Arid Zone Journal of Engineering, Technology and Environment. October, 2003; Vol.3, 31-36

Print ISSN: 1596-2490, Electronic ISSN: 2545-5818
www.azojete.com.ng

COMPARISON OF CHEMICAL CONTENTS OF SHEABUTTER EXTRACTED FROM LOCALLY DESIGNED MACHINE AND OTHER EXTRACTION METHODS

Inegbenebor, A. I.[1] and A.O. Inegbenebor[2]

Abstract

As elemental contents of sheabutter play a vital role in various physiological and metabolical activities in the human body, it is necessary to compare the chemical contents of sheabutter extract from different procedures in order to identify the most important extraction procedure. Sheabutter extracted using a locally developed machine was compared with the composition of extract from two other techniques using a soxhlet extractor and the traditional procedure. The result shows increasing recoveries of most of the elements on progressing to the design machine and soxhlet apparatus from traditional procedure. The chemical analysis results showed the amount of lead, mercury, manganese, iron, copper, calcium, iodine, magnesium and phosphorus present in the sheabutter. The amounts of Ca, Fe and Pb are as high as 22.8 μgl^{-1}. This work also found that the levels of elemental composition in the extracts of 22.8 μgl^{-1} sheabutter from modern machine are more than those from the traditional extracting method of 16.2 μgl^{-1}. Possible reasons and implication of those findings are discussed.

1. Introduction

Sheanut grows on semi-wild medium size tree in the savannah zone where rainfall is not excessive. The tree begins to bear fruits at 12 – 15 years of age and reaches full bearing capacity at 20 – 25 years (Koku, 1989). The fruit produces nuts which taste like pea. It is "egg-shaped" (oval), with stony hard nut containing considerable quantities of oil (Shukla and Pandey, 1982). The sheanuts are collected and stored for oil extraction. The outer coats of the nuts are removed by cracking and the seed kernel is roasted.

Both industrial and domestic uses of oil/fats have necessitated lipid research and the search for the best method of extraction. The design and construction of the sheabutter extractor was made with the view to improve the nutrients in sheabutter in terms of yield and quality of the oil extracted. The construction was made with available local raw materials (see Figure 1).

[1] Department of Chemistry, University of Maiduguri, Maiduguri. Borno State. Nigeria
[2] Department of Mechanical Engineering, University of Maiduguri, Maiduguri. Borno State. Nigeria

Insert figure 1 here

According to Inegbenebor and Abdulkareem (1993), the main components of the design were:

- i The power screw which serves the dual purpose of a conveyor and squeezer or plasticizer. It is a left hand square thread with single start thread and has a lead equal to the pitch.
- ii The housing is a thin seamless walled cylinder. The ratio of the wall thickness (t_w) to the cylinder diameter (d_w) is the design criterion.
- iii An adjuster, which is made of many intermittently parts that include: washer, spring, fasteners and others. The adjuster moves to regulate the pressure in the housing.
- iv A cone which regulates the pressure within the housing by means of other adjuster accessories.

After carefully working out the components of the extractor, cold rolled mild steel was selected for the components. The conditions of selecting such steel were based on its high yield and tensile strength and also its machinability, easy formability and weldability. Bokhari and Ahmed (1990) proposed a level of 20 off-pressure (pf) for groundnut oil extractor. This value is taken as the working pressure for the sheabutter extractor since sheanut is coarse in texture when compared with groundnut.

According to Shukla and Pandey, (1982) and Bokhari and Ahmed (1990), sheanut contains 50 – 55% of sheabutter. In order to improve on the percentage of sheabutter from sheanut, Inegbenebor and Abdulkareem (1993) designed and constructed sheabutter extraction macine (Figure 1). The designed machine was based on the principle of the traditional method (Figure 2) of processing sheanut into butter. The traditional procedures of extraction of sheabutter are inefficient since only 25 – 27% of oil is extracted from the nut as reported by Koku (1989).

Since the design and construction of the sheabutter extractor was made with the view to improve the nutrients in sheabutter, it is therefore necessary to compare the chemical analysis of the product of this machine with the product from other extractors such as soxhlet and the traditional method.

The objective of this work was to compare the elemental composition of sheabutter extracted using locally designed machine with that extracted using other methods.

2. Materials and methods

Extraction methods A (using a soxhlet extractor); B (using the designed machine) and C (traditional procedure) were employed to extract resin for chemical contents of sheabutter.

Dried sheanuts (20 g) were ground to a fine power and extracted with 1 dm^3 of water in the laboratory with soxhlet apparatus. The resulting brownish aqueous extracts were concentrated to about 500 cm^3, and centrifuged to remove the fine precipitate, which had been formed. Supernatant was shaken with ether (5 x 250cm^3). The ether fractions were bulked, dried over NA_2SO_4 and evaporated to dryness. Twenty grams of semisolid product from the designed machine was dried in the oven at 750^{o}C for 24 hours. The dried semisolid was ground in fine power.

The 20 g of semisolid (resin)from the traditional method (C) was obtained as described by Inegbenebor and Abdulkareem (1993). The roasted kernels were pounded to fine paste in a wooden mortar. Water (1 dm^3) was added to paste and was subjected to heating. The floating oil was collected and further heated for pure butter. By this procedure, the percentage of the sheabutter obtained was not much.

