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Research Article

ANTHELMINTIC ACTIVITIES OF STEM BARK OF *PARKIA BIGLOBOSA* ON WEST AFRICAN DWARF GOATS INFECTED WITH *HAEMONCHUS CONTORTUS*

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ABSTRACT. The anthelmintic effects of stem bark extracts of *Parkia biglobosa* was evaluated on West African Dwarf (WAD) goats. The stem bark of the plant was obtained from Kwara state of Nigeria. The extraction was done and yielded Crude Methanol Stem Bark Extracts (CMSBE), Ethyl acetate (EA) fraction and Aqueous (AQ) fraction. The anthelmintic potentials were studied *in vivo* in 18 WAD goats in six completely randomised groups, A, B, C, D, E and F with three animals per group. Group A was treated with 5mL/kg of distilled water as negative control, group B with 6.25mg/kg of Albendazole (ABZ)(positive control), groups C and D with 1000mg/kg and 2000mg/kg of CMSBE respectively and groups E and F with 1000mg/kg of EA fraction and AQ fraction each respectively. Faecal samples were collected for two weeks after treatment to evaluate faecal egg counts. After 16th day, one animal was euthanized from each group to determined percentage deparasitization. The result from this study revealed that, the phytochemical constituents present in CMSBE were alkaloid, anthraquinones, cardiac glycosides, glycosides, flavonoids, oils, phlobatannins, reducing sugar, saponins, sterols/steroids, tannin (condensed and hydrolysable) and terpenoids. *In vivo* result showed significant ($P<0.05$) reduction in egg per gram (EPG) faeces in group B, C, D and E when compared to group A, all at 16th day post-treatment. Group F showed less efficacy in EPG reduction. The deparasitisation obtained in groups D and E were higher than group B, though without statistical significant difference. The study has shown that, CMSBE and EA fraction of *P. biglobosa* exhibited *in vivo* anthelmintic activities at 2000mg/kg and 1000mg/kg respectively that are sufficiently comparable to ABZ, hence, have potentials as a novel anthelmintic ethnobotanic preparation for control of *H. contortus* in WAD goats. It is therefore recommended to carry out a further research on larger population size of goats.

Keywords: *Egg counts, extract, faecal, goats, phytochemicals*

INTRODUCTION

Infections caused by gastrointestinal parasites pose the greatest challenge to goat health and production all over the world especially in tropical and sub-tropical countries [1]. They cause reduced feed intake, weight loss, reduced immunity, impaired fertility, damage gastric function and high mortality rate which lead to enormous economic

losses [2]. In Nigeria, it was estimated that about 40-60% of the lambs die due to gastrointestinal (GI) nematode infections [3]. Consequently, there is need to treat and control infections caused by *Haemonchus. contortus* and other nematodes that coexist with them in small ruminants particularly in goats in the tropics.

The treatment and control of these infections in livestock is mainly by chemical anthelmintic which have the disadvantages of being costly for low income and poor farmers. The risk of environmental pollution as a result of residue in the food chain and environment as well as the development of resistance in all major parasites species are also problems [4,5,6]. Thus, alternative methods for control of gastrointestinal nematodes need to be developed. One of such alternative is through the knowledge of ethno veterinary medicine.

The use of sustainable, integrated parasite control systems, using scientifically proven non-chemical methods and limited use of drugs is being considered to ensure animal health and food safety [7]. The research on medicinal plants that contain bioactive compounds to control helminths either as phytotherapeutic or nutraceutical options is one of the leading areas of research globally [8-9]. A comprehensive natural alternative anthelmintic management program that includes the use of plants as a cheaper and sustainable alternative to synthetic drugs would result in beneficial health and economic impacts on the goat industry. Studies show that plant species can effectively reduce the degree of parasite infestation in livestock and are promising alternatives to conventional anthelmintics [10].

