervention that can address the three intersecting issues of domestic violence survivors' experiences.

From methodological point of view, the researcher adopted the theory of narrative research approach aligned with feminist research (Wood, 2001; Abeya, et. al., 2012). Stories or narratives give special voice to the feminine side of human experience_ to the power of emotion, intuition, and relationships in human lives. Wood argue that women have learned to value subjective ways of knowing, such as listening to a personal inner voice, or intuitively knowing a truth. Subjective knowing has been belittled by society, neglected entirely in our institutions and

determined to be of lesser value in most of our schools. She explains that Feminist ways of knowing are concerned with women's personal empowerment. Likewise, narrative research is attentive to dialogue as a way to have voices heard.

Objectives of the Study

The general objective of the study was to explore the biological (physical health), psychological and social effects of domestic violence against women with reference to narratives of survivors in the Save House of Women Sanctuary and Development Association in Adama City. More specifically, the study tried to:

1. identify biological (physical health), psychological and social effects of domestic violence on survivors in the study area;
2. identify the types of domestic violence women are facing in the study area;
3. determine the main perpetrators of domestic violence against women in the study area
4. describe magnitude of domestic violence against women in the study area.

Methods

Violence, particularly domestic violence is a social problem that occurs between intimate partners and it is not that easy to reveal to external bodies like researchers for a number of cultural, social or psychological reasons. Thus, the researcher set to conduct an in-depth qualitative study using narrative technique since humans make sense of themselves through narrating stories. In-depth interview as a major data gathering tool was conducted with 15 domestic violence survivors in AWSAD. To substantiate the data collected through in-depth interview, the researcher gathered quantitative data from the 15 survivors, 5 psychiatric nurses, psychologists, and social workers from the Safe House, and Adama Zonal Hospital and 13 key informants from women affairs, police, courts and justice offices of east Shoa zone and Adama City administration. Therefore, mixed research design was employed in the course of the study. All subjects of the study were purposefully selected and taken part in the study with verbal consent. No compensation, except refreshment service during interview, was offered for participation.

Analysis was mainly guided by what emerged from the data, rather than by a prior theoretic formulation. The concepts that emerged in the narration of the stories were used to provide conceptual framework or themes for analysis based on the themes of the research questions. Data gathered through main tool of the study_ in-depth interview is concerned each audio recorded interview was listened to and manually transcribed. Then, the transcribed version of the survivors' narrations were read refined by eliminating overlapping, vague, and redundant statements made by the participants and qualitatively analyzed with reference to themes of research questions. Data gathered through questionnaires were presented and analyzed quantitatively using frequencies and numbers in order to supplement the qualitative analysis of data through in-depth interview.

Results and Discussion

Two forms of data (qualitative and quantitative) were gathered from the subjects of the study using an in-depth interview and a follow up questionnaire, respectively. As the research design of the study is qualitative-quantitative, the data gathered using in-depth interview was transcribed and analyzed qualitatively while those obtained via questionnaire were used to supplement the discussion of the qualitative data obtained through in-depth interview.

TYPES OF DOMESTIC VIOLENCE EFFECTS SURVIVORS REPORTED

In-depth interview was conducted with fifteen domestic violence survivors in the Safe House of AWSAD. The interview was conducted in a way that allowed respondents to narrate history of their violence in detail. Out of 15 interviews conducted through audio recording, 10 were transcribed while 5 were rejected for incompleteness due to interrupting interviews on part of the interviewees being emotional. The types of domestic violence effects most of the participants narrated were found to be highly intermingled to the extent that it is difficult to categorize the report narrated under specific effect such as physical or psychosocial, etc. Thus, the analysis and discussion was made by taking sample quotations from narrations of the survivors. Some of the physical, psychological and socio-economic consequences they reported are indicated in this section.

One of the survivors (DVS1) who was abandoned by her husband said,

> *… I could not eat for three days; I felt lonely and got weaker to work as the pregnancy grew… the owner of the house I rented asked me to leave as the compound was on sale. I looked for another rent house. However, I could not find one as people did not want to rent a house to lonely pregnant woman like me."*

The survivor lost appetite because of stress. She was physically weak to work which implies the socio-economic problem waiting ahead. She was lost because of lonesome and socially discriminated to the extent of inability to get rent house.

The second victim (DVS2), who was forsaken by her boyfriend, became helpless as she discovered the truth. "I could not control myself. I did not believe. I did not know what to do or where to go. I became helpless with the baby in my womb." She also mentioned the socio-economic effects she encountered in explaining how much she suffered with sickness of her baby since birth.

> *… The worst thing was that, my baby was extremely sick since his birth. He was hospitalized on his 18ᵗʰ day suffering from 'meningitis' as described by physicians. I passed seven days at hospital. … Again when he was about three months, he was admitted to hospital for appendicitis complication where X-ray was*

> *prescribed. I refused to accept for fearing the consequence ….*

Other survivor was raped by her own cousin. She reported:

> *…It was so strange, shameful and painful thing to me both physically and mentally. I felt badly. Frequent headaches, stress, sleeplessness, loss of appetite for food, for work or for talk, were among the sufferings I experienced,..*

From the above quotation, one can see the biopsychosocial effects the victim encountered because of the violence perpetrated against her by her cousin.

Another evidence of the multifaceted effects of domestic violence perpetrated on the participants is revealed in the narration of DVS4, who was forsaken by a boyfriend. She was scared when she could not find him though he promised to wait for her at Adama to convince her to leave her family at Dassie. She got desperate after looking for him for almost a week. "… I regretted for the mistake I committed refusing the advice of my family and school mates, trusting a selfish boyfriend." But she was ashamed of going back to her family after what happened to her. She decided to live serving as a waiter in hotel, which she had not imagined in her lifetime. "… I worked as a waiter with greater shame and pain in my heart. Many

times, I attempted suicide by drinking toxin detergents while I was tired of washing a lot of clothes every day." She reported missing the comfort, care and love she used to get in her family.

From this case, it is possible to see the psycho-social consequences the violence had brought to the survivor to the extent of thinking to kill herself.

Similarly, DVS5 who suffered from her husband's abuse reported that she was frightened with aggressive reaction of the perpetrator.

> *"I never forget how panic I was when he took off his own shoe and hit me in my face one evening, just for raising about the poor relationship between me and his daughter he got in the previous marriage. My half face got swollen and was burning for the whole night. He got mad at me, which was horrible. I became doubtful about the love between us"*

From this narration, we can see the biological and psychological effect the survivor encountered. She became panic and suspicious of the fake love the man had for her from the very beginning, as she was scared of his horrible personality. The bruise and burning she felt on her face because of the hit and the pain of hunger and pregnancy she felt were among the physical violence's effects she witnessed

suffering from. "He stopped coming home on time; he used to drink with the salary and we were suffering to the extent of lacking food at home." She was economically dependent on the perpetrator who drank with the salary he earns, while the survivor and his own daughter had nothing to eat at home.

She also got unwanted pregnancy that suffered her alone at her young age. Lack of somebody to share her problem, leave alone getting care and support, being a pregnant needy woman, was both socially and psychologically painful than anything else.

> ..., I was suffering from pregnancy pain which was hard to me during the first two months. I did not know what to do or who to share my problem. I had no one to take care of me as he used to pass the whole day at office and most of the evenings drinking.

In general, the survivors reportedly faced physical, psychological and socio-economic consequences of domestic violence perpetrated on them by some ones they expected to love take care of and protect them.

The analyses of responses of professionals from AWSAD safe house, the Hospital, police, court, and women and children offices on the effects of domestic violence

victims usually report also reveal the multifaceted or biopsychosocial consequences of domestic violence with the psycho-social effects taking the dominant place. That is, the physical or biological effect is less frequently reported than that of the other forms of domestic violence.

The finding of the present study is in line with other local researches done on domestic violence against women in different parts of Ethiopia by Abeya, et. al., 2012, Deribe, et. al., 2012, Agumasie, Tefera, and Misra , 2013, and Negussie, et. al., 2009, which reported high prevalence of different forms of domestic violence presumed the multifaceted consequences on the victims.

On the other hand, the result of this study to some extent contrasts with the findings of Kedir, 2004 and Yohannes, 2006, who reported high prevalence of physical violence against women by intimate partner in Kofele District of west Arsi (central Ethiopia). A cross-sectional survey study conducted by Nigatu (2012) on 'prevalence and risk factors of intimate partners' violence against women in Sidama Zone of Southern Ethiopia also revealed that the prevalence of intimate partner violence is high in the study

population with physical violence (beating, causing physical damage and slapping) accounting for the largest share of the overall abusive acts.

This probably implies that physical abuse and its effects are less common compared to the psychological and/ or socio-economic violence which still are frequently reported by victims in the present study area.

Conclusions and Recommendations

The analysis of the data indicates that, domestic violence survivors in the study area report multifaceted effects entailing physical, psychological, and socio-cultural or economic problems. Some sexual abuses like, rape were found to be committed by relatives on young girls below 18 years old. In some cases, the violence ended up in unwanted pregnancy that creates life time physical and psychosocial scar on the victims.

Thus, the study recommends that government bodies such as women and children affairs offices, justice bodies, and hospitals and NGOs working on the victims should consider providing comprehensive service that addresses biopsychosocial effects by recruiting social and more psychologists in addition to health professionals, police and lawyers. Above all these bodies should work on creating public awareness on causes, and consequences of domestic violence to enhance prevention as well as appropriate responses to the victims and perpetrators once it occurred.

Acknowledgements

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Traditional Inter-group Conflict Management in the Upper Awash Region

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Abstract

Intergroup conflict management is concerned with handling conflicts arising between two or more social groups over interests, values or goals. This study aimed at exploring the traditional inter-group conflict management employed by the Karrayu and the Afar pastoralists in the Upper Awash Region. Ethnographic research method was employed to investigate the intergroup conflict situations in the region. The data needed for the investigation were collected through non participant observation which included taking field notes, conducting formal and informal interviews and analyzing document. The data collected using different tools were analyzed using an ethnographic method of data analysis. The investigation revealed that the major causes of conflicts in the region are resource scarcity and cultural requirements. Besides, the study disclosed that all the cultural/ethnic groups inhabiting the area have got well established traditional methods of conflict management. Finally, the study recommended that concerned bodies should attempt to bring together the hostile groups to discuss their differences. Besides the government and the NGOs operating in the area should find ways in which the inhabitant could air out their values and issues.

KEY WORDS: *Conflict, Inter-group conflict, Conflict Management, Pastoralists*

Background of the study

The Upper Awash Region extends from Koka Dam in the North to the Awash Station in the South (EMA, 1988). The altitude of the area ranges from 1600 to 1000 meter above sea level. The region is characterized by high temperature and severe shortage of rainfall (OPEDB, 2001).

As a result, the region is not suitable for rain fed agriculture. Because of this reason, the region is mainly inhabited by agro-pastoralists and transhumant pastoralists whose lives are mainly dependent on drought resistant livestock. In fact, due to the existence of Awash River and extensive

arable land, the region has attracted big government and private investments which aim at growing cotton, sugar cane and fruit farming and agro-processing industries. As a result, the region hosts several large scale government and private mechanized farms.

The Upper Awash Region is inhabited by more than three transhumant and agro-pastoralist ethnic groups: the Oromo, the Afar, and the Argobba. It is the hot bed of intergroup conflicts among different ethnic

and cultural groups. The ever dwindling natural resources and ever expanding expropriation of grazing lands for commercial agriculture by the Federal Government has exacerbated the conflict scenarios in the region. As a result, the seasonally moving Karrayu, Afar and Ittu transhumant pastoralists often enter into conflict. Since all the groups are well armed with machine guns, the conflicts usually result in huge lose on human lives and properties**.**

Statement of the Problem

Intergroup conflict is a ubiquitous social reality which prevails in a situation where two or more social groups live together (Bartos and Wehr, 2002). Black (1990:43) defines conflict management as "the handling of grievances." He explains conflict management in social conditions in five aspects: self-help, avoidance, negotiation, settlement, and toleration. The aim of conflict management in social setting is to ensure peaceful coexistence of rival social groups. The conflict scenarios among pastoralist and agro-pastoralist in Ethiopia in general and in the Upper Awash Valley Region in particular manifest a typical characteristics of intergroup conflicts

between/among different ethnic and cultural groups. This is because almost all the conflicts occurring in the region are either clan based or ethnic based (Ayalew, 2001; Alemaya and Hagmann, 2008). The groups inhabiting the region oftentimes enter into vicious cycles of bloody conflicts over territorial claims and livestock rustling. Besides, the seasonally patterned movements of the Karrayu, Afar and Ittu transhumant pastoralist groups for the search of pasture and water, fuelled with the governmental expansion of the extensive sugar cane farms and private enclosure of communal fields has worsened the conflict situations in the region. As a result almost

all cultural and ethnic groups inhabiting the region have acrimonious relationships which often erupt in the form of open armed conflict.

Despite the fact that the region is infamous for frequent intergroup conflicts, the inhabitants are said to be skillful at managing inter-group conflicts before and after their occurrence (Ayalew, 2001). Especially, the transhumant Karrayu and Afar groups have well established systems of conflict management which focus on both prevention and redressing the impact after

conflicts occur. The traditional conflict management systems which are mainly utilized for in-group conflict situations are oftentimes used in the inter-group conflict situations (Ayalew, 2001; Getachew, 2001).

Therefore, this study aimed at exploring the traditional conflict management skills that theinhabitants of the Upper Awash Valley region employ during conflict situations. The study mainly attempted to identify the conflict management skills that are pertinent to intergroup conflict situations between the Afar and the Karrayu pastoralists.