Residues from extraction methods A, B and C were analyzed for there elemental contents. Approximately 1.0 g of each of the powdered sheabutter was digested by dissolving in formaldehyde and concentrated H_2SO_4 mixture (1:1, v/v) of 50 cm^3. This mixture was heated with further addition of a mixture of HNO_3, HCI and $HCIO_4$ in a 500 cm^3 flask. The heating continued for about 2 hours. The mixture was evaporated to 5cm^3 and together with the residue, it was taken up in 19 cm^3 of 2 M, HNO_3 and 30 cm^3 distilled water into 100 cm^3 volumetric flask. Blank samples and standard solutions for various elements were similarly prepared. All samples were stored in plastic container in a refrigerator maintained at 4^{o}C prior to analysis.

A flame emission spectrometer (FES) Gallen Kamp (FEA 330) was used to determine the Na, K and Ca in the samples. Phosphorus was determined gravimetrically as detailed in Vogel (1978). The other elements were determined by atomic absorption spectrophotometry (AAS) with 9 Unicarm. Airaropane and air/acetylene (ethyne) flames were respectively used in the FES and AAS procedures. A standard calibration quantitative method was used in both procedures. Plots of emission (FES) and absorbance (AAS) readings were prepared for the known standard concentrations. The test elements were drawn from these concentrations of the relevant elements in the pulverized sheabutter. Samples were obtained using their measured emission and absorbance value as the case may be.

3. Results and discussion

The results of the elemental determination of sheabutter extracts are given in Table 1. It appears that the amounts of Pb, Mg and Cd (16.50, 0.18 and 0.23 µg/l respectively) in the sheabutter extracted from traditional procedure differ significantly from those of soxhlet apparatus (20.88, 0.37 and 0.45 µg/l) on the basis of sample extraction procedures.

The Hg, Mn, Fe, Cu, Ca, P, Ag, Cr, Na, Ni and Zn levels show similar differences between the results obtained from samples that were extracted using the designed machine and those obtained from samples that were extracted from soxhlet apparatus and the traditional procedures. In all cases, the Pb, Mn, Fe, Ag, Co, Na and Zn levels obtained from samples extracted from the machine were higher than the corresponding values obtained from samples extracted from the other methods. The difficulty of formation of soluble residues from the traditional method of extraction may be responsible for the difference in the result.

Table 1: Average contents of sheabutter extract using three different methods

Elemental content (μg/l)	Extraction method		
	A	B	C
Pb	20.88	21.91	16.50
Hg	0.07	0.05	0.03
Mn	0.51	0.58	0.41
Fe	19.72	22.80	16.16
Cu	0.18	0.16	0.10
Ca	23.42	22.69	18.31
Mg	0.37	0.33	0.18
P	0.97	0.87	0.65
Ag	0.31	0.35	0.29
Cd	0.45	0.45	0.23
Co	0.39	0.41	0.34
Cr	0.08	0.08	0.05
Na	0.68	0.70	0.55
K	0.21	0.19	0.20
Ni	0.65	0.64	0.35
Zn	0.23	0.25	0.19

The results show increasing recoveries of most of the elements from traditional procedure to designed machine and soxhlet apparatus. From the table, it is clear that losses of the elements were more than 15% in extraction methods A and C alone. Bernas (1973; 1976) has reported on the use of high-pressure-decomposition vessels for the preparation of ininorganic and organic materials prior to elemental analysis by AAS. The machine designed and fabricated by Inegbenebor and Abdulkareem (1993) and the soxhlet apparatus provide this high-pressure-decomposition demand for sheanut extraction.

Majority of the in-field installations operating today including soxhlet apparatus are powered from a constant current source. The designed extractor used in this work is portable and is manually operated, and capable of being used where electricity may not be available. Also, the method of preparation of the extracts from traditional procedure is probably responsible for the lower elemental compositions.

4. Conclusion

Extraction using the designed machine with the use of high-pressure-decomposition vessels manually operated is more efficient for this purpose of extraction. Consequently, extraction with the designed machine and laboratory machine (soxhlet) enables the extraction of higher levels of the elements of the sheabutter than the traditional procedure. This is due to high-pressure-decomposition system, which is incorporated into the design of these machines.

A knowledge of the elemental composition of the sheabutteris necessary for the industrial and domestic applications of the sheabutter. The work was able to show the level of elemental compositions in the extract of sheabutter using modern machines and traditional way of extraction. The traditional procedure should be improved in order to recover higher elemental compositions.

References

Berns, B. (1973) Acid pressure decomposition device for interference free AA analysis. .*Am Lab* **5(8**) 41-43.

Berns, B. (1976) Liquid pressure decomposition, recent application in soil, plant and cement analysis. .*Am Lab* **8** 27-32.

Bokhari, M. H. and M. S. Ahmed (1990). Asean post production information processing factors affecting yield and quantity of mechanically espressed groundnut oil. *Journal of Agricultural Engineering Research*. **45**, 31-43.

Inegbenebor, A.O. and H.A. Abdulkareem (1993). Design and construction of sheabutter extraction machine for rural areas in the developing countries. Proceedings of First Africa – USA International Conference of Manufacturing Technology. Lagos.

Koku, I.T. (1989). *Extraction and characterization of oil from sheanut*. Unpublished work. Mechanical Engineering Department, University of Maiduguri.

Shukla, S.D. and G.N. Pandeywer, (1981). *Textbook of chemical technology*. Lagos.

Vogel, A.I (1978). *A textbook of quantitative inorganic analysis including elementary instrument analysis*. 5th Edition. ELBS and Longman, London.