Parkia biglobosa commonly called the African locust bean is a leguminous tree which belongs to family fabaceae tree is native to Nigeria and other West African countries. The different components of *P. biglobosa* are used by traditionalist and herbal medicine healers to treat several metabolic and some non metabolic disorders like haemorrhages, hypertension and dermatosis [11-12]. Recent survey on the ethno-pharmacology carried out in the Northern parts of Nigeria revealed that the stem bark extract was among the commonly used plants used for the treatment of diabetes mellitus by traditional healers [13]. The efficacy of various preparation of *P. biglobosa* is also widely acclaimed by the Hausa communities of Northern Nigeria for the treatment of diseases as malaria, diabetes-mellitus and pain [14-15]. If the safety and efficacy of this plant *P. biglobosa* could be ascertained, they could be an alternative and effectively cheaper approach anthelmintic for the treatment and control of helminth infections in livestock. Therefore, this plant was selected because of their medicinal properties and their continual use in traditional medicine in the treatment of several diseases. Thus, the aims of the present study are to determine the anthelmintic activities of methanol stem bark extract on the West African Dwarf (WAD) goats experimentally infected with *H. contortus.*

MATERIALS AND METHODS

Plant Collection and Authentication

The fresh stem bark of *P. biglobosa* was collected in the month of March, 2016 in Bokungi village in Edu Local Government Area of Kwara State, Nigeria (Fig.1). The plant collected was identified and authenticated in Herbarium in the Department of Botany, Ahmadu Bello University Zaria, Nigeria. The Voucher number ABU/7064 was assigned to the sample which was deposited in the herbarium in the same Department for future references.

Fig. 1. *Sourcing of stem bark of P. biglobosa (Field source)*

Plant Preparation and Extraction

The fresh stem bark of *P biglobosa* was washed with water and air dried in the shade at room temperature for one month and thereafter crushed with a mortar and pestle into fine powder. These were stored in air tight container for later use [16]. The powder form (100 g at a time) was extracted with 600 ml of methanol in a Soxhlet's apparatus for 4 hours [17]. All the filtrate was evaporated using water bath at 65^{o}C. The weight by weight (w/w) yield of the extract was stored in a capped bottle and preserved inside the refrigerator at 4^{o}C.

Extract Partitioning and Determination of Maximum convenient dose (MCD), maximum Convenient Concentrations (MCCs) and Maximum Convenient Volume (MCV)

Crude methanol extract of stem bark (CMESB) of *P. biglobosa* was partitioned [18]. Three solvents used in partitioning were n- Hexane, Ethyl acetate (EA) and water (AQ). In each partitioning step, the mixtures were vigorously shaken to re-suspend the particles. Impurities were pooled together in a separate beaker and discarded. The different portions collected in separate conical flasks were concentrated to residue over the water bath at 65^{o}C and weighed to determined percentage yield. The different fractions were packed in clean air-tight glass bottles and stored in refrigerator at 4^{o}C until used. The maximum convenient doses (MCD) were calculated, due to lack of information on the actual doses of the plant extracts. The maximum convenient concentrations (MCCs) of the CMESB and the various fractions of stem bark of *P. biglobosa* extracts were prepared [19-20] using the methods of Lorke (1983) and Ibrahim (1984). The maximum convenient volume (MCV) that could be administered to the goat by the oral route (gavage) is 5ml/kg [19-21]. The MCDs (g/kg) was calculated by multiplying the MCCs (g/ml) by the MCV (ml/kg) [22].

Qualitative Screening of Phytochemical Constituents in Plant Extracts

The CMESB and its various fractions were screened to determined the possible presence of alkaloids, flavonoids, saponins, tannins, terpenoids, anthraquinones, glycosides, cardiac glycoside/cardenolides, phlobatannins, sterols and steroids, carbohydrates, starch, proteins and oils. The screening were carried out using the standard phytochemical methods [23-24].

Recovery of Infective Larvae (L_3) of H. contortus for Goats Infection

Infective larvae of *H. contortus* were obtained from abomasums purchased from goats slaughtered in Minna Abattoir. Abomasums were then transported to the Biology Laboratory I in the Department of Animal Biology, Federal University of Technology, Minna, in a cooler with ice block and then washed immediately. Female worms were separated from male worm by their large size and presence of vulva flap. Female worms were then gently crushed to rupture the uteri in order to release their eggs for culturing. Eggs were cultured at room temperature in damp heat-sterilized bovine faeces for 7 days to provide development. Cultures were baermannized to recover larvae at the end of the period. The harvested larvae were stored in distilled water at 4°C. Thereafter, goats were inoculated accordingly [25].