Objectives of the Study

The major objective of the study is to explore the traditional inter-group conflict management between the Afar and the Karrayu pastoralists in the Upper Awash Region.

The specific objectives of the study are to:

- identify the specific situations which trigger inter-group conflicts between the Afar and the Karrayu groups ,

- find out how the Afar and the Karrayu groups traditionally manage conflicts before and after they happen,

Research Questions

1. What are the factors which trigger intergroup conflicts between the Afar and the Karrayu groups in the Upper Awash Valley Region?

2. How do the Afar and the Karrayu groups traditionally manage conflicts before and after they happen?

Research Design

The objective of this study was to explore the traditional conflict management techniques employed by pastoralists in the Upper Awash Region. Hence, the researcher employed an ethnographic research method which is more appropriate to conduct this exploration. As suggested in Murchison (2010) and *Bailey (2007)* ethnographic research is conducted by personally availing oneself in the research settings. Therefore, the researcher spent around six months in order to look into the way the communities are traditionally managing conflicts. As the subjects of the study i.e. the pastoralist communities were living in different parts of the region, the investigator was required to move from one area to another area; as a result, multi-sited ethnographic approach was adopted for the study.

Sampling Techniques

The researcher employed purposive sampling in order to select the subjects which could provide him with adequate information. Specifically, he used criterion sampling and snow ball sampling procedures. For example, when the researchers sought for information on intergroup conflict and management, they chose people who were involved in some form of intergroup conflicts and management. Similarly, snow ball sampling was used when the researcher identified key informants who were knowledgeable in the area of intergroup conflict as a result of living in the area for a long period of time. In addition, snow ball sampling was also used in searching for elderly people who could provide the researcher with various types of data. The number of the informants depended on the saturation level of the data. Hence, no predetermined number of sample sizes was employed for the study.

Methods of Data Collection

The necessary data for the study were collected through observations, interviews, informal discussions and document analysis. Non-participant observation was employed as a principal method of data collection. Moreover, formal as well as informal discussions were conducted with different

people living in the rural areas of the region. In addition to these, secondary data from documents in AAU's Institute of Ethiopian Studies Library were utilized.

Unstructured interview was conducted with key informants from each cultural group under the study. The key informants were all middle aged and old men. The subjects selected as key informant for in-depth interview were community elders. Besides, similar form of interview was conducted with government officials, civil servants, and police officers operating in the area. Since the researcher could speak Afan Oromo, which is spoken by the Karrayu cultural group, hewas forced to hire a translator only to deal with the data in Afar language.

Method of Data Analysis

As suggested by Marvasti (2004: 89) and Atkinson and Hammersley (1983), the first step in the ethnographic data analysis is sorting and organizing the data. Therefore, when the researcher reached the level of saturation, he was able to collect a large amount of data through the field observation, interviews, discussions and documents. Explanation and interpretation of the data were made through meticulous and constant comparison of the data from different sources. In fact, as Berg, (1989) and Atkinson and Hammersley (1983) expound that analytic induction was undertaken through the infusion of existing literature and theories in the interpretation and explanation process. Accordingly, descriptions of the topic of exploration have been made as follow.

Result and Discussion

Intergroup Conflicts in the Upper Awash Region

Conflict is a ubiquitous social reality (*Fisher, 2006*). However, the degree and the frequency of conflict, make the Upper Awash Region exceptional in the context of intergroup conflict. Almost all the inhabitant groups of the region have very deep rooted acrimonious relationships. The Afar and the Karrayu pastoralists have been arch rival enemies who do not set foot in each other's territories. As a result, no Afar ethnic group

member goes into the Karrayu territories in Fentale Woreda. The same is true for the Karrayu cultural group members. Let alone in bordering lands, these ethnic groups do not even go to the bigger towns administered by the rival ethnic group.

Generally, these two pastoralist and agro-pastoralist communities in the region have hostile relationships which often erupt to open armed conflict. Sometimes the conflicts between the different groups would exert a pull on even Regional Governments. Even if we couldn't verify it through our observation, the Karrayuu cultural groups usually claim that the Afar pastoralists get ammunition and military personnel support from the Afar Regional State police department.

Causes of Inter-group Conflict in the Upper Awash Valley Region

There are several causes for the intergroup conflicts in the Upper Awash Region. Some of the causes of the conflicts could be attributable to the cultural background of the ethnic/cultural groups, while the major causes of the present day conflicts are the desire to control resources and cattle rustling and counter rustling.

In both Afar and Karrayu cultures, participating in warfare was considered as the major duty of the able male members of the cultural groups. Participating in warfare and killing enemy members was highly condoned in both communities. Especially, in the Karayu culture there were occasional raids which were carefully organized at clan level against the enemy occupations. These raids were held for two main reasons. The first reason for the raid was the manifestation of bravery and might which were highly desired in the community and the second reason was that the raid was seen as a means of accumulating quick wealth since the raid usually involved looting of the enemy's properties. Accordingly, there were occasional well organized raids and counter raids in both communities.

The present day conflicts are mainly caused by claims of resources. Especially, territorial claims are prevalent in all pastoralist and agro-pastoralist communities in the region. For instance, the Karrayu cultural group claims that its territories have been illegitimately taken by the Afar community. These claims have often forced the Karrayu community to enter into armed conflict with

their neighboring ethnic group. Similarly, the Afar cultural group in the region claims that its territories have been illegitimately taken by the Karrayu cultural group.

In fact, the expropriation of large tracts of land for mechanized farming, for the national park and for the construction of the KesemTendaho Dam has exacerbated the conflict scenarios in the region. The existed grazing fields had already dwindled, and when the government started appropriating additional land for the expansion of sugar plantation and for the construction of the dam on Kesem River, the pastoralist were left to squabble over the remaining land which could hardly sustain the customary pastoralist way of life. The loss of the lands because of government expansion, farmers' expansion and enclosure of public grazing land for personal farm land have put very severe obstacle on the pastoralists who usually move seasonally from place to place. As a result, the region is characterized by active and latent intergroup conflicts.

In addition, there are some petty intergroup cattle rustlings in the region. Some individuals may intrude into the other group's territories and steal livestock. Besides, there are circumstances in which straying livestock may enter into the out-group's territories and in most occasions the individuals who intercept the livestock would take them deep into their territory or sell them in the nearby markets in their territory. The livestock theft and loss would inevitable result in conflicts between the losers of the livestock and the occupants of the suspected area. Indeed, the governments' efforts to control such rustlings through Woreda Security Militias have born some fruits in curbing the prevalent intergroup cattle rustlings. However, there are still pocket livestock thefts among all the communities in the region and the theft usually triggers skirmishes between these hostile groups.

Traditional Conflict Management in the Upper Awash Region

Conflict management is the process of alleviating the negative impacts of conflict. The aim of conflict management in social setting is to ensure peaceful coexistence of rival social groups. The Afar and the Karrayu cultural/ethnic groups in the region

practice traditional conflict management techniques to prevent and redress conflicts occurring between pastoralist groups. They have survived in the conflict ridden region by effectively utilizing the traditional conflict management techniques.

The Karrayu Oromo pastoralists are highly skilled in managing conflicts occurring between different Karrayu clan groups as well as between the Karrayu and the other ethnic groups inhabiting in the region. Since the Karrayu and the Afar pastoralists seasonally move with their livestock, they are highly susceptible to intergroup clashes. However, the movement of these pastoralists is very cautious and watchful. Before they cross into any other clan group's territories, they always seek permission from the clan leaders by sending representatives ahead of the herding groups. Indeed, they take a serious care when they are moving into another ethnic group's territories since the consequence of trespassing another group's de facto land can trigger serious conflict.

In order to prevent unexpected clashes with enemy group, the pastoralist herding the cattle always employ a reconnaissance group called the *Salfaa* who are sent before the herders in order to check the presence of any danger, i.e. the reconnaissance group checks whether enemy herders and the gaadduu are present in the area. If the *salfaa* are intercepted by the enemy herders, they could fight off or give signals to the herders to move the livestock before any harm is inflicted on the livestock and the herders. Similarly, the *Salfaa*thoroughly monitor the *gaduu* who ambush and stealthily take straying cattle or shoats from the herd.

The other precautionary measures that the Karrayu and the Afar pastoralists take include abandoning the grazing ground altogether. If the two groups of pastoralists believe that herding the livestock could pose some danger to the herds, they usually avoid going to this area. As a result, there are several grazing fields with lush green grasses and bushes which have not been utilized by any group. One typical example to this situation is the foothill of Fentale Mountain, which is the breeding ground of conflict between the DullachaKarrayu and the Debine Afar clan groups: there are lots of grasses and bushes unutilized by both groups.

In addition to these, the Karrayu and the Afar pastoralists have a traditional way of seeking permanent guardianship from the out group. Especially, during a severe drought season, if they believe that there are plenty of grasses in another group's territories, the elders officially request the elders of the other group to show mercy to the troubled group and help them feed their livestock until the worst season passes. In the past, such desperate requests from the Karrayu pastoralists were warmly welcomed by the Afar pastoralist groups. The same was true on the side of the Karrayu Oromo groups. And once the refugee group is allowed the temporary co residence, the members of the refugee group would enjoy every right that the hosting group members enjoy. The refugee group is protected from any kind of external attack by the hosting group.

Even if the groups take very serious preventative measures, there were/are many occasions in which conflicts could happen. When conflicts break every able member of the Karrayu and the Afar groups is expected to show his allegiance by marching toward the conflict arena carrying weapons and ammunitions. The conflict news is often propagated by female members through loud shouting, and it reaches to all Karrayu and Afar villages through chains of shouting. When the male members hear the shouting, they gather at their village through the coordination of clan leaders. Ignoring the call for the participation in combat field is considered as a serious felony and it is punishable by the traditional Karrayu and Afar laws. It could result in severe punishment and total ostracization from the clan system. Therefore, every able male member attends intergroup fights.

As the fighting goes on, elders could send women arbitrating group in order contact the elders of the fighting enemy and request for cease fire and restoration of normal relationship between the fighting groups. The women are deliberately sent because it is unacceptable to harm women by any of the pastoralist groups in the area. As a result, women are used as go-betweens until the reconciliation process takes shape, i.e. until calm is maintained in the opponent group. When the fighting groups come down, if any of the fighting group has inflicted severe loss on the enemy, the elders request for formal reconciliation which includes reparation payment to the enemy for the loss

of both human beings and livestock. Similarly, if the Karrayu members are the victims of the fighting, they could request for compensation for their loss.

The blood money is paid by the harm inflicting group in order to deter further losses and establish a normal relationship which is free from grudges. The compensation is usually paid (would be paid) in terms of livestock, and all members of the paying group are expected to contribute either money or livestock. As decided by the negotiating elders, the clan members make their contribution in terms of cash or in terms of livestock. The blood money is given to the victim group by organizing a special reconciliation event which should openly display to the

important members that a genuine reconciliation is made with the conflicting party.

These days, traditional reconciliation rituals between the Afar and the Karrayu cultural groups are rare. Instead Federal Government officials and NGOs often attempt to mediate between the two groups whenever there are bloody conflicts. However, such third party mediated reconciliations could not bring a lasting peace between the two groups. This is because, on most occasions, the Government and NGO mediated reconciliations between conflicting pastoralists groups are held in big town, and they usually involve community elders, local government officials and few pastoralists.

Conclusion

The major factor that triggers conflict in the Upper Awash Region is scarcity of natural resource and cultural requirements. Since the majority of the inhabitants of the region are transhumant pastoralists or agro-pastoralists, they often engage in bloody conflicts over the control of grazing fields and water points. Besides, the government schemes of expanding the big state farms for

sugar cane and fruit faming have had big blow on the very ways of living of the inhabitants.

In fact, it should be noted that in the past the major triggering factor for the conflicts between the inhabitants of the region was the culture of the groups. The culture of all the inhabitants in the region would

encourage killing people from enemy out-group. Hence, members of the groups would kill members of the enemy out-group in order to fulfill their cultural requirements. However, currently the culture driven conflict scenario has changed through time and scarcity of natural resource, especially grazing land and water, are the major conflict triggering factors.

The ethnic/cultural groups inhabiting in the Upper Awash Region are very skillful in managing conflicts. Since waging an open conflict is often costly for all the groups, they always take preemptive measures before conflicts happen. Seeking permission from out-group (including the other clan of the same ethnic group), using reconnaissance groups before moving their cattle and abandoning the fields which are claimed by out-groups are the major ways of managing conflict before they erupt.

The role of the government in the region is paradoxical. The government often interferes when armed groups engage in bloody conflicts. In such situations the government plays a mediating role to ascertain the peaceful coexistence all the groups inhabiting the area. On the other hand, the government is a guilty party in terms of triggering conflict. This is because when the government owned farms enclose more lands for the expansions of the farm related projects, the inhabitants do nothing but squabble over the remaining grazing lands.

All the ethnic and cultural groups inhabiting in the Upper Awash Region have age old traditions of resolving conflicts arising within group and with out-group. They mainly manage bloody conflicts using compensatory methods in which the victim group is given reparation in terms of heads of cattle or money.

Recommendation

Since the major cause of conflict in the region is scarcity of resources, the governments and the concerned NGOs should find ways in which the inhabitants

could get alternative employment in the nearby farms and factories.

The government and concerned NGOs should find ways in which the inhabitants

come together and discuss their own issues. Mass media could play big role for this purpose. Therefore, the concerned bodies should launch FM radio programs which mainly focus on regional issues using the languages spoken in the region. FM radio programs which are relatively cheap to establish can offer floors in which the two groups can air out their concern and establish mutual understanding. The two groups share several common cultural practices and mode of subsistence and if these commonalities are properly publicized their differences may not deter them from sharing resources instead of abandoning them altogether.

