

## **Evaluation of the efficacy of cassava leaves in the control of gastrointestinal nematodes in pigs**

## **Evaluación de la eficacia de las hojas de yuca en el control de nematodos gastrointestinales en cerdos**

DOI: 10.53499/sfjeasv2n2-011

Received in: January 3rd, 2022

Accepted in: March 31th, 2022

### **Maido Quefasse Manhique**

Degree in Zootechnical Engineering from Instituto Superior Politécnico de Gaza (ISPG)  
Mozambique-Gaza, Lionde-Chokwe Polytechnic Campus  
E-mail: pesquisa: crtt.ispg@gmail.com

### **ABSTRACT**

The creation of pigs is an activity practiced in the country however, one of the biggest difficulties has been in the control of gastrointestinal nematodes that consequently lead to economic expenses, low productivity and indiscriminate use of anthelmintic drugs. In this context, it becomes necessary to search for easily accessible and low-cost forms of treatment such as cassava leaves that have condensed tannins which is the active principle with anti-helminthic effect. In this context, the efficacy of the use of cassava leaves (FM) in the control of gastrointestinal nematodes in pigs was evaluated. The trial was conducted in the district of Chòkwé in the production unit of the Civic Services of Mozambique (SCM), in the period from April to June 2019. Eighteen piglets from Large white and landim cross breed aged between 1.5 and 2 months were used carrying natural infection by gastrointestinal nematodes, verified by counting the number of eggs per gram of feces (OPG). The piglets were divided into 3 treatments: T0 (control, not dewormed); T1 (dewormed with FFM-Manioc Leaf Meal); T2 (dewormed with Albendazole), in a completely causalized design (DCC) with 6 randomly chosen animals where the data obtained were analyzed in the statistical package Mintab18. The calculation of efficacy was based on the percentage of reduction through the RESO statistical package. As a result, it was observed that FFM had a better reduction capacity with an efficacy of (82% and 90%) compared to Albendazole which obtained (64% and 73%) efficacy at 60 and 75 days respectively. Estrongylideos sp., were the group most sensitive to the effect of cassava leaf meal. FFM also stood out with the highest return (25.47 meticais) in the economic feasibility analysis compared to Albendazole (2.72 meticais). It can be concluded that FFM has anti-helminthic efficacy in the control of gastrointestinal nematodes and is also feasible in reducing costs of constant reacquisition of conventional dewormers and can be an alternative for use in family pig farms.

**Keywords:** piglets, parasitology, albendazole, condensed tannins.

## RESUMEN

La crianza de cerdos es una actividad que se practica en el país sin embargo, una de las mayores dificultades ha sido en el control de los nematodos gastrointestinales que consecuentemente llevan a gastos económicos, baja productividad y uso indiscriminado de medicamentos antihelmínticos. En este contexto, se hace necesaria la búsqueda de formas de tratamiento fácilmente accesibles y de bajo costo como las hojas de yuca que tienen taninos condensados que es el principio activo con efecto antihelmíntico. En este contexto, se evaluó la eficacia del uso de hojas de yuca (FM) en el control de nematodos gastrointestinales en cerdos. El ensayo se llevó a cabo en el distrito de Chòkwé en la unidad de producción de los Servicios Cívicos de Mozambique (SCM), en el período de abril a junio de 2019. Se utilizaron 18 lechones de raza Large white y landim de entre 1,5 y 2 meses de edad portadores de infección natural por nematodos gastrointestinales, verificada mediante el recuento del número de huevos por gramo de heces (OPG). Los lechones se dividieron en 3 tratamientos T0 (control, no desparasitado); T1 (desparasitado con FFM-Manioc Leaf Meal); T2 (desparasitado con Albendazol), en un diseño completamente causalizado (DCC) con 6 animales elegidos al azar donde los datos obtenidos fueron analizados en el paquete estadístico Mintab18. El cálculo de la eficacia se basó en el porcentaje de reducción a través del paquete estadístico RESO. Como resultado, se observó que el FFM tuvo una mejor capacidad de reducción con una eficacia del (82% y 90%) en comparación con el Albendazol que obtuvo una eficacia del (64% y 73%) a los 60 y 75 días respectivamente. *Estrongylideos sp.*, fue el grupo más sensible al efecto de la harina de hoja de yuca. El FFM también destacó con el mayor rendimiento (25,47 meticais) en el análisis de viabilidad económica en comparación con el Albendazol (2,72 meticais). Se puede concluir que el FFM tiene eficacia antihelmíntica en el control de los nematodos gastrointestinales y también es factible en la reducción de los costos de readquisición constante de los antiparasitarios convencionales y puede ser una alternativa para su uso en las explotaciones porcinas familiares.

**Palabras clave:** lechones, parasitología, albendazol, taninos condensados.

## 1 INTRODUCTION

Animal production in Mozambique has been growing in the raising of pigs, the production of which is mostly owned by the family sector rearing in an extensive manner, and there is currently a gradual change to semi-intensive and intensive rearing of pigs through the entry of new investments in this sector, with a production growth of 5.4% of the national livestock (Ferrão, 2001).

Pig farming is an expanding activity in the family sector in our country as a source of protein and income. However, parasitism by gastrointestinal nematodes has been one of the main limiting factors for the growth of this activity, as it is responsible for the decrease in herd productivity due to high morbidity, reduced weight gain, animal mortality and condemnation of carcasses and viscera (Ferrão, 2001). Associated with this problem is the poor use by the family sector of anthelmintic dewormers due to difficulties of access and due to the high cost and when they have access to dewormers they apply

them indiscriminately which favors the presence of contaminating residues in the meat or the environment (Fávero et al., 2003).