Sourcing and Experimental Infection of WAD Goats with L_3 of H. contortus

Eighteen (18) apparently healthy WAD goats with an average weight of 10 kg of both sexes (males and females) which have homogeneous characteristics were purchased from small scale farmers in Niger state. Infections of these goats were confirmed in Biology Laboratory I in the Department of Animal Biology, Federal University of Technology, Minna in collaboration with Niger State Veterinary Hospital Minna [26-27]. After confirmation, any animal with gastrointestinal infection and ectoparasites were dewormed. These animals were then immunized with *pestes des petit* (PPR) vaccine purchased from the Nigerian Veterinary Research Institute Vom, Plateau State. The animals were maintained in concrete-floored pens constructed in Biological Garden of Centre for Preliminary and Extral-mural Studies, FUT, Minna. The animals were fed with standard diet (fed with cured, cut and carry forage supplemented with maize offal, Groundnut hay, yam peeled, beans husk, salt lick) and water *ad libitum*. The study was conducted in accordance with the ethical rules on animal experimentation as approved by the Ethical Committee of FUT, Minna. The animals were then acclimatized for two weeks before the commencement of the study [17, 28]. Each animal was inoculated with a 5 ml aliquot of the L_3 of *H. contortus* parasites solution estimating a dose of 2500 larvae per animal using syringe [29-30].The inoculums were administrated orally and care was taken to ensure oral administration was as far back in the goat's mouth as possible to reduce expectoration of the solution [31]. Twenty one days after experimental infection, animals were randomly allotted into six treatment groups (A, B, C, D, E and F) of three animals each. The grouping was done using complete randomized design (CRD), taking into consideration their live weight [17]. The six groups were assigned to different treatment groups as follow: group A were administered with 5 mL/kg of distilled water, group B were administered with 6.25 mg/kg of Albendazoles, group C and D were administered with 1000mg/kg and 2000mg/kg of CMSBE of *P. biglobosa,* respectively, group E were administered with

1000mg/kg of EA fraction of CMSBE and 1000mg/kg of AQ fraction were administered to group F.

Faecal Egg Counts (FEC)

Faecal samples (2g) were collected directly from the rectum of each goat on days 0, 4, 8, 12 and 16. The modified McMaster technique was used for egg count [26-27]. Egg per gramme (EPG) was calculated by multiplying faecal egg count (FEC) by a factor (20) [27, 32]. The formula are shown below;

$$\text{Number in one gram} = \frac{Number\ in\ two\ chambers}{0.3} \quad \text{x dilution factor}$$

$$\text{Dilution factor} = \frac{Total\ volume\ of\ suspension\ in\ ml}{Total\ volume\ of\ faeces}$$

Percentage Reduction of Egg Per Gram (EPG) and Deparasitisation of Adult worm

Anthelmintic efficacy of CMSBE, EA fraction and AQ fraction of *P. biglobosa* were assessed by counting the eggs and worms in the treated animals and comparing with counts from the untreated control WAD goats. The percentage efficacy (Deparasitisation) of adult parasites and Percent reduction in faecal egg count were calculated using the following formulae [33].

$$\%\ \text{Efficacy} = \frac{\text{N} - \text{n}}{\text{N}} \text{X}\ 100, \qquad \text{Where}$$

N= Mean number of *H. contortus* in control (untreated) animals
n = Mean number of *H. contortus* in treated animals.

Percent reduction in faecal egg count will be computed by the following formula:

$$\%\ \text{Reduction} = \frac{\text{Mean EPG on day 0} - \text{Mean EPG on day 16}}{\text{Mean EPG on day 0}}$$

Post Mortem Examination of Animals after in vivo Study

One animal in control groups (un-treatment - group A and standard drug – group B) and treatment groups (C, D, E and F) each was slaughtered on day 16 post-treatment for total worm count. The gastrointestinal tract was observed for presence of adult *H. contortus*. Also, the abomasal contents were collected and the walls of the abomasums were washed with water. The washings and the contents of the large bowel were combined and wash through sieves of appropriate aperture for worm counts [34].

Statistical Analyses

The data were computed to determine the means and standard deviation. Data obtained for egg and adult counts were expressed as mean±SEM. T- test and One Way Analysis of Variance (ANOVA) followed by Turkey's post hoc test were used where necessary.