The government should confer with the inhabitants before taking any measures which could affect the livelihood of the inhabitants. No land should be taken by the government without unanimous consent of all the concerned individuals. Since making decisions by conferring with only the leaders of the community could trigger objections from the common members of the community, decision making discussions should include ordinary members of the community.

The age old practices of managing conflicts in the region should be given adequate recognition, and they should be employed in resolving the current hostile relationships between the different groups inhabiting the region.

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Factors in Students' Attrition: Adama Science & Technology University in Focus

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Abstract

The main objective of this study is to find out factors contributing to students' attrition in Adama Science and Technology University. Students with academic dismissal, withdrawals, dropouts, and those with academic warning were the target of this study. The main registrar was used as sources of information to obtain students' academic record and attrition rate. In the selection of academic dismissal, and academic warning students, random sampling technique was employed after stratification based on their school and gender. Accordingly, 145 students with academic dismissal, 160 students with academic warning were used as primary sources of information. In addition, one hundred students with GPA of greater than or equal to 2.00 but less than 2.25 were also used as sources of information. To gather information from the respondents, questionnaire with open ended questions and Likert scale type were used. Documentary analysis was employed as a means to secure information about students' academic background, GPA and attrition rate. ANOVA and multiple regression analyses were used to examine the effect and the contributing factors in students' attrition. The level of significance was fixed at α=0.05. The results indicate that academic background, induction program (academic and social integration) and achievement motivation are found to have statistically significant effect on students' grade and attrition. Besides, it was reported that discrepancy of evaluation procedures used in high school and university have negative effect on first year students' academic performance. Finally, alternative strategies were suggested to reduce attrition rate and increase students' retention.

Keywords: attrition rate, gender, academic background, induction program, achievement motivation, evaluation procedures.

1. INTRODUCTION

The problem of attrition is as old as education. Though it has a long past, it has short history as focus of research. It had got the attention of American researchers in 1960s (Tinto, 1975). Thus, U.S. researchers have taken the lead in developing a wide range of models that attempt to explain key factors that contribute towards students' attrition in higher education (Tinto, 1975, 1993; Bean, 1980, 1983; Bean & Metzner, 1985; Astin, 1985; Braxton, 2000 in Anne, 2006). The issue of attrition has got the attention of Ethiopian researchers in late 1980s. The first research focusing on students' attrition in higher education in Ethiopia was published in 1989 by Asmerom and his colleagues. Now days, student retention rate become an issue of concern for most of the higher learning institutions for it is the most important measure of institutional efficiency. An educational

system is said to be efficient if maximum output (graduation) is obtained from a given input (enrolment), or if a given output is obtained with minimum possible input.

Most researchers gave attention to freshman year as freshman year represents a stressful transition and some students are less able to successfully manage this transition. Worldwide, it is estimated that 40% of students leave higher education without getting a degree (Porter, 1990) with 75% percent of such students leaving within their first two years of college (Tinto, 1987). Mallinckrodt and Sedlacek (1987) also indicated that freshman class attrition rates are typically greater than any other academic year and are commonly as high as 20-30%. Similarly, Attewell and Lavin (2007) designated that the expansions of higher education and high enrolment have been accompanied by non-completion where the first year takes the highest proportion in students' attrition.

According to Johnes (1990) some risk factors associated with university students' attrition are academic difficulty, lack of self-confidence, illness, fear of failure (escaping mechanism), lack of direction or reason to complete and substance use. Noel (1985) adds that the major themes

related to attrition appear to be academic boredom and uncertainty about what to study, adjustment problems, unrealistic expectations of college, academic under-preparedness, incompatibility, and irrelevancy. To Martinez (2003), Conway (2000) and Solomon (2005) student attrition is the combined effect of many reasons including demographics, ethnicity, family, economics, experiences, background and related variables.

An examination of attrition separately amongst males and females identifies striking differences between the two groups (DeBerard & Julka, 2000). According to DeBerard and Julka, male gender was related to lower Grade Point Average (GPA) and greater likelihood of academic warning in the developed world. On the contrary, Emebet (2000) as cited in Hedija (2002) pointed out that those female students with low GPA found to have poor academic background. However, Ryland, Riordan and Brack, (1994) suggested that gender is not a consistent predictor of overall academic achievement.

Academic and social integration are also taken as a robust predictors of students' chance of success (Nicholl and Sutton, 2001 in Solomon, 2005; Tinto, 1975,

1982). Academic integration includes students' learning experiences, academic activities and performance, the interaction of students with the faculty and students' classroom experiences. Social integration incorporates students' participation in the institution's social activities such as socializing with peers, sense of social belongingness, their overall capacity to integrate with the institution's community and their commitment to the institution as measured by their decision to persist until graduation in the same institution.

Achievement motivation, attribution, interest and level of degree aspired have also paramount importance in students' academic performance and tendency in attrition. Achievement motivation is the drive to work with diligence and vitality to constantly steer toward targets even in challenging and difficult situations (Bigge and Hunt, 1980). There is a positive relationship between achievement motivation, academic engagement and academic achievement (Akpan & Umobong, 2013; Emmanuel, et. al, 2014) that influences student persistence in college (Allen, 1999)

Difference in mode of assessments between high school and university further unfavourably affect students' performance in university and their persistence. Most assessment procedures and examinations in high schools are of objective type, whereas most examinations in universities are of essay type focusing on accentuating differences among students and grading on the normal curve. Above all, the first test has significant place in students' university life. Evidence shows that how well or how poorly students do on that very first test can have a profound influence on their achievement over the remainder of the semester (Thayer, 1973 in Guskey, 1988). Students who did well on the first test given in a course generally improved their marks throughout the semester and achieved even higher grades on subsequent tests. Students who did poorly on the first test, however, rarely improved their performance. They feel bad, deficient, undesirable and develop a failure identity that negatively affects their personalities and aspirations (Kifer, 1975 in Guskey, 1988) and academic performance too.

In Ethiopia, with the expansion of higher education students' enrolment rate has increased in different universities. This increasing enrolment has been accompanied by high rate of student attrition. For example, between the academic year 2013/14 and 2014/15, 978 (M=422, F=556) and 767 (M=402, F=365)

students were academically dismissed out of 12159 (M=8888, F=3271) and 8713 (M=6319, F=2394) from Adama Science and Technology University respectively. This is 8% and 8.8% attrition rate within two academic years with the exclusion of dropout and withdrawal students. High attrition denotes the inefficiency of university and wasted opportunities for those who dropout, withdraw or academically dismissed students to develop the knowledge, skills, attitudes and values needed to live productive lives. The situation can also develop students' self-doubt, personal embarrassment and sometimes discourage even the most ambitious students who aspire to join a university.

In spite of government's interest in expanding higher education, growing interest to increase student enrolment and endeavour to improve quality of education and accompanying high rate of academic dismissal, and despite the potential deleterious consequences of attrition, there is no study made in Adama Science and Technology University, at least to the researcher's knowledge. Studies made at different times in different institutions of learning by different researchers are different from this research at some points. Some focused on a single higher learning

institution (e.g. Solomon, 2005), some on primary schools (e.g. Habtamu, 2002), some omit the variable of gender and had done 20 years back (e.g. Asmerom et al, 1989) and other focused on casual attributions as causes of attrition (e.g. Tamire, 1997) and all of them gave inadequate attention to the impact of academic and social integration in students' attrition. Thus, this study was initiated by the absence of study made in Adama Science and Technology University regarding attrition and a huge amount of students' academic dismissal in spite of the university plan to reduce attrition rate by less than 3%.

From the scrutiny of notions and empirical research findings discussed above, Tinto's (1975, 1993) Longitudinal Theory of Institutional Departure and Bean and Metzner's (1985) Nontraditional Student Attrition Theory were used as theoretical frameworks in this study. Tinto's (1975, 1993) Longitudinal Theory posits that students' background characteristics and pre-college academic achievement directly influence their initial commitment to the goal of graduation and to the institution. Upon entering college environment students interact with and integrate at various degrees into the diverse social and academic communities

of the institution. Successful social and academic integration influences subsequent commitment to the goal of degree completion and commitment to the chosen institution, thus affecting the decision to leave or continue at the institution. A voluntary decision to leave the institution might indicate unsuccessful integration into social or academic life at the university.

Bean's (1990) Student Attrition Model is an integrative model that addresses the departure puzzle from multiple perspectives: sociological (background characteristics, academic and social integration of the student with the institution, work and family responsibilities), economic (student finances), organizational (admissions, rules and regulations, course scheduling and offering, academic advising, and financial aid), and psychological (attitudes, self-beliefs and academic intent). Bean hypothesized that factors affecting how students integrate academically and socially would shape their self-confidence, development, as well as their perceptions of the utility of university education.

The two student attrition models were selected as theoretical framework of this study as both of them are useful in the explanation students' retention or attrition from the perspective of factors including background characteristics, social integration, academic integration and achievement motivation.

Consequently, this study was intended to answer the following research questions:

- How well academic background, induction program and achievement motivation predict students' success in university and attrition?
- Is there gender difference in attrition rate?
- To what extent discrepancy in evaluation procedures used in high schools and university affect students' performance in university?

The objectives of this study are:

- To examine the independent and combined effect of academic background, lack of adequate orientation program, achievement motivation and gender difference to the variance e of attrition rate.
- To pinpoint whether or not gender difference exists in attrition rate.
- To suggest some retention strategies.

2. RESEARCH METHODOLOGY AND DESIGN

In this study, a descriptive survey type research based on Tinto's (1975, 1993) longitudinal model of institutional departure and Bean and Metzner's (1985) non-traditional student attrition model was utilized. In this section, the research participants, data gathering tools and procedures, and method of data analysis that were devised as part of the empirical study are described in detail.

Participants and Sampling Procedures

The target population of this study are Adama Science and Technology University students with academic dismissal, withdrawal, dropouts and students with academic warning. From among academic dismissal and academic warning students, 145 students with academic dismissal and 160 students with academic warning were used as sources of information. In the selection of academic dismissal, and academic warning students, random sampling technique was employed after stratification based on their school and gender. One hundred students with Grade Point Average (GPA) of 2.00 and above but less than 2.25 were also used as source of information.

Instruments

Questionnaire was the major data gathering instrument. It was developed from different literatures. In particular, the theoretical models of Tinto (1975, 1988) and Bean and Metzner (1985) were useful in generating items. The questions focus on the demographic factors, academic background, effectiveness of university's academic and social integration, ranking of teaching methods, the focus of assessment procedures, and achievement motivation. The questionnaire was reviewed by two research experienced lecturers for clarity and relevance and their constructive suggestions were incorporated with care.

Pilot study was also conducted and reliability of the instruments was checked using Cronbach alpha. Accordingly, the reliability coefficients of scale on adequacy of induction program and achievement motivation were found to be 0.86 and 0.88 respectively.

Documentary analysis was also used to secure information about students' academic records such as ESLCE and entrance exam result, CGPA, students with academic dismissal and academic warning as well as attrition rate.

Data Collection Procedure

In the administration of the questionnaire to the academic dismissal students, trained data collectors such as department secretaries were used. These data collectors handed the questionnaires to the academic dismissal students up on their coming before they collect their grade reports. The researcher administered the questionnaire to academic warning and students with CGPA of 2:00 and above but less than 2.25 in a face-to-face situation.

Methods of Data Analysis

In data analysis, ANOVA was used to examine the effect of academic background, induction program, and achievement motivation on students' attrition. Multiple regression analysis was used to examine the contribution of predictor variables in the variance of students' attrition. Percentile was used to examine the effect of gender and evaluation difference on attrition rate. The level of significance was fixed at $\alpha=0.05$ level.

3. Results & Discussion

In this section the data obtained from both primary and secondary sources are presented and analyzed that eventually followed by discussion.

3.1 Results

In this subsection, attrition rate and factors in students' attrition are analyzed using percentile, ANOVA, regression analysis and rank ordering.

Attrition rate of 2011/12 Entry Students

The number of students enrolled in 2011/12 in Adama Science and Technology University were 4647 (M=3359, F=1288). Out of these enrolled students only 1600 (M=1231, F=369) students could graduate from 3 years programs in 2013/14 and 1817 (M=1415, F=402) students from 5 years programs in 2015/16, which is a total of 3417 (M=2646, F=771) graduates. From this data, the overall attrition rate is 26.5% when we compute the difference between enrolled and graduated students. It was also found that the attrition rate of male students is 21.23% and the attrition rate of female students is 40.14%.

Table 1: Regression Analysis of Educational Background, Induction, Achievement Motivation and Gender on Attrition Rate

Source	SS	Df	MS	F	P	R^2
Regression	5142.623	4	1285.656			
Residual	2008.242	400	5.021	256.076	<0.001	.716
Total	7150.864	404				

As can be observed from Table 1, the four variables, i.e., educational background (ESLCE and entrance exam), induction (social and academic integration), achievement motivation and gender are important antecedents of attrition. They are significant predictors of attrition for 71.6 percent of attrition is accounted for by the linear regression of the four variables. When stepwise regression analysis used, academic background found to have the highest contribution (R^2=.42) more than other variables. Most students experienced attrition for academic reasons. Induction is the second important factor in students' persistence or discontinuation, especially, during the first year of university life. The third important factor in academic success is the need for academic achievement. Students' academic achievement is characterized by consistent work, starting work as early as possible, future orientation, regret for unsatisfactory performance, interested in and enjoy challenges.