Therefore, in view of these constraints, it became necessary to search for new ways to control gastrointestinal nematodes where, the use of medicinal plants with anthelmintic action as is the case of cassava culture demonstrated itself as a simple and inexpensive alternative treatment. Therefore, the present study evaluated the efficacy of the use of cassava leaves as a dewormer in pigs constituting a local and low-cost alternative to reduce dependence on conventional chemotherapeutic anthelmintic treatments.

## 2.1 OBJECTIVES

### 2.2.1 General objective

- To evaluate the efficacy of the use of cassava leaves as a dewormer in pigs

### 2.2.2 Specific Objectives

- Identify and quantify the species of gastrointestinal parasites in pigs;
- Compare the efficacy of cassava leaves (phytotherapeutic) with albendazole (chemotherapeutic) as dewormers in pigs;
- Evaluate the economic feasibility of using cassava leaves and albendazole as dewormers.

## 2 LITERATURE REVIEW

### General considerations on cassava (*Manihot esculenta* crantz) culture

Cassava belongs to the genus *Manihot*, family Euphorbiaceae, and the species *Manihot esculenta* crantz is of greatest agronomic interest. It is a plant of South American origin, grown mainly in latitudes 15°N and 15°S and low altitudes or up to 600 to 800 meters are the most favorable. The ideal temperature is between 20 and 27°C, requiring rainfall between 1,000 and 1,500 mm per year, although it is widely grown in semi-arid regions, with 500 to 700 mm per year low acidity (pH 5.5 to 7.0, 6.5 being the ideal), high fertility, as well as in physically degraded soil and low nutrient content, where most tropical crops would not produce satisfactorily due to adverse conditions (Souza and Souza, 2000).

## **Geographical distribution of cassava in Mozambique**

The Portuguese brought this crop to Mozambique many years ago, and today it is spread in all provinces of the country, more concentrated in coastal regions. The world production of cassava in 2002 was 184 million tons, with 99 million, or more than half, only from Africa, thus noting the great importance in the diet of millions of Mozambicans. Cassava is one of the food crops produced in Mozambique occupying the second place after maize, produced mostly along the coast in the provinces of Zambezia, Nampula, Cabo Delgado and Inhambane. It is estimated that cassava occupies 50% of the total cultivated area (Sánchez et al., 2010).

## **Cassava varieties**

Cassava is classified as wild, bitter or poisonous, for industrial use (its content is around 20 mg HCN/kg of fresh pulp). The bitter cassava, when intended for food purposes, is mainly used for the production of flour (bombó and crueira). The sweet ones, which have substantially less toxin content, are prepared domestically for immediate consumption. However, it is important to note that "sweet" or "bitter" are designations that do not have great accuracy, since these characteristics are not necessarily linked to the production of cyanogenic glucosides, because one can also find high levels in some sweet varieties, so the study of varieties is essential to minimize the risks of poisoning (Carvalho, 1990).

## **Cassava leaf hay**

The process of haying cassava leaves consists of dehydrating the leaves by spreading them on land and turning them periodically facilitating the dehydration of the material by the action of the sun, which plays a key role in the process, when dry is ground to obtain the flour of cassava leaves hay, subsequently stored in bags, and stored in a place with good ventilation, low relative humidity and protected from rain (Almeida and Ferreira, 2005). The flour can be added to feed up to 25% of the diet of growing and finishing pigs and up to 30% of the diet of gestating sows. These diets are supplemented with oil and methionine, to adjust the energy content and this amino acid, which helps in the detoxification of toxic residues that remain in the meal (Modest et al., 2007).

## **Gastrointestinal parasites of pigs**

Gastrointestinal parasites contribute to the occurrence of economic losses in production because they interfere with the development of the pig due to reduced feed intake, feed conversion, weight gain of contaminated animals and condemnation of affected organs. Some of these parasites are considered zoonoses because they also affect humans (Weng et al., 2005). The occurrence of parasitic diseases in pigs varies according to the management system, types of facilities, sanitary measures, geographical location and age of the animal, with the most affected being the younger ones from six weeks to six months, in which the parasitic action is more evident and severe. Among the most prevalent gastrointestinal helminths in pigs are the genera *Ascaris* sp, *Oesophagostomum* sp., *Strongyloides* sp., *Estrongylideo* sp, *Trichuris* sp and *Metastrongylus* sp (D'alencar et al., 2011). Adult animals are usually carriers of infection, contaminating younger ones, the most prominent example being parasitized adult females that are a source of infection for growing piglets. Larval eggs of the parasites that adhere to the skin of the breasts are ingested by the piglets during suckling. In addition, *Strongyloides ransoni* larvae pass through colostrum or via the skin (Urquhart et al., 1998).

## **Control measures**

Measures are aimed at reducing the parasite load to prevent clinical disease. Preventive control is performed at regular periods, on pre-established dates, throughout the herd, with the aim of avoiding clinical or subclinical infections. However, the active principle does not eliminate 100% of the infecting forms, selecting resistant strains. Curative control is performed only when there are evident clinical signs or even death by parasitism (Githiori et al., 2003). Suppressive control consists of deworming the animals every 2-4 weeks with drugs of short persistence. This type of control is used in research work when it is desired to verify the effect of parasites on herd productivity (Fonseca, 2006).

## **Phytotherapy**

Phytotherapy is the treatment of diseases through fresh vegetables, it is a practice already known and used by man, but that has recently been highlighted in scientific research. However, when phytotherapy is applied to parasite control, ethical principles must be respected and its use validated scientifically. If its use is well understood and planned, it stimulates the cultivation of plants of interest, promoting local development

and avoiding the destruction of native vegetation, being one more tool, which will increase the variety of products to be used by professionals and offer therapeutic options of medicines (Lapa et al., 2004).