Value of P< 0.05 was considered significant. GraphPad Instat version 3.05 Windows from Graphpad Software (2000), San Diego, California USA (www.graphpad.com) was used to analyze the data.

RESULTS AND DISCUSSION

The solvent partitioning of 284.28 g of CMSBE was negligible for n- Hexane but yielded 160.53 g and 97.15g for aqueous (AQ) and Ethyl acetate (EA) fractions respectively (Table 1). The remaining 26.6 g portion was discarded as residue. The colour and percentage yield of the plant material are shown in Table 1. Generally, partitioning with water resulted in the highest quantity of crude extract and followed by ethyl acetate. The phytochemical constituents present in partitioning of crude methanol stem bark extract of *P. biglobosa* are shown in Table 2. In comparison, both EA and AQ fractions contained anthraquinones, cardiac glycosides, phlobatannins, saponins and tannins (condensed and hydrolysable). The EA fraction alone revealed the presence of alkaloids, flavonoids, oil and sterol/steroids while AQ fraction alone revealed the presence glycosides, reducing sugar and terpenoid. The saponins and tannins (condensed and hydrolysable) in EA fraction were higher when compared to AQ fraction. However, anthraquinones was higher in AQ fraction, all without significant difference.

The effects of CMSBE and its fraction on egg per gram faeces (EPG) are showed in Table 3. Significant (P<0.05) reduction in EPG was observed in all extract-treated groups in all the dose level used during the study (Table 3). A graded dose response in EPG reduction was recorded in group D which was more effective than observed in other groups. Although, generally, a significant (P<0.05) decrease in EPG was observed in group B (positive control), D and E on day 4 when compared to other groups as shown in Table 3. The decrease in EPG in group B, D and E also continued from 4, 8, 12 and 16 days without significant different (P>0.05) but the decrease in group C and F for 4, 8, 12 and 16 days was significant (P<0.05) different (Table 3). The untreated group (group A) showed no reduction in EPG, rather there was slight increase in EPG from day 0 to 4 and 8 days with fluctuations on the 12th and 16th days (Table 3). In all the days of faecal eggs examinations for EPG in group A, there was no significant difference (P>0.05) as shown in Table 3. However, the faecal eggs examination for EPG on day 0 of group B, C, D, E and F differ significantly from different days (4, 8, 12 and 16 days). Therefore, the best *in vivo* anthelmintic activity based on faecal egg count reduction test (FECRT was exhibited by group D followed in descending order by group B, E, C and F at day 16 post treatment (Table 4).

The highest percentage (99.4%) deparasitisation of adult worms in WAD goats was found in group E administered with EA portion of CMSBE of *P. biglobosa* as shown in Table 5. This was followed in a decreasing order by group D, B, C and F with percentage deparasitisation of 93.1, 92.3, 76.8 and 30.1%, respectively.

Table 1. *Percentage Yields of Stem Bark Extracts of P. biglobosa of Crude Methanol Partitions*

CMSBE partitioning	Initial weight (g)	Final weight(g)	Colour of extract	Percentage yield (%)
Aqueous fraction	284.28	160.53	Dark brown	56.47
Ethyl acetate (EA)	284.28	97.15	Light brown	34.17
n- Hexane	284.28	0	No colour change	0
Residue	284.28	26.6	Dark browm	9.36

Table 2. *Qualitative Phytochemical Screening of Partitioning of Crude Methanol Stem Bark Extracts of Parkia biglobosa*

Chemical constituents	Test methods	Crude Metanol extract	Ethyl acetate fraction	Aqueous fraction
Alkaloids	Mayer's test	+++	++	–
	Wagner's	+++	+++	–
Anthraquinones	Bontrager's test	+++	++	+++
Cardiac Glycosides	Keller-Kiliani test	+	+	+
Flavonoids	NaoH test	++	++	–
Glycosides	Benedict's test,	++	–	++
	Ferric chloride test	++	–	++
Oil	Filter paper test	++	+	–
Protein	Millon reagent test	–	–	–
	Biuret test	–	–	–
Phlobatannins	Hcl test	++	+	+
Reducing Sugar	Fehling test	++	–	+++
Saponins	Frothing test	+++	+++	++
Starch	Iodine test	–	–	–
Sterols and Steroids	Conc H_2So_4 test	++	++	–
Tannin (Condensed)	Ferric chloride test	+++	+++	++
Tannin (Hydrolysable)	Ferric chloride test	++	+++	++
Terpenoid	Salkowski test	++	–	++
Triterpenoids	Salkowski test	–	–	–