Table 2: ANOVA Summary Table

Source	Sum of Squares	Df	MS	F	P
Corrected Model	7148.515	105	68.081	4.53	<0.01
Intercept	29855.829	1	29855.829	98.64	<0.001
Education Background (E)	18.45	1	18.45	14.21	<0.01
Induction (I)	968.99	23	42.13	3.48	<0.05
Achievement Motivation (M)	508.32	18	28.24	1.95	<0.05
Gender (G)	0.13	1	0.13	5.69	<0.05
ExI	934.09	29	32.21	1.35	NS
ExM	486.80	20	24.34	2.57	<0.05
ExG	21.63	3	7.21	2.41	NS
IXM	1675.32	46	36.42	2.48	<0.05
IxG	530.48	19	27.92	0.90	NS

MxG	266.14	14	19.01	2.09	NS
ExIxM	31.17	1	31.17	2.89	NS
ExIxG	9.97	1	9.97	1.74	NS
IxMxG	34.28	1	34.28	1.92	NS
ExMxG	18.67	1	18.67	2.14	NS
ExIxMxG	30.31	1	30.31	2.93	NS
Error	3168.97	119	26.63	-	-
Total	36100.000	404	-	-	-
Corrected Total	7148.515	403	-	-	-

As can be seen from Table 2, academic background, induction, achievement motivation and gender exert statistically significant influence on attrition rate. That is, the highest academic success in high school, effective induction program, and high need for academic achievement, the highest academic achievement in university and the highest students' persistence. Inversely, poor academic background, inadequate orientation program and the lowest academic achievement, the highest the attrition of students. Female gender is associated with the highest attrition rate. The interaction of educational background and achievement motivation as well as between induction and achievement motivation are also significant. But the rest of the interaction effects are not significant.

Table 3: Difference in Evaluation Format Used in High Schools and University

Item	Frequency	%
Yes, difference exists	405	100
No, there is no difference	0	0

All the research participants agreed that there are disparity of evaluation procedures used in high schools and universities. Essay is the most widely used evaluation format in universities while objective type questions are commonly used in high schools. They reported that this variation affected their first year academic performance in university. Besides variation in evaluation procedures used, 87% of the respondents denoted that university evaluation focuses on accentuating difference among students rather than focusing on improving teaching and learning, increasing the confidence of students and enhancing the development of

individual students. When asked rank ordering of evaluation procedures used at university, all respondents agreed that essay/workout is the most common evaluation procedures employed in university. Evaluations based on laboratory reports are the next most commonly used assessment technique in engineering and natural sciences. Individual/group assignments are also utilized across different courses.

From open ended questions, person-related and university-related factors were identified as source of students' attrition. Person-related factors include fear of failure; love affairs with opposite sex students; failure to attend classes, indifference, peer pressure and drug addiction; lack of adequate preparation for rigor learning, illness, academic difficulty and lack of self-confidence. University-related factors comprise lack of training on appropriate study skills; assignment to departments which are not their choice; lack of proper support like unswerving guidance and counselling services and tutorial class; degree holders teaching degree students; and inadequate facilities like cafeteria service, lounge, recreation, etc.

3.2 Discussion

The prime concern of this study was to find out factors in students' attrition in Adama Science and Technology University. The present section deals with discussion and comparison of the results with other empirical findings.

3.2.1 Academic Background, Induction Program, Achievement Motivation and Attrition

In this study poor academic background, ineffective induction (academic and social integration), and low need for academic achievement are found to be associated with students' attrition. Consistent with this study Allen (1999), Asmerom, et al. (1989), Elliott (1997) and Solomon (2005) found that academic variables such as high school grades, high school rank and academic under-preparedness are some of the common factors in students' attrition.

The second important factor in students' attrition found in this study was inadequate induction program. This result is consistent with some research findings (e.g., Fozdar, Kumar & Kannan, 2006) in that students' low performance and attrition are attributed to inadequate

student-support related reasons such as orientation programs, course- specific

academic counselling and information services

3.2.2 Gender Difference in Attrition Rate

The overall attrition rate of students from Adama Science and Technology University is 26.5% for the academic year of 2011/12 entry. But variation exists among male and female students where females are the highest victims of attrition. Research results are inconsistent regarding gender difference in attrition rate. Roderic (1993) found that attrition rates vary widely among different social groups and gender that increases with increasing educational levels. Rumberger (1987) in Habtamu (2002) says that attrition is common among boys rather than girls. On

the contrary, there is a claim that dropout, failure and repetition rates are higher for girls than boys, especially, in developing countries (e.g., UNICEF, 2000; World Bank, 1999; Women's Affairs Department, 1999 in Habtamu, 2002). Studies conducted in Ethiopia are consistent with the later finding (e.g. Ayalew, 1997; Darge, 1997; EMIS-MoE, 1999; WAD, 1999; Tilaye, 1997 in Habtamu, 2002; Emebet, 2000 as cited in Hedija, 2002) which are also consistent with this study.

3.2.3 The Effect of Discrepancy in Evaluation Procedures in High Schools and University on Student Performance in University

In this study, it was found that all subjects agree that there are disparity of evaluation procedures used in high schools and university. That is, essay is highly emphasized in universities while objective type questions are highly emphasized in high schools. They reported that this variation affected their first year academic performance in university. Evidences from different research results show that deviation of assessments is the most significant reason for student losses during

their first year at university. Above all, the first test has paramount importance in the later achievement and persistence (Thayer, 1973 in Guskey, 1988). Contrary to students who did poorly on the first test those who did well on the first test given in a course generally improved their marks throughout the semester and achieved even higher grades on subsequent tests. Those students, who did poorly on the first test, tend to develop failure identity and feel less positively about themselves and about

their chances of success in future learning situations (Bloom, 1976; Kifer, 1975 in Guskey,(1988)

Conclusion

From the results and discussion made, it can be concluded that academic background, induction program (social and academic integration) and achievement motivation are antecedent factors both in students' success and persistence in university. It was also found that attrition is common among female students more than male students. Moreover, it can be established that discrepancy in evaluation procedures used in high schools and university affected students' performance in university negatively. The implication is that there is a high demand for putting intervention strategies in place to materialize social and academic integration programs, increase achievement motivation, and curtail disparity between evaluation procedures used in high schools and universities in order to reduce students' attrition rate.

Recommendations

Reducing attrition rates requires a commitment on the part of university systems to direct resources to and to prioritize attrition prevention initiatives. University systems must also have a base of knowledge with which to design interventions, and to resolve debates over the appropriate direction of prevention efforts. On the bases of these premises, results of the study and conclusions made, the following alternative solutions could be sought:

1. Care must be taken in the selection of competent students. The selection need to combine results from high school results, ESLCE, entrance exam prepared by Ministry of Education and the University.

2. Intensive and extensive orientation must be given for the students before and after they join the university. Before they join the University, information need to be disseminated through plasma, internet, newsletters, etc. Welcome ceremony need to be prepared on their arrival. After they join the university, induction program need to be arranged to ensure students' social and academic integration.

3. Learning assistance programs should be available to help under

prepared students to achieve university level work.

4. Academic programs should provide competent advisers and well-trained staff who are alert to the special problems of students who are at risk of attrition.

5. Improving academic counselling, library facilities, medical services, cafeteria services, recreation opportunities, etc.

6. Assertiveness training need to be given for female students, especially, in the first year.

7. Enhance students' achievement motivation and tap them into self-motivation, self-direction and independent study.

8. Assigning students to departments based on their ability and interest.

9. Motivate students by helping them to be successful on the first or two tests with increasing difficulties so that they may develop self-confidence.

10. Teachers need to employ continuous assessment and give specific and prescriptive feedback soon after the performance is completed.

11. Finally, intensive study including other demographic factors (age and region), attribution factors (ability, effort, luck and nature of task) and risk factors (smoking, drinking, chewing chat and other illegal drugs) is recommended.

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Antimicrobial activity of some selected traditional medicinal plants from central Ethiopia

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Abstract

Medicinal plants have great roles in the treatment of infectious diseases in developing countries where trained man power is in scarce and/or where health institutions are inaccessible to the community. In Ethiopia, several traditional medicinal plants (TMPs) have been using for the treatment of various ailments for a long period of time though their biological activities have not adequately evaluated. The aim of present study was to evaluate the possible antimicrobial (in vitro) potentials of nine TMPs so as to determine their claimed biological activities by traditional healers against pathogenic bacteria, and to explore an efficient solvent for extraction of potential antimicrobial phytochemicals. TMPs screened for this study include Cordia africana, Schinus molle, Dovyalis abyssinicum, Eucalyptus camaldulensis, Asparagus africana, Zingiber officinalis, Calpurnia aurea, Ocimum lamiifolium and Ageratum conizoide. Crude plant material was sequentially extracted with chloroform, ethyl acetate, methanol and aqueous solvents. Three gram negative (Escherichia coli, Pseudomona aeruginosa, and Salmonella typhi) and two gram positive bacteria (Staphylococcus aureus and Bacillus spp) were tested with each solvent soluble extract. Organic solvents (chloroform, ethyl acetate and methanol) plant extracts were exhibited more antibacterial activity than the corresponding water extracts. The highest (78%) and the least (22%) antimicrobial activities were obtained from methanol and water soluble extracts, respectively. Although degrees of growth inhibitions vary, all the screened plants showed antimicrobial activity to two or more bacterial strains. S. molle, E. camaldulensis, A. conizoides and D. abyssinicum showed broad spectrum nature of antibacterial activities whereas C. africana leaf extract, C. africana stem bark extract and O. lamiifoliumwere specific to E. coli, Bacillus spp and S.typhi, respectively. The result of this study substantiates folklore usage of the studied plants and it suggests that some of plant extracts possess potential antimicrobial phytochemicals. Thus, the relationship of traditional therapeutic claims with the specific antimicrobial activity, as illustrated in the present groundwork results, also give clues for further investigations of the bioactive principle(s). For extraction of potential antimicrobial phytochemicals, methanol (with an intermediate polarity) showed promising efficiency than an extreme polar (water) and non-polar (chloroform) solvents.

Background

Ethiopians, like many other people in developing countries, have relied on a system of traditional medicine for centuries. Traditional medicine consists of either

emprico-rational and magico-religious elements or combinations of the two elements at a time. Infectious diseases that account major proportion of primary health care system are often treated with these approaches. For empirico-rational or/and magico-religious traditional health care system, plants are the center of therapy in re-establishing or maintaining wellbeing of the people (Geyid et.al, 2005). In this country, using traditional medicinal plants have continued to the present days for a number of reasons: mainly for conserved ethno medical tradition, less side effects of TMPs and residence in an area with diverse flora over many generations (Dawit et.al, 2003).

Traditional healers hereafter, traditional health practitioners (herbalists, bone-setters, birth attendants and diviners) provide TMPs for their patients/clients to treat acute ailments, chronic infectious diseases and various health disorders. Of these, they usually treat; the infectious diseases of bacterial origin are known to dominate the traditional health practitioners' routine health care systems. For instance, *Nerium oleander* (dressing wound), *Rumex steudilii*

(gonorrhea and fever), *C. aurea* (diarrhea), boiled *Datura stramonium* seeds (tooth ache), *A. africana* (gonorrhea and other sexually transmitted infections) are a few among others (Lulekal et .al, 2013; Geyid et.al, 2005). The herbalists provide preparations from leaves, roots, stems, fruits, seeds, etc. It is obvious that the curative elements are not the entire stated plant parts rather the bioactive secondary metabolites that plant use for defense against predators, herbivores, fungal and other microbial invasions (Dawit et.al, 2003). Plants rich in wide varieties of secondary metabolites belonging to chemical classes including tannins, terpenoids, alkaloids and polyphenol are generally superior in their antimicrobial activities (Kueteet.al, 2006). The effects of these natural products depend on the diversity and quantity of the constituents. The study of Geyidet.al(2005) showed that 20 plant species which were identified in accumulating 2-5 compounds inhibited the growth of three or more organisms compared to 19 plant species with 2-3 compounds which inhibited the growth of only one type of organism.

According to Soberon et.al (2007) plant kingdom constitutes are the sources of new

chemical compounds which have potentials as an alternative medicine and important options for various biological applications (food flavor, food preservative, fragrance and biocides). Of the 250,000 species of higher plants exist on our planet, only about 30% of the world drug sales are based on plant natural product (Jeevan et. al, 2006). However, herbal medicine is still the basis for about 75-80% of the world population, mainly in developing countries for primary health care. In the last few years, major increases in herbal medicine have been also observed in the developed world too (WHO, 2008).