### **Use of cassava leaves in the control of parasites**

Cassava leaves present functional characteristics in the elimination of gastrointestinal helminths due to the presence of Condensed Tannins (CT) that are bioactive compounds that have nematocidal potentiality. The TC present in cassava leaves can affect the biological processes of nematodes depending on the level of ingestion and how tannins bind with various nematode structures such as the sheath, cuticle, digestive or reproductive system (Brunet and Hoste, 2006).

The anthelmintic effect of CTs against gastrointestinal nematodes can be direct when CTs act on the parasite, severely affecting the biological processes of the nematodes, and indirect when CTs act indirectly by improving the protein utilization by the host and consequently a better immune response of the host to the parasites, TC bind to proteins forming complexes (tannin-protein), causing proteins of higher biological value not to be degraded and used, and these complexes are dissociated in the small intestine where amino acids are absorbed (Waghorn, 2008). If the TC content is higher than 1% in the dry matter of monogastrics it can bring losses in production, affecting the consumption and digestibility of proteins and essential amino acids. Haying decreases the TC content, mature cassava leaves (12-18 months) at the time of root harvest, have concentration higher than 6% but haying of the aerial part reduces the TC concentration up to 2-4% in dry matter (Wanapat, 2002).

### **Use of chemical anthelmintics in parasite control**

The first broad spectrum anthelmintics praziquantel and later mebendazole, albendazole, ivermectin, among others, were launched in the 60's. However, the use of anthelmintics is limited by factors that include drug efficacy, mechanism of action, pharmacokinetic properties, host related characteristics, parasite characteristics such as degree of hypobiosis, location in the body and resistance. The ideal anthelmintic should have broad spectrum of activity against mature and immature forms, be easy to administer to a large number of animals, have a high safety margin, be compatible with other compounds, leave no residues, and be economical to use (Willian et al., 1996).

Albendazole is a broad-spectrum anthelmintic of the benzimidazole class widely used for the control of gastrointestinal parasitism and acts against young and adult forms of gastrointestinal and pulmonary nematodes, cestodes and trematodes, Its active ingredient is albenol, which acts by binding to free beta-tubulin, inhibiting the polymerization of microtubules, leading to changes in the energy metabolism of the parasite causing paralysis, starvation and subsequently death (Ayres et al. , 2002).

There is a tendency for resistance levels to increase, due to the persistence of the use of the albendazole base because breeders attribute to this drug a high efficacy, facilitated by the reduction in price of commercial formulations and by often changing only the commercial name of the anthelmintic (Mattos and Hoffmann, 2010).

### **Tests for evaluation of anthelmintic activity**

The Reduction of Eggs Per Gram of Feces Test (RCOF) is a practical and rapid method that does not require the sacrifice of animals and can thus be implemented at the farm level to determine the effectiveness of the products used. It can be performed on ruminants, horses, pigs and with all anthelmintics and all nematode species, whose eggs are eliminated in the feces. This test presents some intervening factors that require caution in interpreting its results, such as: the egg count (OPG) (Echevarria and Trindade, 1989).

## **3 METHODOLOGY**

### **Methods**

#### **Materials**

For the present study, the following were used: Experimental animals (18 pigs); Conventional anthelmintic (Albendazole); Scales; Experimental anthelmintic (Cassava Leaf Meal); Syringes; Plastic bags; Gloves; Brooms; Shovels; Pullers; Plastic bottles; Markers; Field notebook; Feed; Bags; Saline solution; Ballpoint pen; Pipettes; Tamis; Flasks; Microscope; Slides; Mc Master chamber; Slides; Dropper.

#### **Location and experimental period**

The study was conducted in Gaza province in the Chòkwé district, in the animal production unit of the Civic Services of Mozambique (SCM), lasting 75 days in the period from April to June 2019. The district of Chókwè is situated in the South of the province of Gaza, in the middle course of the Limpopo river, having as limits to the North the Limpopo river which separates it from the districts of Massingir, Mabalane and Guijá, to

the South the district of Bilene and the Mazimuchope river by district of Bilene, Chibuto and Xai-Xai, to the East it borders with the districts of Bilene and Chibuto and to the West with the districts of Magude and Massingir. The district's climate is dominated by the semi-arid type (dry savanna), where precipitation varies from 500 to 800mm, confirming the gradient from the coast to the interior, while the reference potential evapotranspiration is in the order of 1400 to 1500mm. Average annual temperatures range between 22°C and 26°C and average annual relative humidity between 60-65% (MAE, 2005).

### **Experimental Design**

In setting up the experiment, a completely causalized design (DCC) was used, with 3 treatments and 6 repetitions, based on the following treatments:

- ❖ Treatment 0 (T0) - Non-dewormed piglets (Witness).
- ❖ Treatment 1 (T1) - dewormed piglets with ingestion of FFM at 1% of the animal's live weight (kg)
- ❖ Treatment 2 (T2) - Piglets dewormed with Albendazole (5mg/kg) applied 3 times during the trial (1st; 30th; 60th days).

To form the treatment groups, the animals were randomly separated so that each group corresponded to a treatment with equal and/or approximate weights and OPG (without significant differences), being submitted to the statistical package Mintab 18.

### **Experimental procedure**

#### **Animals and experimental facilities**

For the performance of the experiment, 18 newly weaned piglets from Large white and Landim cross breed with 1.5 to 2 months of age and with a weight ranging from 4 to 12kg were used, whose selection of animals for the experiment was based on the following criteria: positive diagnosis as carriers of natural infection by gastrointestinal parasites, verified through laboratory count of the number of eggs per gram of feces (OPG) greater than or equal to 150 and not having been treated with anthelmintic drug in the last two months according to Coles et al (1992). The animals were housed in an intensive system pen, with a cement floor divided into individual compartments with feeders and drinkers. For identification, the piglets were marked on the ear using a marker with a number and the respective treatment.