Key= - Absent, + Present, ++ Very present, +++ much present

Table 3. *Effects of CMSBE, Ethyl Acetate Portion and Aqueous Portion of P. biglobosa and Standard Drug (Albendazole) on Mean EPG in WAD Goats Infected with L_3 of H. contortus*

Experimental Groups (mg/kg)	Pre-treatment Day 0	Post-treatment Day 4	Day 8	Day 12	Day 16
A	14593.33±40.71^{a}	15026.67±43.54^{a}	16460±14.7^{a}	14520±48.00^{a}	14895±26.00^{a}
B	13793.33±90.35^{a}	500±90.35^{b}	413.33±16.84^{b}	413.33±89.69^{b}	273.33±81.92^{b}
C	13773.33±11.27^{a}	3260±27.33^{c}	1726.67±27.41^{b}	1486.67±22.01^{c}	1593.33±26.40^{bc}
D	13573.33±71.83^{a}	450±39.74^{bd}	200±52.92^{b}	180.00±20.00^{bd}	180.00±20.00^{bd}
E	14666.67±19.50^{a}	933.33±95.16^{be}	486.67±48.96^{b}	446.67±46.97^{be}	420±49.67^{bce}
F	13760±67.03^{a}	2433.33±53.24^{f}	2373.33±13.00^{bf}	3726.67±35.19^{f}	6340±11.40^{g}

The mean with different superscript alphabet in the same column and row are statistically significant different ($P<0.05$)

Keys :

A^{+} = Untreated control - distilled water (DW) 5ml/kg
B^{*} = Treated control- Albendazone (ABZ) 6.25 mg/kg
C= CMSBE of *P. biglobosa* (1000mg/kg)
D= CMSBE of *P. biglobosa* (2000mg/kg)
E= EA fraction of CMSBE (1000mg/kg)
F= AQ fraction of CMSBE (1000mg/kg
*MCD as recommended by manufacturer
$^{+}$MCV
$^{+}$MCV

Table 4. *Percentage Reduction of EPG from WAD Goats Infected with 2500 L_3 of H. contortus and Orally Treated with CMESb, EA Portion and AQ Portion of P. biglobosa for Three Consecutive Days.*

Group	Pre-treatment Day 0	Post-treatment Day 4	Day 8	Day 12	Day 16	Percentage change
A	0	-3	-13	1	-2	
B	0	96.4	97.00	97.00	98.02	97.11^{a}
C	0	76.33	87.46	89.21	88.43	85.36^{a}
D	0	96.68	98.53	98.67	98.67	98.14^{a}
E	0	93.64	96.68	96.95	97.14	96.11^{a}
F	0	82.32	82.75	72.92	53.92	72.98^{b}

F = 10.438 = (MStreatment/MSresidual). a, b differ significantly ($p<0.05$) from one another

Keys

A^{+} = Untreated control - distilled water (DW) 5ml/kg
B^{*} = Treated control- Albendazone (ABZ) 6.25 mg/kg
C= CMESb of *P. biglobosa* (1000mg/kg)
D= CMESb of *P. biglobosa* (2000mg/kg)
E= EA fraction of CMSBE (1000mg/kg)
F= AQ fraction of CMSBE (1000mg/kg
*MCD as recommended by manufacturer
$^{+}$MCV

Table 5. *Percentage Deparasitization of Adult H. contortus from Infected WAD Goats Administered Orally with CMSBE, EA Portion and AQ Portion of P. biglobosa for 3 Consecutive Days*

Experimental group (mg/ml)	Total adult count	% Deparasitisation
A	362	0
B	28	92.3
C	84	76.8
D	25	93.1
E	2	99.4
F	253	30.1

Keys

A = Untreated control - distilled water (DW) 5ml/kg
B = Treated control- Albendazone (ABZ) 6.25 mg/kg
C= CMESb of *P. biglobosa* (1000mg/kg)
D= CMESb of *P. biglobosa* (2000mg/kg)
E= EA fraction of CMSBE (1000mg/kg)
F= AQ fraction of CMSBE (1000mg/kg