Since ancient times mankind has relied on medicinal plants, but in 20th century the tendency shifted towards chemical drugs. Now a days, the situation is reversed back to plant based medicines due to various reasons: resistance development of pathogens to commercial antibiotics, the high costs of synthetic drugs, inaccessibility of modern health facilities, cultural acceptability and better compatibility of

medicinal plants with human body and fewer side effects (Ulysses et al, 2007; Parekh et al, 2005). It has been also realized that plants contain almost infinite molecular structural variations which have valuable sources for a novel drug discovery. Hence, recently the demand for new, safe and effective antimicrobial agents-from natural sources- has been significantly increasing worldwide (WHO, 2008). In Ethiopia, several plants have been using for the treatment of various ailments for a long period of time though their antimicrobial activities have not yet been adequately determined. The present study, therefore, aimed to evaluate the possible antimicrobial (*in vitro*) potentials of nine TMPs so as to find out their claimed biological activities, by traditional health practitioners, against pathogenic bacteria, and to explore an efficient solvent for extraction of potential antimicrobial phytochemicals. The selected and screened TMPs include *C. africana, S. molle, D. abyssinicum, E. camaldulensis, A. africana, Z. officinalis, C. aurea, O. lamiifolium* and *A. cognized.*

N o.	Scientific name (Family)	Plant parts traditionally used	Folkloric uses
1	*C. africana* (Boraginaceae)	Stem bark, leaf, root	Leaf or stem bark juice is used to treat scabies, wounds and eye infections; fresh leaf heated on fire, powdered and mixed with butter is applied on wounds and skin rashes; root and stem bark powder mixed with water is taken orally for the treatment of stomach ache (Dawit et.al, 2003).
2	*S. molle (Anacardiaceae)*	Leaf, bark	Leaf juice is used to treat eye infections, toothache, constipations, gonorrhea and joint pains; bark extract infusion is used for the treatment of diarrhea (Dawit et.al, 2003); many peoples in the study areas believed that it helps in fighting depression, and they also clean their houses with leaf and branches of this plant to keep away the house flies and other insects, and brush edges of beds to repel biting bed bugs
3	*D. abyssinicum (Salicaceae)*	Leaf	Leaf decoction is used for the treatment of sore throats, tape worm and toothache (Elizabeth et al., 2014; Dawit et.al, 2003).
4	*E. camaldulensis (Myrtaceae)*	Leaf, bark	Leaf extract is used to treat skin infections, fever, stomach cramping; leaf is boiled with water and vapor is inhaled and /or drunk with *Citrus limon* fruits to treat cough, flu and sore throat; the leaf extract is also used in treating joint pain, poorly healing wounds, dysentery and intestinal parasites such as pinworm and tape worm(Dawit et.al, 2003).
5	*A .africana* (Liliaceae)	Root	Root extract is drunk for the treatment of diarrhea, gonorrhea and pneumonia; fresh crushed root mixed with water is taken to dilate birth canal and to stimulate milk secretion (Elizabeth et al., 2014).
6	*Z. officinalis* (Zingiberaceae)	Rhizome	Rhizome chewed and swallowed as remedy for stomach pains, nausea, vomiting and diarrhea; rhizome decoction is also used to treat joint pains, fevers, headaches, toothaches, jaundice, sore throat and coughs (Samir et al., 2003;Dawit et.al, 2003).
7	*C. aurea* (Fabaceae)	Leaf, stem, root, seed	Fresh leaf, root or stem is crushed and homogenized in water to drink for the treatment of diarrhea, toothache, inflamed epiglottis and wounds; crushed seeds are swallowed to treat jaundice, malaria and ascariasis, and powdered seed mixed with water that stayed overnight is provided for male's impotency(Elizabeth et al., 2014; Tadeg et al., 2005; Dawit et.al, 2003).
8	*O.lamiifolium* (Lamiaceae)	Leaf, root	The fresh leaf is squeezed and the juice sniffed served with boiled coffee to treat coughs, fever with headache and colds. The juice is also used as an eye rinse to treat eye infections. Root or leaf water extract is used for wound dressing (Lulekal et .al, 2013).
9	*A.cognized (Asteraceae)*	Leaf, whole plant	Leaf or whole plant aqueous extract is used to treat fever, joint pains, headache, stomach cramping, dysentery and pneumonia. Leaf juice is employed for dressing burning wounds (Dawit et.al, 2003).

Materials and Methods

Plant materials collection and identification

Nine fresh plant/plant parts (Table 2) were collected from different parts of central Ethiopia mainly East Shoa and West Shoa administrative zones based on claims of traditional health practitioners and practices of the local communities. The specific sites where samples were collected include Guder, Ambo, Ejere, Bishoftu and Holetta with an elevation range of 1920 to 2812 meter above sea level. Rhizome of *Z.officinalis* was purchased from the local open market. Sampled plants/plant parts were washed under running tap water thoroughly and dried in well ventilated shade areas at room temperature. The air dried plant materials were ground into a powder using an electric plant grinder machine, and the powder was sealed in polyethylene bags until extracted by aqueous/organic solvents. The plants were identified by Botanists using standard Flora of National Herbarium at Addis Ababa University, where voucher specimens have been conserved. The studied plants have been described in the Flora of Ethiopia, Volumes I-VII.

Organic solvent crude extraction

Organic solvents (chloroform, ethyl acetate and methanol) and water were used for crude extraction of coarse powdered plant materials in the increasing order of solvents' polarity (Fig. 1). Five-hundred-gram powder of each plant material was soaked in 750 ml of chloroform for 24 hrs, and the supernatant was filtered by Whatman No.1 filter paper. The procedure was repeated three times by soaking the residue with fresh chloroform. The leftover residue, after extraction with chloroform, was extracted with ethyl acetate and methanol accordingly with their increasing polarity following similar procedures as of chloroform. Briefly, after powder plant sample were extracted with chloroform, the residue was soaked in 750 ml ethyl acetate followed by methanol. The samples were kept in each solvent for 24 hrs. The crude extracts were harvested one after the other. Solvents were removed from the final crude extract with a rotary evaporator and sterilized by 0.2 µm pore size membrane filter paper, kept in screw capped bottle and stored at $4^{o}C$ until

antibacterial test was carried out (Panthi et al., 2006).

Aqueous crude extraction

Organic solvent extract leftover residue was extracted with distilled water for 6 hrs at a low heat ($50^{o}C$). It was extracted in distilled water in the ratio of 5g /50 ml (w/v) for 20 minutes. Every two hours, the extract was filtered through standard filter paper Whatman No.1 followed by centrifugation at 5,000 rotations per minute (rpm) for 15 min. The supernatant was collected in labeled clean screw capped bottles. The procedure was repeated thrice to exhaustively extract the crudes. The crude extracts were then sterilized with 0.2 μm pore size membrane filter paper and stored at $4^{o}C$ until antibacterial tests were performed as described by Hussain et al. (2004).

Dry Powder Plant Materials (500g)

Chloroform   Residue

Ethyl acetate   Residue

Methanol   Residue

Water   Residue (discarded)
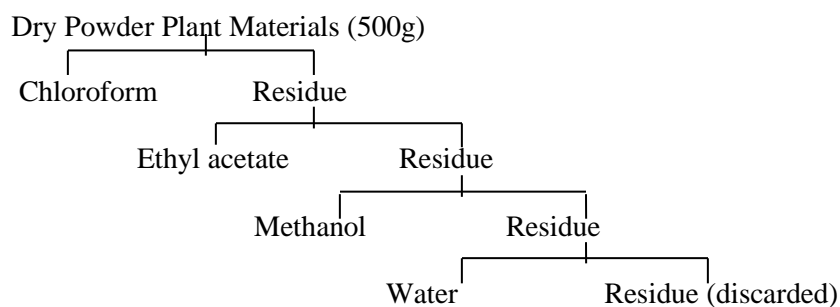
Fig. 1. Flow chart showing sequential extraction of plant materials with different solvent

Tested Bacterial Strains

Three gram negative (*E. coli,* ATCC *25922; P. aeruginosa*, ATCC 27923 and *S. typhi*) and two gram positive bacteria (*S. aureus, ATCC 27853 and Bacillus spp*) were tested with each medicinal plant extract. The first four bacterial strains were procured from stock of Ethiopian Health and Nutrition Research Institute (EHNRI) and *Bacillus spp* was isolated from soil at Ambo University Biology Laboratory. Three bacterial strains namely, *E. coli, P. aeruginosa* and *S. aureas* were indicated by their isolate and reference numbers whereas *S. typhi* (Identification number 5266) was isolated from patient sample at Clinical Bacteriology Laboratory of EHNRI. The

cultures were transported and kept at Ambo University, Biology Laboratory in agar slants at 4^oC temperature until tested with extracted plant materials. Each bacterial

Isolation of *Bacillus* species

Twenty gram of fresh soil sample was suspended in 50 ml of distilled water and shaken vigorously for 2 min. The suspension was allowed to settle down and placed in an 80^0C water bath for 15 min. The suspension

Media preparation and culture transfer

Nutrient broth (NB) was used for growth of tested bacteria. The inoculums were prepared by transferring a large number of bacteria from fresh culture plates to test tubes containing nutrient broth and incubated overnight at 37^0C. The tubes were shaken to uniformly distribute bacteria and aerated to promote growth. Mueller Hinton Agar (MHA) plates (8 mm thickness) were used to test susceptibility of bacteria to medicinal plant extracts. Turbidity of

Bacterial susceptibility tests

Tested bacteria seeded agar plates were divided into four equal parts. The partitions were labeled clockwise as Chloroform, Ethyl acetate, Methanol and Water

strain was sub cultured every week to maintain its characters, and freshly sub cultured (24 hrs before of tests).

was removed from water bath, cooled rapidly, and finally bacterial *spp* were confirmed by their morphological and biochemical tests as demonstrated and described by Aslim et al (2002).

actively growing bacterial suspension was adjusted to match the turbidity standard of 0.5 McFarland standard which was prepared by mixing 0.5 ml of 1.75% (w/v) Barium chloride dihydrate with 99.5 ml 1% (v/v) sulfuric acid (Willey et. al, 2008).After maintaining appropriate turbidity, sterile swabs were dipped and streaked evenly on the medium by rotating the Petri dish three times each 60^0 (Stephen et.al, 2005).

sequentially with increasing solvent polarity. The disc diffusion method (Bauer et. al,1966) was used to test the plant material extracts with slight modifications. Briefly,

dried and sterilized filter paper discs (6 mm diameter) were impregnated with 250 mg/disc crude extracts dissolved in respective solvents using micropipette and the residual solvents were completely evaporated. Water dissolved crude extract and impregnated with this extract was dried for two days at room temperature in an aseptic condition. Discs saturated with crude extracts were placed on MHA that uniformly seeded with the test bacteria. Standard discs of ampicillin and kanamycine (for *P. aeronginosa*), and blank discs (impregnate with solvents followed by evaporation) were used as a positive and a negative controls,

respectively. After 24 hrs of incubation, at 37^0C, clear diameter of zone of growth inhibition was measured. Growth inhibition zone less than 5 mm was considered as a positive (+), and visually unclearly visible growth inhibition zone was indicated as a minus (-). The test was carried out in triplicates. The mean, percentage and least significant differences (LSD) of mean separations at 5% confidence interval were statistically determined by Statistical Package for Social Science (SPSS) version17software and expressed as mean $\pm$ standard deviation.

Results and Discussion

A total of nine selected folklore medicinal plants were extracted with different solvents and tested for their antimicrobial activities on three gram negative and two gram positive bacteria. The purposes of this study were to evaluate antimicrobial activity of the selected traditionally used medicinal plants, and to explore an efficient solvent for the extraction of potential antimicrobial plant materials. The plants were well familiar to local people of the study areas, and the traditional health practitioners claim plants' medicinal potential for treatment of several

infectious diseases and chronic health disorders.

Plants/parts thereof used and the ethno-botanical information of the selected and screened plants are summarized in Table 1. Plant parts traditionally used in treatment regimen differ from plants to plants: some are aerial (stem, stem bark, leaf, inflorescence, fruit and seed) or underground (root, root bark, rhizome) or the entire plant. Based on traditional health practitioners' claims and local community practices, root and leaf extract are

commonly used and more effective than other plant parts which is possibly due to leaves and roots are more vulnerable to herbivores (insects, fungi, nematodes, microbe, predators etc.) than the other plant parts. As a result, plants have been evolved to produce and accumulate diversified secondary metabolites, in these parts, for defense against herbivores damages. Various surveyed literatures on antimicrobial studies of medicinal plants (Moshi et. al, 2012;Singhet. al, 2012; Gotepet al, 2010; Geyid   et.al, 2005) strengthen this view; root and leaf extracts showed more antimicrobial activities in comparison with other plant parts.
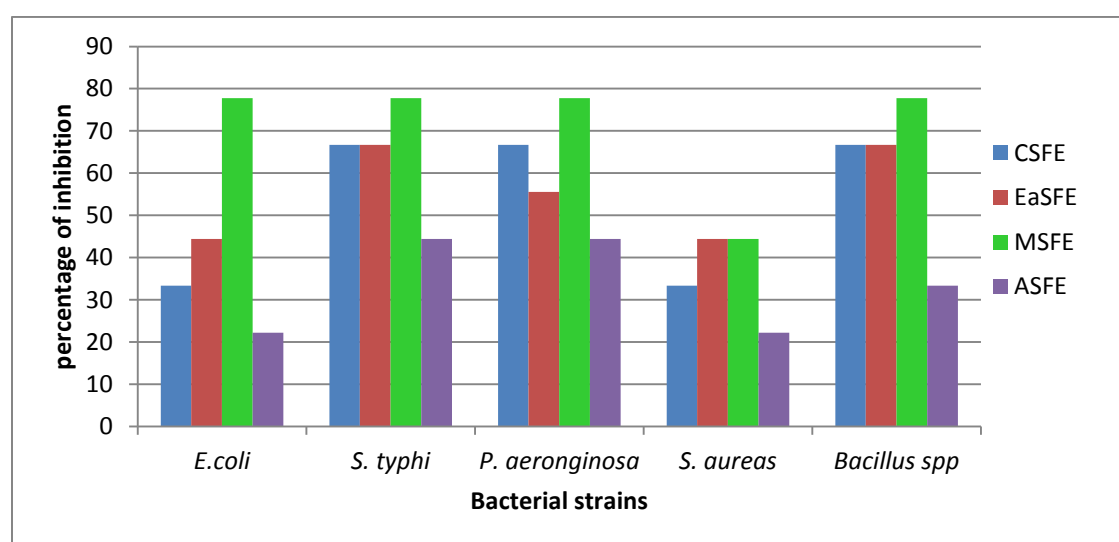
Fig. 2. Efficacy of plant extracts against different bacterial strains extracted using different solvents. CSFE, Chloroform soluble fraction extracts; EaSFE, Ethyl acetate soluble fraction extracts; MSFE, Methanol soluble fraction extracts; ASFE, Aqueous soluble fraction extracts

Successful prediction of ethno-botanical bioactive compound is largely dependent on the type of solvent used in the extraction procedures. Traditional health practitioners often use warm water to extract crude plant material or order their patients/clients to dissolve coarse plant powders in hot tea/coffee and drink along with it. However, several recent studies showed that plant crude extracts with organic solvents (such as methanol, ethanol, petroleum ether, carbon tetrachloride, chloroform, and hexane) have more consistent antimicrobial activity than the aqueous extracts (Mukhtar and Ghori 2012; Vieira et al., 2010; Yasminet.al, 2009;Parekhet.al, 2007; Geyid et.al, 2005; Parekh et al, 2005). The result of the present finding also agrees with those studies in which organic solvents (chloroform, ethyl acetate and methanol) plant crude extracts

had more antibacterial activity than the aqueous plant extracts (Fig. 2). The highest (78%) and the least (22%) antibacterial activities were obtained from methanol and water extracts, respectively. The effects of ethyl acetate and chloroform soluble fraction extracts relatively showed comparable antibacterial activities. The alcoholic (methanol and ethanol) extracts of *Moringa oleifera* and *Annona muricata* (Vieira et al., 2010), 67 plant species (Geyid et.al, 2005), 44 medicinal plants (Dawit et.al, 2003) exhibited higher antibacterial activities than

The preliminary results of antimicrobial activity of the selected TMPs against the tested bacteria are shown in Table 2. Organic solvent soluble fraction extract of *C. Africana* leaf has significant growth inhibition against *Bacillus spp,* but had no effect against other tested bacterial species.