## **Initial management**

In the initial management, the facilities were cleaned, the animals were initially weighed, and feces were collected for OPG testing in order to select the animals used in the experiment. The adaptation period was 7 days to stimulate the level of intake of the cassava leaf meal and also for the animals to adapt to the study environment. Next was the phase of formation of the treatment groups.

## **Cassava leaf processing**

Cassava leaves of the Xinhembua variety aged less than 6 months were purchased from the Chókwè market and dried in the sun for a period of 2 days. During drying the leaves were turned over for more sunlight. The dehydration culminated with the production of hay, which was crushed in a pestle, thus originating the flour, which was then stored in a safe place without interference from climatic factors. The meal was then fed to the animals mixed with water. The amount administered was 1% of the animal's live weight (kg), and was administered twice (8 am and 4 pm) to ensure total intake of the proposed amount per day.

## **Analytical Procedures**

### **Fecal sample collection**

Fecal samples were collected fortnightly from each piglet directly from the rectal ampulla using plastic bags and placed in flasks previously identified with the number corresponding to the animal and treatment, and kept under refrigeration for a maximum period of 48 hours to be later sent to the parasitology laboratory for counting eggs per gram of feces. Six collections were made: the first pre-experimental collection before the beginning of the trial, the second at 15, the third at 30, the fourth at 45, the fifth at 60, and finally the sixth at 75 days, where 108 stool samples were processed during the trial.

### **Counting the number of eggs per gram of feces (OPG)**

The evaluation of the intensity of infestation of gastrointestinal parasites dewormed with cassava leaf hay and albendazole was based on the technique described by Gordon and Whitlok (1939) cited by Ueno and Gonçalves (1998). After weighing, the pig feces was ground with a stick in a sieve, diluted in 28 ml of hypersaturated sodium chloride solution, and the suspension formed was mixed with a pipette. Then a small amount of the mixture was taken and filled in both spaces of the Mc Master chamber, left

to stand for 5 minutes, and then taken to the microscope under a 10x objective where the egg count was performed. The number obtained in each area was counted and multiplied by 100 and the results expressed in OPG.

For classification of parasite load based on OPG count, we used the classification proposed by Hansen and Perry (1994) described as light parasite load for OPG less than 500, moderate parasite load for OPG between 500-1500, and heavy or severe load for OPG greater than 1500.

### **Variables or parameters to be evaluated**

Efficacy of the anti-helminthic effect of albendazole cassava leaves

Efficacy was calculated based on the percentage of egg reduction (RCOF) using the formula of Coles et al (1992):  $\% \text{ RCOF} = [1 - (\text{Mean OPG}_t / \text{Mean OPG}_c)] \times 100$ , where t, (treated group) and c (untreated group). According to the classification of Coles et al (1992) if the percentage of reduction is less than 95% with confidence interval less than 90% it means that the anthelmintic is not effective in reducing OPG.

### **Data analysis**

The data were analyzed in the Mintab18 statistical package. Comparison of treatments was done using analysis of variance (ANOVA), complemented by Tukey's test at a 5% significance level. Evaluation of anthelmintic efficacy was based on the statistical program RESO (1989) following the instructions of Coles et al (1992) described previously.

### **Deworming cost analysis**

This variable was based on the comparison of deworming costs based on 2 scenarios of anthelmintic treatments where, we have the chemotherapeutic dewormer (ALBZ) and the phytotherapeutic dewormer (FFM) and the partial budget method was used that allows to evaluate the economic viability of the treatments under study.

## **4 RESULTS AND DISCUSSION**

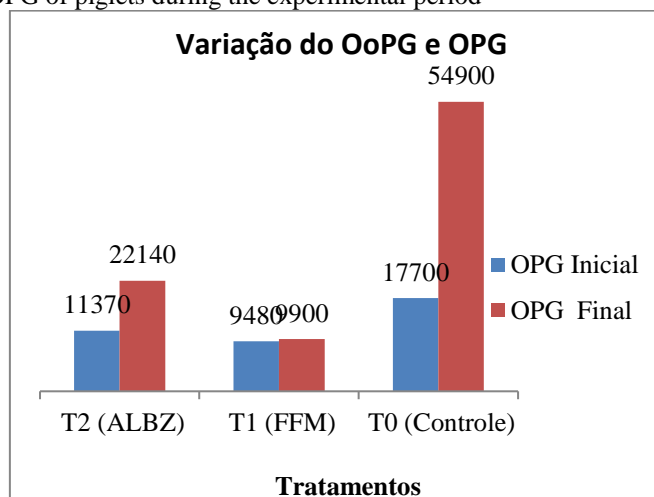
During the trial, 108 samples of pig feces were collected and processed from 5 genera of parasites namely: Eimerias sp (44.81%), Estrongylideos sp (25.42%), Strongyloides sp, (22.20%), Trichuris sp (3.91%) and Ascaris sp (3.93%). The results of predominance of Eimerias sp. (44.81%), probably according to Wegher (2017) is due to

the difficulty of strict hygiene of the facilities which facilitates the proliferation of eimerias oysters.

In the nematode group the highest predominance was *Strongyloides.sp* (25.42%), resembling the study conducted by Amuta et al (2015) which revealed the highest predominance of the genus *Strongyloides.sp* of the nematode group.