Medicinal plants offered a great prospect for the development of novel chemotherapeutic agents that are essential for the management of various diseases in food animals and human. In this study, the result of qualitative phytochemicals screening of CMSBE of *P. biglobosa* showed the present of alkaloid, anthraquinones, cardiac glycosides, glycosides, flavonoids, oils, phlobatannins, reducing sugar, saponins, sterols/steroids, tannin (condensed and hydrolysable) and terpenoids. This result was similar to the findings of Ezekwe *et al*. [35] in methanol stem bark extract of *P. biglobosa*. Millogo Kone *et al.* [36] also reported the presence of saponins, Glycosides, tannins and other phenolics with trace quantity of alkaloids while Banwo *et al.* [37] confirmed the same. The report of Builder *et al*. [17] differed slightly from this result and the previous finding of Banwo *et al.* [36-37] due to absence of alkaloids from the methanol stem bark extracts. Thus, the difference between the phytochemical constituents may not be a minus for the medicinal efficacies of stem bark of *P. biglobosa* but could be the methods of processing and geographical location of this plant.

Generally, partitioning with water resulted in the highest quantity of crude extract, while n-Hexane yielded nothing. This high percentage yielded by water might be due to the high polarity associated with it and to some extent some less polar compounds were extracted [38]. N-Hexane is non-polar and this probably account for its inability to extract those biologically active compounds. The general trend of the yield obtained in ascending order was n-hexane < Ethyl acetate < water. Ethyl acetate and water are polar solvents; this explained the fact that the secondary metabolites extracted from this plant using these solvents are polar compounds. This showed that like solvents dissolved like [11]. Although, water is more polar and have tendency to extract hydrosoluble compounds, substances like Ethyl acetate in addition to hydrosoluble extracted, have tendency to extract lipid substances, alkaloids, and phenols [39]. The semi polar nature of the ethyl acetate which can extract both apolar and polar secondary metabolites explained why the Ethyl acetate fraction extracted alkaloid and oil that could not be extracted using water. Thus the extraction of active principles from the medicinal plants for pharmacological

evaluation was to some extent dependent on the polarity of the solvents used in the extraction and partitioning.

In this study, ABZ, CMSBE of *P. biglobosa* and EA and AQ fractions were tested *in vivo* for anthelmintic activity and they were found to be a very potent anthelmintic. They produced reduction in faecal egg count/egg per gram (FEC/EPG) and deparasitisation as observed from daily faecal analysis and adult worm counts postmortem in WAD goats. All the treatment based on ABZ, CMSBE, and EA and AQ fractions of *P. biglobosa* exhibited high reduction in FEC of WAD goats infected with *H. contortus.* The 96.4% drop in the faecal EPG count in the group B treated with ABZ (6.25 mg/kg) on 4th day, clearly indicates the high anthelmintic effectiveness in goats. The groups C, D, E and F had 76.33%, 96.68%, 93.64% and 82.32% reduction in the faecal EPG respectively on 4th day. This also indicated the effectiveness of the extracts. On 16th day post treatment, FEC had reduced to 98.02% for ABZ and 88.02%, 98.67%, 97.14% and 53.93% for groups C, D, E and F, respectively. It could be stated that ABZ in group B, CMSBE in group D and EA in group E were effective against *H. contortus* and that there was no resistance of this parasite against the ABZ and the extract used as well, since the FEC reduction was greater than 90%. The criteria for evaluating the degree of efficacy of an anthelmintic, was in accordance to Bliss *et al.* [40] and recommendation of the World Association for the Advancement of Veterinary Parasitology (WAAVP) which say, anthelmintic resistance is present if percentage reduction of egg counts is less than 90% [41].