C. aurea leaf extract was variously acted against the tested bacterial growth. Chloroform extract was inhibited the growth of *E. coli* and *S. typhi,* while ethyl acetate extract was retarded the growth of *E. coli* only. The methanolic and aqueous leaf extract had no antibacterial activity that agrees with the study of Lulekal et .al,

the corresponding petroleum ether and aqueous extracts. These results can be justified by the polarity of the compound being extracted with the solvent; polar organic solvent soluble fraction extracts had more antimicrobial potential than the extreme non-polar or extreme polar soluble fraction extracts. In addition to this, prolonged exposure of plant material to heat (for aqueous soluble fraction extracts) during decoction could lead to destruction or partial inactivation of bioactive substances.

Chloroform and methanol bark extracts of this plant inhibited only the growth of *E. coli.* The study of 67 TMPs (Geyid et.al. 2005) illustrated differences in phytochemicals composition and magnitude in different parts of the same plant.

(2013) in which ethanolic extract did not show any inhibitory effect against 11 tested bacterial strains including bacterial strains tested in this study. On the other hand, bacterial growth inhibition of methanonic extract disagrees with study of Shemsu (2013)on anti-diarrheal and antimicrobial activity of *C. aurea* leaf extract which could

be due to differences in the extraction procedure.

Apart from chloroform, crude extracts that didn't inhibit the growth of *E. coli,* all organic solvents extract of *S. molle* were retarded the growth of all the tested bacterial strains. Aqueous extract of this plant positively retarded the growth of two bacterial strains: *S. typhi* and *P. aeroginosa.*

This indicates either polar or non-polar solvent soluble fraction extract of *S. molle* has antimicrobial potentials against both gram positive and gram negative bacteria; even against *P. aeroginosa* that has developed resistance to many potent commercially available antibiotics.

Contrary to other studied plants, *D. abyssinicum* growth inhibition efficiency inclined towards polar solvent soluble fraction extracts; antibacterial activities were more promising for ethyl acetate and methanol soluble fraction extracts than chloroform soluble fraction extracts. Growth inhibitions of aqueous extract of present study strengthen these facts. Its action against B*acillus spp* was recorded 11 ± 1.3 mm which was the second highest growth inhibition zone next to *A. conizoides* aqueous soluble extracts (12 ± 1.9 mm) against the same bacterial *spp*. All solvent soluble fraction extracts of this plant influenced growth of all bacterial strains except *E. coli*.

Table 2. Antibacterial activity of crude extracts of selected traditionally used medicinal plants collected

Scientific name	Local name	PPI	Solvent	Zone of growth inhibition (mm) mean ± s.d				
				E.c	S. t	P. a	S. a	B.spp
C. africana	Wanza	Lf	CSFE	-	-	-	-	8 ± 0.07
			EaSFE	-	-	-	-	8 ± 0.80
			MSFE	-	-	-	-	7.5 ± 0.7
			ASFE	-	-	-	-	-
		Sb	CSFE	8 ± 0.4	-	-	-	-
			EaSFE	-	-	-	-	-
			MSFE	8.5 ± 0.8	-	-	-	-
			ASFE	-	-	-	-	-
C. aurea	Cheka	Lf	CSFE	7 ± 0.2	-	8 ± 1.1	-	-
			EaSFE	8 ± 1.1	-	-	-	-
			MSFE	-	-	-	-	-
			ASFE	-	-	-	-	-
S. molle	Kondo-barbare	Lf	CSFE	-	10.5 ± 0.6	8.5 ± 0.2	9.5 ± 0.8	7 ± 0.3
			EaSFE	8.5 ± 1.1	8 ± 0.9	8 ± 0.3	9.5 ± 1.3	7 ± 0.8
			MSFE	8 ± 1.7	8.5 ± 0.4	8 ± 0.9	+	6.5 ± 0.4
			ASFE	-	+	+	-	-
D.abyssinicum	Koshim	Lf	CSFE	-	+	+	+	+
			EaSFE	-	+	7 ± 1.2	+	8 ± 0.8
			MSFE	-	+	7 ± 1.0	7 ± 0.4	6.5 ± 0.3
			ASFE	-	+	9 ± 1.3	7.5 ± 1.2	11±1.3
A. conizoides	Ebicha	Lf	CSFE	-	6.5 ± 0.7	7 ± 0.3	+	+
			EaSFE	7 ± 1.6	+	-	8 ± 0.7	7 ± 1.0
			MSFE	6.5 ± 0.3	+	-	8.5 ± 0.3	9.5± 0.6
			ASFE	+	+	+	8.5 ± 1.5	12 ± 1.9
E. camaldulensis	Nech Bahir zaf	Lf	CSFE	6.5 ± 1.2	+	+	7 ± 0.07	9 ± 1.4
			EaSFE	+	7 ± 0.5	6.5 ± 1.4	7 ± 0.7	8 ± 0.8
			MSFE	8.5 ± 0.6	+	10 ± 2.5	7 ± 0.7	9 ± 1.3
			ASFE	8 ± 1.8	-	6.5 ± 0.6	+	+
A. africana	Kestencha	Rt	CSFE	7.5 ± 1.4	+	8.5 ± 0.8	-	-
			EaSFE	8.5 ± 1.2	+	6.2 ± 1.0	-	-
			MSFE	+	+	+	-	-
			ASFE	+	+	+	-	-
Z. officinalis	Zengbil	Rh	CSFE	-	+	+	-	7 ± 0.3
			EaSFE	-	+	+	-	6.5 ± 0.7
			MSFE	-	+	+	-	8 ± 0.6
			ASFE	-	+	+	-	8.5 ± 0.6
O. lamiifolium	Damakessie	Lf	CSFE	-	-	-	8 ± 0.7	-
			EaSFE	-	+	-	7.5 ± 0.8	-
			MSFE	-	+	+	-	-
			ASFE	-	+	+	-	-
Ampicillin/Kanamycine*				14 ± 0.2	10 ± 0.1	31 ± 0.1*	16 ± 0.1	13 ± 0.1

from central Ethiopia

Degree of *A. conizoides* antibacterial activity tended more to gram positive bacteria than gram negative bacteria that in line with various earlier TMPs antimicrobial activity reports (Lulekal et .al, 2013;Vieira et al., 2010; Panthi et al., 2006; Linet al., 1999). This could be partly attributed to differences in cell wall structure of the bacteria; Gram positive bacteria have a single peptidoglycogen layer cell wall structure, but Gram negative bacteria possess cell wall of multilayered outer membrane that make the cell wall impermeable to antimicrobial chemicals (Hodges, 2002). On the other hand, antimicrobial activity results of *A. africana* root extract contradicts with this assumption, and there were irregularities for the remaining screened TMPs which, of course, require other independent further studies.

E. camaldulensis is one of the most famous TMPs well known to local community of the study areas. The community uses it for different health related problems ranging from common cold to chronic infectious diseases (Table 1). The present result revealed that there is a promising antibacterial potentials regardless of solvent employed for extraction and tested bacterial strains. Except *S. typhi,* which was resistant to aqueous soluble fraction extract*s,* all the rest solvent soluble fraction extracts showed substantial growth inhibitions (5- 10 mm). Among the tested bacterial strains, *Bacillus spp* were more susceptible to chloroform, ethyl acetate and methanol soluble fraction extracts.

Z. officinalis rhizome is an important home remedies used in several primary health care system including stomach complaints, respiratory infections, diarrhea, hepatitis and others aliments (Table 1). In this study antimicrobial activity of Z*. officinalis* was slightly different from other screened plant crude extracts; all employed solvent soluble fraction extracts inhibited growth of *S.typhi*, *P*. *aeroginosa* and *Bacillus spp* in the same manner. That is, the potential antimicrobial phytochemicals were similarly extracted in all solvents which may be due to the potential bioactive principle(s) is/are soluble either in polar or non-polar solvents similarly. This finding contradicts with the study of Voravuthikuchai et. al. (2006). These authors evaluated antibacterial activity of 33 plant extracts and found that only chloroformic extracts of five plant species (belonging to family Zingibiraceae,

family Acanthaceae and family Piperaceae) exhibited antibacterial properties and effective against only gram positive bacteria. These differences might be due to differences in methods employed for plant material extraction. In this study, plant material was sequentially extracted with increase in solvent polarity, but the forenamed authors extracted plant material with one solvent at a time. *E. coli* and *S. aureas* were resistant to all solvent soluble crude extracts. It was expected that *Z. officinalis* would exhibited antimicrobial activities against these bacterial strains as local people have serious claims on extracts of this plant in curing bloody dysentery, respiratory tract infections, boils and many other skin diseases. This could be possibly due to active ingredients degradation in the process of drying plant materials. According to local people's practices and traditional health practitioners' claims, fresh plant/parts thereof were more effective than the corresponding dried plant materials. Similarly*, C. aurea* was expected to be effective against tested bacterial strains that failed to show activity against three of the bacterial strains.

Antibacterial activities of a few plant material extracts were specific to tested bacterial strains (for example, *C. africana* leaf extract to *E. coli* and *C. africana* stem bark extract to *Bacillus spp*). Hence, giving attention to extracts exhibiting such specificity is an important remark as this might reveal unique antimicrobial properties that help in the process of bioactive principle(s) isolation and purification.

Chloroform and ethyl acetate soluble fraction extracts of *O. lamiifolium* were inhibited growth of *S. aureas* which was mostly resistant to other plant extracts. *S. typhi* and *P. aeroginosa* were positively (< 5 mm growth inhibition zone) susceptible to both chloroform and ethyl acetate soluble extracts, whereas *E. coli* and *Bacillus spp* showed resistance to all solvent extracts of this plant *.O. lamiifolium* antimicrobial activity study by Lulekal et .al, (2013) showed *S. aureas* growth inhibition and resistance of *E. coli* to this plant extracts that complements the present work.

Conclusion

Majority of the screened TMPs have antimicrobial activities against tested bacterial strains though degree of inhibition varies with tested bacterial strains and solvent employed for the extraction of plant materials. *S. molle, E. camaldulensis*, *A. conizoides* and *D. abyssinicum* traditionally used medicinal plants are the most promising ones, in exhibiting broad spectrum nature, for further investigation of lead compound against microbes. On the other hand, a few plant species showed antimicrobial potential to specific bacterial strain: *C. africana* leaf extract to *Bacillusspp*, *C. africana* stem bark extract to *E. coli* and *O. lamiifolium* leaf extract *to S. typhi* and *P. aerunginosa*. The variations partly appear to be directly related to the quantitative and /or qualitative diversity of the phytochemicals of the investigated plant parts.

Growth of bacterial strains was differently inhibited with different solvent soluble fraction extracts; some of them were more susceptible to specific extract and others showed broad spectrum nature which is, of course, beyond the scope of this study. *Bacillusspp* (53%) were the most susceptible to tested plant extracts followed by *P. aeroginosa* (39%), *E. coli* (36%), and *S. aureas* (33%). *S. typhi* (14%) was the least susceptible to the examined plant extracts. For extraction of potential antimicrobial phytochemicals, methanol (with an intermediate polarity) showed promising efficiency compared to extreme polar (water) or extreme non-polar (chloroform) solvents.

The present finding substantiates the traditional therapeutic claims of traditional health practitioners and the knowledge of local community. It's the preliminary scientific validation of the claims. The results also give clues for quantitative phytochemical profiling (ongoing) and for investigating pharmaceutically bioactive principle(s).

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Institutional Teamwork Practices of Academic Staff in Higher Education in Ethiopia: Perceptions, Benefits and Challenges.