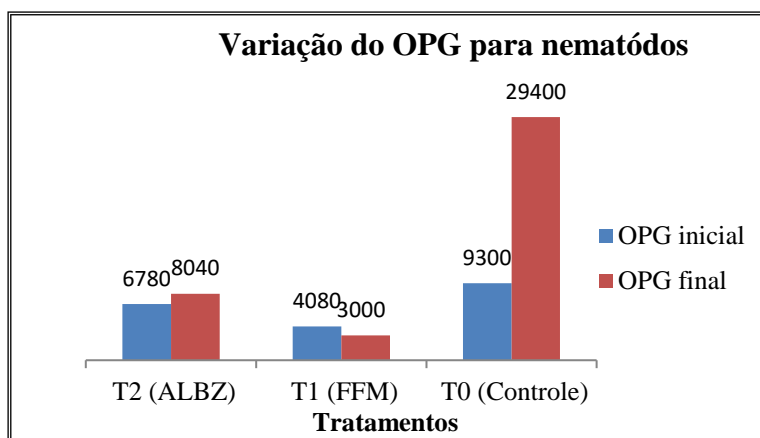
Overall based on figure 1, it was found that the control group (T0) had the highest increase in parasite load (37200 OPG) ending the trial with the heaviest load of all treatments (54900 OPG). Then T2 (ALBZ) had the second highest increase (10770 OPG), while T1 (FFM) had the lowest OPG increase (420 OPG) although it also finished the trial with a heavy load (9900 OPG), according to Hansen and Perry's (1994) classification. In relation to the treated groups it is visible that T1 outperformed all treatments in reducing parasite load, these results resemble those obtained by Aguiar (2009) in a study when supplementing piglets naturally infected by helminths with cassava leaves where in comparison with the control group and conventional anthelmintic had a greater reduction of parasite load in piglets supplemented with cassava leaves. This result obtained in this trial, probably is related to the concentration of condensed tannins present in cassava leaves that act as an active principle in reducing parasite load.

Figure 1. OoPG and OPG of piglets during the experimental period



Extracting from the previous data the results only for nematodes (*Strongyloides* sp and *Strongyloides* sp), which is the class that causes the most damage to the animals, as illustrated in figure 2, it was observed that the group (T0) ended the trial with a heavier parasite load (29400 OPG), having increased (20100 OPG). In T2 (ALBZ), the parasite load also increased (12600 OPG) compared to T1 (FFM), which was the only group to show a decrease (10800 OPG) in the parasite load of nematodes.

Figure 2. OPG of the nematode group during the experimental period



These results corroborate Hosaneide (2002) in demonstrating the superiority of cassava leaves in reducing OPG compared to the conventional anthelmintic Albendazole, having pointed out the nematode action of tannins against adult parasites found in the gastrointestinal tract of animals. The effect of cassava leaves has already been tested in studies by several authors Padilha (1996); Bianchin et al (1997); Silva et al (1998); Patino et al (2010) who also verified the reduction of nematode OPG as the levels of cassava leaves increased.

Therefore, the results obtained in the present trial clearly demonstrate the existence of the anti helminthic effect of FFM with the ability to significantly reduce or inhibit the development of gastrointestinal parasites in piglets.

Table 1. Fortnightly variation of OPG for the group of nematodes (Strongyloides and Strongyloides sp)

Species	Evaluation days	T0-Control	T1FFM	T2ALBZ	DP	CV	P-Value
<i>EST</i>	Day 15	2.887 <sup>a</sup>	2.560 <sup>b</sup>	2.808 <sup>ab</sup>	0.2251	8.18	0.020
	Day 30	3.217 <sup>a</sup>	2.717 <sup>b</sup>	2.938 <sup>c</sup>	0.2422	8.19	0.000
	Day 45	3.297 <sup>a</sup>	2.865 <sup>b</sup>	2.974 <sup>b</sup>	0.2151	7.06	0.000
	Day 60	3.351 <sup>a</sup>	2.589 <sup>b</sup>	2.928 <sup>c</sup>	0.347	11.74	0.000
	Day 75	3.394 <sup>a</sup>	2.338 <sup>b</sup>	2.878 <sup>c</sup>	0.492	17.72	0.000
<i>STR</i>	Day 15	2.913 <sup>a</sup>	2.658 <sup>b</sup>	2.915 <sup>a</sup>	0.1705	6.06	0.001
	Day 30	3.192 <sup>a</sup>	2.838 <sup>b</sup>	3.072 <sup>ab</sup>	0.2226	7.34	0.010
	Day 45	3.196 <sup>a</sup>	2.561 <sup>b</sup>	2.869 <sup>ab</sup>	0.3753	13.05	0.005
	Day 60	3.274 <sup>a</sup>	2.426 <sup>b</sup>	2.692 <sup>b</sup>	0.444	15.86	0.000
	Day 75	3.364 <sup>a</sup>	2.440 <sup>b</sup>	2.681 <sup>b</sup>	0.441	15.59	0.000

Source: Author (2019); P - Treatment Effect a,b,c - Equal letters in the horizontal row do not differ statistically from each other by Tukey's test (P>0.05) ; EST- Strongyloides STR- Strongyloides.

According to the comparison of means of the treatments (Table 1 above) for the genera of strongylids, significant anthelmintic activity was observed in T1 (FFM) (P<0.05) at 75 days compared to the others (P<0.05) T2 (ALBZ) and T0-Control.

Strongyloides sp were more sensitive to T1 (FFM) - dewormer with cassava leaf meal in reducing the OPG.

For Strongyloides sp, T1 was more significant (P<0.05) than T0, but when compared to T2 there were no significant differences (P>0.05) in almost all evaluation periods. Strongyloides sp were not sensitive to T1 (FFM) dewormer with leaf meal and T2 (ALBZ) dewormer with Albendazole in reducing OPG eggs.