This result agreed with that of Naandam and Iddrisu [42] who reported 80.4% reduction in ova counts in infected sheep administered with 4 mL of boiled pods extract of *P. biglobosa* after one month. It was observed that there was an increase reduction in faecal EPG counts in group F between days 4 and 8 but decline on days 12 and 16 as faecal EPG counts was greater than days 4 and 8. This suggested that the aqueous extract as a drug may be acting over a reasonable number of days as recorded by Birkett [43], who confirmed that after a single dose, drug concentration falls with time. The increase in EPG between days 12 and 16 might be due to the fact that active ingredients such as tannins and saponins lost their potency as secondary metabolites with time, which led to an increase in the population of worms. The criteria of WAAVP were fulfilled by ABZ, CMSBE (2000 mg/kg), and EA fraction (1000 mg/kg) which had 98.02%, 98.67% and 97.14% reduction of EPG of faeces on 16th day respectively. These results agreed with the results of Naandam and Iddrisu [42] who reported 93.8% reduction in ova counts in infected sheep administered with 4 ml of pounded and soaked pods of *P. biglobosa* after one month. It can then be said that the efficacy of CMSBE administered to goats at 2000 mg/kg and EA fraction at 1000 mg/kg are comparable to that of ABZ (the conventional anthelmintic) at a dose rate of 6.25 mg/kg.

The result of anthelmintic study also indicated that EA fraction of *P. biglobosa* produced 99.4% deparasitisation followed by CMSBE and then lastly AQ portion. It is worthy to note that the percentage deparasitisation of EA portion was even more than the standard drug ABZ that has 92.3% deparasitisation. This is an indication that the extracts showed high *in vivo* anthelmintic efficacy than the ABZ. It was then considered that CMSBE (at 2000mg/kg and 1000mg/kg) and EA fraction of *P biglobosa* at 1000 mg/kg administered to infected goats were effective. The criteria of Githiori *et al.* [44] was also established, who reported that the efficacy of the plant extracts would be biologically significant if a reduction in total worm count (TWC) above 70% occurred.

The active principle(s) in extract(s) responsible for this anthelmintic activity might be individual phytochemical constituents as detected during phytochemical screening or a number of them working in synergy. The higher effect, according to Wabo *et al*. [45*]* could be due to secondary metabolites such as tannins, flavonoids, polyphenols and alkaloids. This assertion was made from their findings on *in vitro* study on leaf extracts of *Ageratum conizoides* on against *Heligmosomoides polygyrus*- the nematode of rat. These compounds created unfavorable conditions to the survival of the parasites. Sina and Traoré [46] had reported that the bark, leaves and pod husks of *P. biglobosa* was rich in tannins, which Max *et al*. and Octhere and Naandam [47-48] suggested had direct toxicity action on worms in drench sheep. Condensed tannins-containing forages have the potential to help control anthelmintics resistant gastrointestinal parasites. They have been shown to decrease EPG in sheep and goats and may decrease hatching rate and larval development in faeces [49]). This is also in agreement with Max *et al*. [50], who showed that there is an effect of tanniferous browsers meal on faecal egg counts and internal worm burdens. The tannins contained in plants have been reported to posses antiviral [51], antibacterial [52] and anthelmintic [53-55] properties.

The pharmacological basis of the treatment of helminthes possibly involves disruption of the energy processes of the helminthes. The benzimidazoles/probenzimidazoles (e.g. albendazole, mebendazole, thiabendazole, fenbedazole, and flubendazole) act by interferring with polymerization of microtubules [56]. These drugs bind to the protein tubulin of the parasite, therefore causing death by starvation [57].

The modes of action of anthelmintics are many, reflecting the natural differences in the physiology of the parasites and its potential host. It has been firmly established that one of the hallmark effects of any anthelmintic is the destruction of the worm's cuticle. This is due to the fact that the tegument and/or cuticular structures are the primary parasite-host interface vital for absorption of nutrients and perception of the surrounding micro-environment provided by the host [58-59].

CONCLUSION

This study has established that the CMSBE of *P. biglobosa* and its EA fraction extract have potentials anthelmintic activities against experimental *H. contortus* infection in WAD goats at doses 2000mg/kg and 1000mg/kg of goats respectively. It is worthy to note that the percentage deparasitisation (99.4%) of EA fraction was more than standard drug ABZ that has 92.3% deparasitisation. This is an indication that the extracts showed high *in vivo* anthelmintic potentials than the ABZ. The high *in vivo* anthelmintic exhibited in this study may be attributed to the presence of secondary metabolites in the extracts. It is therefore recommended to carry out a further research on a larger population size of goats.

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