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Abstract

Within the complex operation of higher education institutions in the 21st century, teamwork is a vital approach in bringing about educational improvement and effectiveness. The purpose of this study was to examine the existing teamwork practices of academic staff in higher education institutions in Ethiopia. More specifically, the study attempts to investigate the nature of teamwork practices, the benefits acquired as a result of teamwork, the perception of teachers towards teamwork and the challenges associated with teamwork in higher education institutions. A descriptive survey method and a mixed approach of research design were employed to collect and analyze the data obtained from the research participants. A self-structured questionnaire and interview were used for data collection from the academic staff and middle level management bodies of three universities. Accordingly, eighty six (86) instructors and twelve (12) department heads and academic program offices were participated in the study. Simple random sampling technique was employed to select the required numbers of academic staff. The department heads and academic program offices were included in the study purposively since they are important constituents in the study of teamwork. Various statistical tools such as percentage, weighted mean, standard deviation and ANOVA were used to analyse the data. The outcome of the data analysis generally showed that there are certain teamwork practices in the selected higher education institutions. These practices helped the academic staff to improve their professional duties. However, it was reported that the present practices are overwhelmed with multifaceted problems in its implementation. The study, therefore, suggests that there should be clear rules and guidelines for effective implementation of teamwork in higher education institutions. In addition, it is crucial to equip the academic staff with the basic knowledge and skills about teamwork and provide them with the necessary support they need to be successful in teamwork practices and gain optimal benefits out of the practices.

Keywords: Academic staff, Higher Education Institutions, Team, and Teamwork

1. Introduction

1.1. Background of the Study

The focus on educational change and improvement in the last two decades has greatly increased teachers' roles in educational institutions and has created a need for shared responsibility to help them to become more effective in their planning, decision making and implementation of their programs (OECD, 2008). The need for

people, in every walk of life, to work together was never more pressing than it is today. Especially, at present there is a clear sense amongst academic staff that their role has become more challenging, and that the complexity and range of tasks they are required to undertake has increased greatly due to a number of inter-related factors such

Teams provide the diversity of knowledge, attitudes, skills and experience required to generate an innovative response to challenges or perform according to expectations. Luca and Tarricone (2001) have noted that successful teamwork relies upon the synergy existing between all team members creating an environment where they are all willing to contribute and participate in order to promote and nurture a positive, effective team environment. Team members are expected to be flexible enough to adapt to cooperative working environments where goals are achieved through collaboration and social interdependence rather than individualised and competitive goals. None of us is as smart as all of us (Thompson, 2004).

On the other hand, Fajana (2002) asserts that teamwork is an integration of resources and inputs working in harmony to achieve

as the dramatic expansion of programs, the scarcity of human and material resources and lack of adequate support from stakeholders to effectively run educational programs. These situations demand cooperation and teamwork among all concerned to attain educational objectives.

organisational goals, where roles are prescribed for every organisation member, challenges are equally faced and incremental improvements are sought continually. A series of studies have been reporting the positive relations between team-based working and the quality of products and services offered by an organization (Gibson, Porath, Benson & Lawler, 2007). Educators noted that the success of organizations and the overall production of knowledge depend to a large extent on the effectiveness of teams (Wuchty, Jones & Uzzi, 2007). Thus, at present teamwork is very prevalent in different organizations/companies including educational institutions. Its advantages are recognized from time to time both in developed and developing nations. Improving productivity, quality, and finding solutions easily for problems are some of the

advantages mentioned widely in the literature.

However, teams sometimes fail to achieve the high performance expected of them due to different challenges associated with teamwork (Sims, Salas & Burke, 2005). In this respect, the scholars have indicated that the effectiveness of teamwork are contingent upon many factors, including the organizations' culture and climate, effectiveness of team leadership, employee commitment, the system of compensation,

1.2.   Statement of the Problem

Today in Ethiopia with increasing demands placed on academic staff in contexts of increased tendencies of responsibility for research, community services and teaching-learning process, it is difficult to discharge responsibilities alone. As a matter of fact, instructors have too many responsibilities and excessive non-teaching roles such as community services and administrative tasks (MoE, 2005:51). On top of this, students' numbers are escalating year after year and there is momentous expansion of programs at present than ever before. Institutional tasks become more complex and intricate. Instructors are expected to accomplish multidimensional roles in their respective

rewards and recognitions, and the level of employee autonomy.

The purpose of the present study is therefore, to examine the practices of teamwork in higher education institutions in Ethiopia, with particular reference to three universities; Adama, Arsi, and Haramaya Universities. To this end, data was gathered to identify the perceptions, benefits and challenges associated with teamwork practices in the context of these higher education institutions.

colleges and departments. These situations call for the collaborative efforts of college community and academic staff to attain the intended vision and mission of the University. One of the key activities to be done to enhance the quality of education, as briefly indicated in the document produced by MoE (2009), is building teamwork at all levels of the education system to discharge responsibilities to the expected standard; because teamwork plays a key role in improving educational outcomes by influencing the motivations and capacities of teachers as well as creating positive climate and environment in educational institutions.

However, the present situations in higher education institutions reveal that most activities are carried out by individual instructors. The involvement of instructors in group performances and other teamwork activities seem limited. Part of the problems may be lack of awareness about the contributions of teamwork in improving the quality of instructors' performances, poor working conditions and facilities, lack of competence and commitment on the part of instructors, and lack of supportive organizational structures... Undoubtedly these problems limit the success of teamwork. Thus, this research is directed to investigate the extent to which academic staffs are currently practicing team performances in their respective colleges and departments to attain the desired objectives of their institutions.

Three government higher education institutes in Oromia (Adama, Arsi and Haramaya Universities) were selected for this study mainly based on the different experiences these universities have in terms of staff composition and resources/facilities. Furthermore, the researcher has been good working relationship with the academic staff of these universities. This experience may help him to facilitate data collection activities and other support from the academic staff of the target universities. More importantly, there is a critical research gap in relation to the issue under study (to the best knowledge of the researcher). Thus, researches are required to understand the present practices of teamwork in higher education institutions in this country in general and in the selected universities in particular.

Therefore, this study was to investigate the existing practices of teamwork in higher education institutions. The study also tried to investigate the perception of academic staff towards team performances as teamwork intended to improve the quality of education. Moreover, the study investigated the potential advantages of using teamwork for various activities in higher education institutions. It was also the focus of the study to identify the challenges that have been encountering during teamwork practices in these universities. To this end, the study attempted to answer the following basic research questions.

1. What are the existing areas of teamwork practices in the selected higher education institutions?

2. How do the academic staffs perceive the potential advantages of teamwork?

3. Is there any significant difference among academic staff in their perception towards teamwork in terms of their qualification, experience and field of study?

4. What challenges have been encountering in teamwork practices in higher education institutions?

2. Research Design and Methodology

2.1. Research Approach

The research involves both qualitative and quantitative research methods. The researcher uses the qualitative research that presents data as a narration of words (McMillan & Schumacher 2001:15). Qualitative research assumes multiple realities that are socially constructed through individual and collective perceptions in the same situation. It is more concerned with understanding the social phenomenon from the participants' perspectives. In addition, quantitative data analysis was employed from a large number of academic staff to understand the extent to which teamwork is effectively practiced by the academic staff to attain the objectives of the university. Thus, mixed research approach (concurrent type) was conducted in the analysis and interpretation of the data.

2.2. Sample Size and Sampling Techniques

2.2.1. SAMPLE SIZE

Three academic program officers from the three universities (one from each university) were involved in the study to provide relevant and adequate information about the issue under discussion. Moreover, nine department heads (three from each university) were included in the study as a result of their experiences and position in the university which is directly related to the teamwork practices. Again, from each university some representative numbers of academic staff (a total of 86) were participated to provide necessary information related to the subject under study.

2.2.2. Sampling Techniques

The academic program officers were included as a result of their position so availability sampling method was used for the selection of this study group. The department heads were included using purposive sampling technique basically to include those who have good experiences in the university and willing to provide information related to the issue under study. Academic staff was selected by stratified simple random sampling techniques. The

strata encompass sex, experience, qualification and field of studies. A total of 90 academic staffs were initially selected from the three universities. However, a total of 86 (M=75, F=11) instructors were properly replied to the questionnaires distributed to collect data in this study. Consequently, 36 instructors from Haramaya, 25 from Adama and 25 from Asela University were participated in the study.

2.3. Data Collection Instruments

The main instrument used for data collection from academic staff was questionnaire. The questionnaire was developed with respect to the basic research questions formulated at the initial stage. The questionnaire was administrated to the three Universities by the researcher and three data collectors trained and assigned for data collection to assist the researcher.

Semi-structured interview was also developed and administered to the University's academic program officers and department heads. In this regard, information related to teamwork practices of

instructors (academic staff) and factors affecting the team performances of instructors were addressed. More importantly, due attention was given to understand how university leaders at different levels motivate and reward academic staff for teamwork so that instructors can exert their maximum effort for the teaching profession. Furthermore, the extent to which the current teamwork practices (if any) help instructors to promote their professional competence was addressed during the interview.

2.4. Data Collection Procedures

After participants identified, instruments of data collection were developed on the basis

of the literature reviewed and research questions formulated. Thereafter, the

instruments were pre- tested to establish the validity and reliability of the tools with the help of experts in the area of study and using Cronbach's alpha test. Accordingly, data collection instruments were developed and get checked by potential colleagues for the face validity and clarity of the items. Pilot-test was also employed to check for the ambiguity of the items. Then, the instruments were revised by taking into account the constructive comments given.

In addition, the reliability of the survey instruments was tested to determine the extent to which items in each domain effectively grouped together. To this end, Cronbach's coefficient alpha was used to measure the internal consistency of items. The results of all reliabilities in each domain were greater than .80 and hence the instruments were considered to produce reliable data. Finally, the data solicited from the study participants were analyzed via quantitative and qualitative data analysis methods.

2.5. Methods of Data Analysis

Different statistical tools were used to analyze and interpret the data collected from the respondents. Both quantitative and qualitative methods of data analysis were employed. Quantitative analysis was employed for questionnaire items set in a form of rating scales. In this regard, descriptive and inferential statistical methods such as percentage, aggregate mean, standard deviation and ANOVA were used to analyze the data. Instructors responded to each item using a 5-point Likert scale with the options ranging from "strongly agree" to "strongly disagree". Responses were rated as: strongly agree = 5;

agree = 4; neutral = 3; disagree = 2; and strongly disagree = 1. The average point for the rating scales was 3 and values greater than 3 were considered as positive responses and those less than 3 as negative responses. Other types of rating scales are also used ranging from "very low" to "very high" and from "frequently" to "not at all". On the other hand, the following criteria were used to determine differences in the responses of instructors. When the mean value is calculated as p $p \leq 0.05$, the perception is accepted as having significant difference; when the mean value calculated is equal to

or higher than $p \geq 0.05$, the perception is accepted as having no significant difference. Qualitative analysis was also used for a critical investigation of views, opinions and suggestions obtained from instructors and university leaders to open-ended questions and interview questions. The qualitative data

analysis was started by transcribing interview results followed by coding, and then by categorizing into themes. The researcher then read the transcription of each interview looking for key words, key comments, and commonalities in the responses from each of the participants.

2.6. Ethical Considerations

Permission to collect data was requested and obtained from each university with the help of a permission letter obtained from Arsi University. The researcher has explained to the participants what this research is all about, for what purpose it is going to be employed and he assured the participants the confidentiality of documents and information obtained from the study groups. It was hoped that this decreases the extent of receiving misleading information and losing

the relevant documents; a situation that would have happened if these confidentiality, transparency and trustworthiness had been missing. Eventually, anonymity and confidentiality of the data collected were ensured by not disclosing the names of the Universities and the participants in any form. Furthermore, all the materials and research reports used for this study have been duly acknowledged.

3. Results and Discussion

This part presents the major findings of the study. The outcomes of the major findings will have a considerable value for future improvement of teamwork activities in higher education institutions in the country in general and in the three universities in

particular. Thus, the data collected from the academic program officers, department heads and academic staff of the three Universities were presented and analysed as follows.

3.1. Presentation and Analysis of the Data
Table 1: Instructors Participation in Teamwork (N=86)

Common Areas of Teamwork Practices	M	SD
Reviewing and evaluating teaching materials	1.97	0.61
Conducting research	2.10	0.65
Solving disciplinary problems of students	2.12	0.62
Participating in various committees of the university/college/ dept	2.66	0.47
Conducting peer coaching/ mentoring among dept members	2.16	0.68
Participating in group decision making processes	2.02	0.62
Conducting student assessment	2.05	0.65
Working with staff outside my college/dept	1.80	0.78
Weighted Mean=	2.11, SD= 0. 63	

Note: 1=not at all; 2=sometimes; 3=frequently

Table 1 was projected to examine the extent to which instructors are participating in various teamwork activities in the three higher education institutions. As indicated in the table above (Table 1), the average mean score of all items was 2.11 and SD=0.63. This confirms that the mean value of all respondents is falling in between 'some times' and 'frequently'.

The aggregate mean value (M=2.11) is very much closer to 2. This value tells us that the instructors participation in teamwork with regard to the variables listed in the table is regarded as 'sometimes'. In light of this, a significant number of instructors rated high mean score (M=2.66, M=2.16 and M=2.12) for items like participating in various committees of their colleges/departments, conducting peer coaching/ mentoring among department members and solving the disciplinary problems of students in teams respectively.

Although the majority of respondents were agreed that they are sometimes participating in various teams, a significant number of respondents rated low mean score to specific items such as working with other staff members outside their college or department (M=1.8) and reviewing and evaluating teaching materials with colleagues or in teamwork (M=1.97). The reasons for the low rate of these specific items might be lack of experiences and shortage of resources and facilities for team performances.