### Efficacy of dewormers

The effectiveness of dewormers was evaluated by reduction test (RCOF) according to Coles et al (1992) in RESO- STATISTICAL program where the results show that the highest RCOF was in T1 (FFM) group with 90% at 75 days as illustrated in Table 2 below.

Table 2. Fortnightly reduction percentage of piglets treated with FFM and ALBZ

Treatment/Days	RCOF	RCOF	RCOF	RCOF	RCOF	Average RCOF
	15	30	45	60	75	
T1-FFM	65%	68%	72%	82%	90%	75%
IC maximum	79	79	81	89	94	
IC minimum	43	52	51	72	81	
T2-ALBZ	40%	37%	50%	64%	73%	53%
IC maximum	64	57	65	74	80	
IC minimum	2	7	28	51	63	

Source: Author (2019); CI-Confidence interval; RCOF-Percentage of reduction

When comparing T1 (FFM) and T2 (ALBZ) it can be seen that animals treated with T1 increased efficacy incrementally over the trial period with 65%, 68%, 72%, 82% and 90% at 75 days.

But for the animals treated with (ALBZ) there was a small oscillation in efficacy at 30 days (37%), where the drug had to be applied to improve efficacy to 50%, 64% and 73% at 45, 60 and 75 days respectively.

In Treatment T1 the highest efficacy was seen at 75 days 90% and the overall average efficacy was 75%. For Coles et al (1992) and Woods et al (1995) this means inefficiency, but according to Githiori et al (2003) using the same reduction test recommended by Coles et al (1992), they considered that the efficacy of the plant preparations is biologically significant when the percentage of reduction reaches 70%. This suggests that T1 began to have an effect at 45 days (72%) until 75 days with 90% efficacy.

For T2, the highest efficacy was seen at 75 days (73%) and the overall average efficacy was 53%. The GMC (1996) recommends that for chemical substances to be considered efficient dewormers, they should not have an efficacy lower than 80%, which would mean insufficiently active in reducing parasite eggs, a fact that can probably be attributed to albendazole. According to Lapa et al (2004), these results can possibly be explained by the occurrence of resistance to the drug, considering that albendazole is a chemical base that is widely used in the control of helminths, where most producers do not adopt a strategic vermifugation scheme, nor do they annually alternate the chemical groups used, which facilitates the parasites to quickly develop resistance to the drugs available on the market.

### **Economic viability**

The economic analysis of piglets dewormed with (FFM) compared to (ALBZ) is very necessary, since in animal health there have been large expenditures on the purchase of dewormers for the treatment and control of gastrointestinal parasites that have affected animals in both the family and private sectors. The economic feasibility of using medicinal plants in deworming animals is a deciding factor for the health and welfare of the animals. The economical deworming cycle of piglets involves other factors that are not considered here (Table 3 below) such as consumption of electricity, water, transportation, depreciation of equipment and others. Note that costs that do not differ between treatment are not included in the table. According to Cimmyt (2001) these do

not affect the farmer's choice of control treatment and in this decision they have been ignored.

Table 3. Costs of deworming piglets with Cassava leaf hay and Albendazole

	T1FFM		T2ALBZ		
	Quantit.	Cost (mt)	Quantit.	Cost (mt)	
Cassava leaves	20kg	200	Albendazole	1 Bottle (1L)	1500
Bags	3	35	Syringes	2	50
Labor	1 Seasonal	250	Labor	1 Technician	1500
Total		485			3050

Source: Author (2019); Qty - Quantity of the inputs; mt-metical

To calculate gross revenue (RB) was multiplied the amount of piglets in (kg) of live weight with the unit price of piglet (mt/kg) and for net revenue (RL) was subtracted the Gross Revenue (RB) of the total cost of deworming for each treatment. And for marginal rate of return we divided net revenue (NR) by total deworming cost by multiplying by 100. The marginal rate of return (MRR) is expressed as a percentage where the treatment (T1FFM) showed the highest financial rate of return of 2547.4226 % which means that for every 1 metical invested you get 1 metical plus 25.474226 additional meters. So, the pig farmer, without considering the indirect costs would be earning about 26.474226 meters by investing in deworming piglets using FFM.

Table 4. Economic analysis of the cost of deworming with FFM and ALBZ

Description	T1FFM	T2ALBZ
N° of piglets	6 (64.2kg)	6 (56.8kg)
Piglet PU (mt/kg)	200	200
RB	12840	11360
CT (mt)	485	3050
RL	12355	8310
TRM	25.474226	2.724590
TRM (%)	2547.4226	272.4590

Source: Author, (2019); PU- Unit Price of piglet; RB- Gross Revenue; TC- Total Cost; RL- Net Revenue; TRM- Marginal Rate of Return

The results of economic feasibility analysis in Table 4 above showed that the treatment with the highest economic feasibility is (T1FFM), the feasibility was more efficient because cassava leaves are easy to acquire in the field by local farmers, moreover they can be used for easy deworming of animals after the cassava harvest, when compared with (T2ALBZ) which is a commercially available anthelmintic.

## 5 CONCLUSION

- ❖ From the results obtained we identified the species of *Eimerias* sp (44.8112%), *Strongylideos* sp (25.4296%), *Strongyloides* sp, (22.2066%) *Trichuris* sp (3.9108%) and *Ascaris* sp (3.6347%) with their respective percentages.
- ❖ Cassava leaf meal had higher and better efficacy of 90% at 75 days in decreasing OPG compared to albendazole which had an efficacy of 73% at 75 days.
- ❖ *Strongyloides* sp, were the group most sensitive to the effect of cassava leaf meal
- ❖ Cassava leaf meal proved to be more feasible in its use as a dewormer compared to Albendazole in pigs. Therefore, the use of (FFM) can be an alternative for efficient parasite control, reduction of production costs and obtaining higher profits by reducing the acquisition of chemical dewormers in the market.

## 6 RECOMMENDATIONS

- ❖ For the control of gastrointestinal parasitoses, it is necessary to improve the hygienic-sanitary management with the creation of a Zooprophyllactic schedule to reduce the development of parasites;
- ❖ Further similar studies are needed for the validation of cassava culture as a phytotherapeutic dewormer with active ingredients acting against gastrointestinal parasites and as a low cost alternative;
- ❖ Perform bromatological analysis of cassava leaves to identify the percentage of condensed tannins that has anthelmintic effect in pigs.

## REFERENCES

1. Aguiar, P.C. (2009). *Aspectos epidemiológicos das parasitoses gastrintestinais de suínos naturalizados de criações familiares do Distrito Federal*, Brasília-Brasil p-106-110
2. ALMEIDA, J de; FERREIRA F, J, R. (2005) *Mandioca: uma boa alternativa para alimentação animal*. Cruz das Almas, BA: Bahia Agrícola, v.7, n.1.
3. AMUTA, E. U.; HOUMSOU, R. S.; AMUTA, P. O.; OCHKWUNU, O. (2015) *Gastrointestinal parasites of swine under small scale management in Makurdi, Benue State, Nigeria*. Nigerian Journal of Parasitology, v. 36, n. 1, p. 67-71.
4. AYRES, M.C.C.; ALMEIDA, M.A.O.; SPINOSA, H.S.; GÓRNIK, S.L.; BERNADI, M.M. (2002). *Agentes antinematódeos, Agentes antiparasitários In: SPINOSA, H.S. Farmacologia aplicada à medicina veterinária*. 3ª Edição. Rio de Janeiro: Guanabara Koogan, p.476-488.
5. BIANCHIN, I. (1997) *Controle estratégico de parasitos em bovinos de corte*. Revista Brasileira de Parasitologia Veterinária, v. 6, n. 2, suplemento 1.
6. BRUNET, S; HOSTE, H. (2006) *Monomers of condensed tannins affect the larval exsheathment of parasitic nematodes of ruminants*. *Journal of Agricultural and Food Chemistry*, Washington. v 54, n 20 p.7481-7487.
7. CARVALHO, J. L. H. (1990) *A mandioca: raiz e parte aérea na alimentação animal*. In: *Encontro sobre o uso da mandioca na alimentação animal*. Botucatu, SP: Apostila Casa da Agricultura de Botucatu, Prefeitura Municipal de Botucatu, p-39.
8. CIMMYT. (2001) *World Wheat Overview and Outlook: Developing No-Till Packages for Small-Scale Farmers*. México.
9. COLES, G. C.; BAUER, C.; BORGSTEEDE, F. H. M., GEERTS, S., KLEI, T. R., TAYLOR, M. A., WALLER, P. J. (1992) *World Association for the advancement of Veterinary Parasitology (W.A.A.V.P.) methods for detection of anthelmintic resistance in nematodes of veterinary importance*. *Veterinary Parasitology*, v. 44, p. 35-44.
10. D'ALENCAR, S.; FARIAS, M. P. O.; ROSAS, E. O.; LIMA, M. M.; FAUSTINO, M. A. G. (2011). *Influência do manejo higiênico-sanitário na infecção por helmintos gastrintestinais em suínos de granjas tecnificadas e de subsistência abatidos na região metropolitana de Recife e zona da mata do estado de Pernambuco*, Brasil. *Arquivos do Instituto Biológico*, v. 78, n. 2, p. 207- 215.
11. ECHEVARRIA, F. A. M.; TRINDADE, G. N. P. (1989) *Anthelmintic resistance by Haemonchus contortus to ivermectin in Brazil*. *Veterinary Record*, v. 114, p. 147-148 <<http://www.fao.org/ag/agp/agpc/gcds/>>. Accessed on: 05 Junho 2018.
12. FÁVERO, J. A.; CRESTANI, A. M.; PERDOMO, C. C.; BELLAVER, C.; PILLON, C. N.; FIALHO, F. B.; LIMA, G. J. M. M.; ZANELLA, J. R. C.; MORÉS, N.; SILVEIRA, P. R. S. (2003) *Boas Práticas Agro-pecuárias na Produção de Suínos*. *Circular Técnica*. Embrapa Suínos e Aves. Concórdia. Brasil.