In general, although the practices are not strong, it was confirmed that there were different teamwork practices and group activities in the three universities under study. However, instructors' participation was not on the regular basis rather it was on

occasion that leaders form teams or a kind of ad hoc committee for specific tasks to be accomplished for a particular duration. After mission accomplished the teams are immediately dissolved. The information obtained through interview from department heads and academic program officers also support this fact.

Table 2: The Potential Benefits of Teamwork as Perceived by Instructors (N=86)

The potential Benefits of Teamwork	M	SD
Promote teacher satisfaction and strong commitment to work	3.0	.77
Enhance quality of performance and services	3.2	.67
Facilitate communication process in the system	3.4	.65
Pave ways for innovation and creativity	3.0	.87
Help to share experiences among team members	3.5	.50
Increase cooperation to solve educational problems	3.6	.72
Increase the acceptance of decisions made by teams than individuals	3.4	.67
Diversity helps to view problems from different perspective	3.4	.75
Provide greater opportunity to have more expertise in the team	3.3	.75
Encourage for more flexibility in work arrangements	3.2	.78
Help for effective management of work related problems	3.2	.82
	Weighted mean = 3.3, SD=0.72	

1=strongly disagree; 2=disagree; 3=undecided; 4=agree; 5= strongly agree

As can be seen in the table (Table 2) the aggregate mean score of the study group is M= 3.3 and SD=0.72. This result is falling in between 'much' and 'very much'. This shows that the majority of respondents were in a position to rate the advantages of teamwork to improve and promote instructors professional practices in higher education institutions. More specifically, it was indicated in the table that teamwork increases instructors cooperation (M=3.6), helps to share experiences (M=3.5), helps to view and solve college/department problems from different perspectives (M=3.4) and facilitate communication process. These were items rated at the top of the scores ranked in that order. The relatively lowly rated items include: team practices promotes teachers satisfaction and commitment to work (M=3.0) and teamwork paves ways for innovation and creativity (M=3.0). In general, the result indicated in the table above reveals that teamwork practices in higher education institutions helps the academic staff to do their job in a better way.

On the other hand, instructors were requested to point out additional information on an open ended question about the benefits that they have gained due to their

engagement in team works. As described by the great proportion of the sample population (78%), team performances enable them to improve their teaching skills and develop confidence in teaching their courses, provide opportunities to develop good sprit of teamwork with other staff members, and acquire considerable knowledge in improving communication and share experiences with other colleagues and students.

Related questions were raised during interview with academic affair officers and department heads to describe the potential advantages of teamwork. It was reported that the contribution of teamwork to improve the quality of performances is unquestionable and undeniable. It would allow the instructors to share experiences among each other, helps to make appropriate and timely decisions to their problems and builds sense of ownership in their attitude. The interviewees further confirmed that it is through teamwork that sustainable improvement can be realized in higher education institutions. In this regard, the responses obtained from instructors and academic affair officers and department heads are alike.

In addition, academic program/affair officers and department heads were asked to describe their specific roles in team formation and follow-up. All of them have described that they are organizing and coordinating the team activities, briefly explaining roles to be accomplished by the team, allocating necessary resources and facilities for the team, supporting the team by providing adequate information and feedback and solving problems encountered during team performances.

In general, it can be realized from the responses that at present the immediate bosses of the instructors are trying to organize various teams for various tasks to attain the desired mission and objectives of their universities.

Table 3: ANOVA-Mean differences of Instructors' Perception about the Benefits of Teamwork

Variables		Sum of Squares	Df	Mean Square	F	Sig.
	Between Groups	2.394	8	.299	.444	.892
Field of study	Within Groups	85.537	77	.674		
	Total	87.930	85			
	Between Groups	6.871	8	.859	1.176	.319
Educational status	Within Groups	92.739	77	.730		
	Total	99.610	85			
	Between Groups	5.122	8	.640	.733	.662
Experience	Within Groups	110.972	77	.874		
	Total	116.094	85			

Table 3 provides an insight about the extent to which instructors' responses vary in terms of the variables such as educational status, experiences and field of studies. The findings indicated that respondents' perception level across these variables has no significant difference on the benefits of teamwork practices at $p< 0.05$ level of significance. Their responses are invariable across universities of different geographical locations and different experiences. This indicates that the perception level of academic staff on the benefits of teamwork is almost identical in the three universities under investigation.

In general, the results revealed that there is no statistically significant mean difference in the assessment of respondents at $p< 0.05$ level of significance. This implies that, although the research participants (teachers) vary in some attributes, they unvaryingly responded to the items referring to the benefits of teamwork in HEIs.

Table 4: Challenges Associated with Teamwork in HEIs (N=86)

Possible challenges	M	SD
Fear of conflict among team members	2.7	.92
Lack of commitment to shared objectives	3.1	.82
Absence of clear roles for the team members	2.7	.94
Absence of mutual trust among team members	2.6	.89
Lack of organization & coordination of the team	2.6	.98
Lack of concern to team performance	2.6	.94
Lack of confidence & belief among members	3.0	.65
Insufficient resources and materials for team performances	2.7	1.11
Lack of responsibility for actions to take place	2.7	.84
Lack of necessary skills to do the work in teams	2.9	.91
Absence of adequate time for team work	2.9	1.03
Diversity increases communication barriers	2.9	.89
Weighted Mean=2.8,		SD=0.91

Note: 1=very low; 2=low; 3=moderate; 4= high; 5=very high

In Table 4, it was to examine the determinant factors in teamwork in higher education institutions under the study. As indicated in the table above, the aggregate mean value and standard deviation of all items were M=2.8, SD=0.91. The mean value is closer to 3 which generally indicate that respondents moderately agree to these items that these factors are affecting team performances of academic staff. High mean

score is rated especially to specific items such as lack of commitment to shared objectives (M=3.0), lack of necessary skills to do the work in teams (M=2.9), and absence of adequate time for teamwork on the part of teachers (M=2.9), lack of necessary skills to do the work in teams (M=2.9), and diversity increases communication barriers (M=2.9). These factors were found the most determinant variables in team performances. However, on items such as absence of mutual trust among team members (M=2.6), lack of concern to team performance (M=2.6), lack of organization and coordination of the team (M=2.6) were relatively the least considered factors as determinants of team performances of academic staff in higher education institutions. Furthermore, the information obtained through interview from department heads and academic program officers have shown similar results. In this respect, the interviewees described issues like...lack of commitment to shared objectives, lack of interest on the part of academic staff, lack of confidence and belief among team members, lack of incentives for additional tasks and insufficient resources and facilities for teamwork and lack of

convenient time for all team members were among the major determinants in team performances. On the other hand, there is no significant mean difference in the responses of academic staff as seen from the results of standard deviation across all items.

In general, teamwork is perceived both by the academic staff and middle management bodies as core constituent to be practiced in HIEs to improve the quality of education in general and work performances of the academic staff to attain the overall vision, mission and objectives of the institutions. The current trends of work performances worldwide requires the efforts of groups/teams rather than individual attempts to achieve the intended goal. So, as teamwork is important for any roles and responsibilities of academic staff, it is vital to consider the determining factors for its effective implementation. Actually, literature evidences that teamwork is a means not an end by itself to achieve the desired objectives of an organization. Therefore, clear roles, coordination and support for teamwork is essential to harmonize the efforts of individual teachers' together to maximize the quality of work performances in HEIs.

3.2. Perception of Teachers towards Teamwork

A multiple choice type of question was raised for the academic staffs of the three universities to examine their perception towards teamwork practices. The result indicated that the majority 54(62.8%) of them have optimistic perception that teamwork is essential to bring the desired change in the teaching-learning process especially to improve the academic performance of students. Whereas, the remaining small number 24 (27.9%) and 8 (9.3%) remarked undecided and pessimistic perceptions respectively.

These instructors were further asked to describe reasons why they have negative perception towards teamwork. As the majority of them said, they like to work alone to avoid conflicts with friends and professional colleagues. They prefer to work independently because they have rich experiences and high professional academic rank/status. They further noted that teamwork obstructs their own pace to accomplish a job in a specified time. An amazing idea was also raised by some instructors saying that teamwork is a government agenda associated to politics rather than focusing on teaching learning process. That is why most academic staffs are reluctant to teamwork practices. Teachers form teams for formality and fabricate nice reports at the end and send to concerned bodies which are not on the ground. Generally, they do not take it seriously with the intention to improve the quality of their performances.

The same concern was raised for academic officers and department heads to obtain information related to teachers perception towards teamwork based on their day-to-day observation and experiences. They said that the majority of teachers have positive attitude towards teamwork especially on research projects, curriculum review, exam preparation and provision, and modularized course delivery. However, some instructors are very much dedicated and committed to teamwork while others are not. In general, the perception of academic staff towards teamwork was good but the actual practices were nominal and in name only.

Overall, it is apparent from the data that there are some teamwork practices and group activities in the three universities

under study. These teamwork practices allow the instructors to share experiences among each other, help to make appropriate and timely decisions to their problems, develop confidence in teaching their courses and build positive relationship among colleagues. There is no doubt among study participants regarding the centrality and importance of teamwork to improve their professional practices. By and large, the majority of instructors positively valued

their experiences in teamwork practices for their professional effectiveness. However, instructors claimed that they have little orientation about teamwork. There is no strong culture to work together and the efforts exerted on the part of university management to set up conducive environment and avail resources and facilities for the academic staff to work in teams is not adequate.

4. Conclusion and Recommendations

4.1. Conclusions

The finding of this study has shown that the overall practices of teamwork in HEIs appear not satisfactory. However, there are compelling reasons for assigning academic staffs to work in teams on several tasks and projects. Among these reasons, teams provide diversity in knowledge, attitudes, skills and experience, whose integration makes it possible to offer rapid, flexible and innovative responses to problems and challenges, promoting performance and improving the satisfaction of those making up the team. However, as a result of poor teamwork practices, the benefits are not well captured to improve the quality of performances and services in higher education institutions.

The curiosity of the university leaders to push the academic staff to work in teams for solving educational problems is somehow encouraging. Nevertheless, the prevailing situations in higher education institutions (universities) reveal the existence of de-motivating environments that impede instructors' participation to various teamwork activities such as teaching workload, lack of access to resources and facilities, inadequate support from the management bodies and lack of commitment on the part of instructors themselves are some of the challenges observed in the present practices. As a consequence, the motivation and commitment of the teaching staff to work together in teams is not to the

expected level. This may eventually have unsuccessful results for even the best intentions for improvement in the teaching-learning process. Thus, to efficiently and effectively achieve a high level of academic excellence in line with the mission and vision of the universities, it is vital to rely on teamwork practices than individual efforts. Therefore, the university leaders at different levels are expected to create motivating environment so as to engage academic staff in different teamwork activities. So far the role of leaders is not worth mentioning in promoting the culture of teamwork in their colleges/schools. In general, the conclusions made in this study reveal that there are limitations for proper organization and implementations of teamwork practices in HEIs.

4.2. Recommendations

In order to improve the existing practices of teamwork in higher education institutions, the following recommendations are forwarded by considering the information taken from the available literature and from the practical experience of the present situation. It is believed by the researcher that these recommendations are feasible and implemental for improving teamwork practices. Thus, in order to promote team performances and attain the desired results out of these practices the concerned bodies should play their roles diligently.

1. Instructors

- Teamwork is not fruitful without the internal motives and responsibilities of the instructors themselves.Therefore, the teaching staff is expected to commit themselves and take the initiatives to participate in different teamwork activities. Every instructor has to do his or her own effort to strengthen teamwork activities at their respective college and department levels.

- Instructors are responsible for the quality of education in their respective areas of studies. This can

be maintained and promoted through team performances with professional colleagues. Working together is a success. Therefore, they have to seek all possible ways to work together with team spirit and share experiences from each other. When instructors have such mindset, it is easier to improve personal and professional practices and eventually improve the quality of their work.

2. College Deans/Department Heads

- Teamwork is the most demanding practice in all organizations including educational institutions. It requires resources, facilities, cooperation and cohesion. So, college deans and department heads are responsible to take the frontline initiatives to plan, organize and provide appropriate guidance and support for effective teamwork activities. Without their commitment and readiness, it is hardly possible to harvest the benefits of teamwork;

- There has to be continuous follow-up system by college deans and head of departments on the practical implementation of teamwork practices. Regular meetings and discussion forums should be organized to examine the successes and failures of team practices so as to make timely measures on the drawbacks of team activities;

- They have to make an effort in promoting the awareness of instructors on the contributions of teamwork in improving the quality of students learning;

- They have to conduct further research on the impact of teamwork and how teamwork practices help to be effective compared to the individual work.

3. Top Management of the University

- The context of organization plays a crucial role in the effectiveness of teams (Hackman, 2002). Thus, the university management has to pay great attention in supporting and encouraging colleges and

departments to organize and perform their tasks in teams so as to improve the quality of their work. This can be either by providing opportunities for instructors to further training or arranging experience sharing program within and across similar institutions;

- The universities have to create motivating work environment by allocating the necessary resources (budget, time) and fulfilling the required facilities (internet access, office) for teamwork activities;

- The universities have to set clear guideline that encourages the academic staff to participate in various teamwork practices.

- The universities with the participation of all concerned bodies

should set transmissible incentives, rewards and promotion systems for those instructors who actively engage themselves in teamwork activities and to keep and sustain their interest in team work.

In general, teamwork has to be given due attention by all concerned bodies in designing, and organizing teamwork activities. Taking these into account will lead to success and quality of teaching and learning process. Moreover, the culture of collegiality and experience sharing have to be developed and promoted into the work of higher education institutions to uplift the present worries in the quality of education in Ethiopia.

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