13. FERRÃO, J.L. (2001). *A Pecuária no Sector Familiar em Moçambique – Limitações e Possíveis Intervenções*. Instituto Agrário de Chimoio.
14. FONSECA, A.H (2006) *Helminthos Gastro-Intestinais dos ruminantes*. Universidade Federal do Rio de Janeiro
15. GITHIORI, J. B., HÖGLUND, J., WALLER, P. J., BAKER, R. L. (2003) *The anthelmintic efficacy of the plant, Albizia anthelmintica, against the nematode parasites Haemonchus contortus of sheep and Heligmosomoides polygyrus of mice*. Veterinary Parasitology, v. 116, p. 23-34
16. GMC – GRUPO MERCADO COMUM. (1996) *Regulamento técnico para registros de produtos antiparasitários de uso veterinário*. Decisão n. 4/91, resolução n. 11/93. MERCOSUL, resolução n. 76
17. GORDON, H. M.; WHITLOCK, H. V. (1939) *A new technique four counting nematode eggs in sheep faeces*. Journal Council Science Industry Research. v.12, n.1, p. 50-52.
18. HANSEN, J.; PERRY, B. (1994). *Table of contents: The epidemiology, diagnosis and control of helminth parasites of ruminants*. Obtido em 20 de Agosto de 2016, de Food and Agriculture Organization of the Organization of the United Nations: <http://www.fao.org/Wairdocs/ILRI/x5492E/x5492e00.htm#Contents>
19. HOSANEIDE, A.; (2002) *Parasitas gastrintestinais de suínos criados em sistema de produção de Agricultura familiar no semiárido Paraibano*, nordeste do Brasil.p-663.
20. LAPA, A. J.; SOUCCAR, C.; LIMA-LANDMAN, M. T. R.; GODINHO, R. O. M. L.(2004) *Farmacologia e toxicologia de produtos naturais*. In: SIMÕES, C. M. O.; SCHENKEL, E. P.;GOSMANN, G.; MELLO, J. C. P.; MENTZ, L.; PETROVICK, P. R. (2004) *Farmacognosia: da planta ao medicamento*. 5ª Edição. Porto Alegre: UFSC; Florianópolis: UFRGS. p. 247-262.
21. MATTOS, M. J. T; HOFFMANN, R. P. (2010). *Diagnóstico Laboratorial em Helmintoses*. 3ª Edição. Gráfica UFRGS: Porto Alegre, RS. p. 63
22. MINISTÉRIO DA ADMINISTRAÇÃO ESTATAL (MAE). *Perfis distritais*. Direcção nacional de administração local. MAE (2005). Disponível em: <http://www.govnet.gov.mz/>. Acesso em: 25 Setembro 2015
23. MODEST,C.F; CORRÊA,A.D; OLIVEIRA,E.D; ABREU,C.M.P.A; SANTOS,C.D. (2007) *Characterization of cassava leaf protein concentrate obtained by heat and acid precipitation Superior da Rama de Mandioca Maninhot esculenta Crantz*.
24. PADILHA,T. (1996) *Controle dos nematódeos gastrintestinais em ruminantes*. EMBRAPA-CNPGL.p.258.
25. PATINO,H.O.; SIERRA,M.A.; ANGEL,J.C.; RAMIREZ,M.M.; DEL RÉ,D.; ELGERT,R.M.(2010) *Efeitos da incorporação de folha e raiz de mandioca (Maninhot esculenta, Crantz) secas em dietas de ovinos sobre a carga parasitária*.47ª Reunião Anual da Sociedade Brasileira de Zootecnia Salvador, BA – UFB.p.2-3.

26. ROEPSTORFF, A.; MEJER, H.; NEJSUM, P.; THAMSBORG, S.M. (2011). *Helminth parasites in pigs: New challenges in pig production and current research highlights*. Veterinary Parasitology, v.180, p.72-81.
27. SÁNCHEZ,C; FISCHER,H; VASCONCELOS,C. (2010). *A Mandioca - Uma Cultura de Muita Energia, de Boa Nutrição e até Rendimento* p-1.
28. SILVA, C. R.; MARRA, A. O.; ROCHA, U. F. ALVES, C. J. T.(1998) *Atividade anti helmíntica de uma solução de ivermectina a 1% (Ranger) em suínos naturalmente infestados com nematóides parasitas*. A Hora Veterinária, n.105, p. 35-37.
29. SOUZA, L. D.; SOUZA, L. da S. (2000) *Clima e solo*. In: MATTOS, P. L. De; GOMES, J. de C. (Coord.) *O cultivo da mandioca*. Cruz das almas, BA: EMBRAPA-CNPMF, p.11-13. (EMBRAPA-CNPMF. Circular Técnica, 37).
30. WANAPAT, W. (2002). The role of cassava hay as animal feed. In: R.H HOWELER (edição). **Research and Development in Asia. Exploring New Opportunities for an Ancient Crop**. Asia:, p.1- 15
31. WAGHORN, G.(2008).*Beneficial and detrimental effects of dietary condensed tannins for sustainable sheep and goat production*. Progress and Challenges. A Animal Feed Science and technology, Washington, v.174, n.1-3, p.116-139.
32. WEGHER,W.E.A.*Nova tecnologia grande aumento na produtividade dos bovinos baseada no controle de verminoses e outros paritas*; 2010 Disponível em:[http://:www.Portal do Agronegocio.com.br/conteúdo.Php](http://www.Portal do Agronegocio.com.br/conteúdo.Php)>Acesso em 10 Agosto 2017
33. WENG, Y.B.; HU, Y.J.; LI, Y.; LI, B.S.; LIN, R.Q.; XIE, D.H.; GASSER, R.B.; ZHU, X.Q. (2005) *Survey of intestinal parasites in pigs from intensive farms in Guangdong Province, Peoples Republic of China*. Veterinary Parasitology, v.127, p.333-336.
34. WILLIAN, G.K; LESLIE, J. K; RODNEY, C.T. (1996) *Fenbendazole in a strategic deworming programs*, Food Animal Parasitology, v.18, n.1, p.113-117.
35. WOODS, I.B.; AMARAL,N.K.; BAIDEN,K.; DUNCAN, J.L.; KASSAI, T.; MALONE,J.B.; PANKAVICH,J.A.; SLOCOMBE,O.; TAYLOR,S.M VERCRUSSE,J.(1995) *World association for advancent of veterinary parasitology, second edition of guidelines for evaluating the efficacy of antihelmintis in the ruminants( bovine, ovine, caprine)* Veterinary Parasitology, v.58 p.181-213.
36. UENO, H; GONÇALVES, P.C. (1998). *Manual para diagnóstico de helmintoses de ruminantes*. 4ª Edição. Japan: International Cooperation Agency. p.143
37. URQUHART, G. M.; ARMAOUR, J.; DUNGAM, J. L.; DUNN, A. M. e JENNINGS, F. W. (1998) *Parasitologia Veterinária*. 2ª Edição, Rio de Janeiro: Guanabara Koogan, p.138