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FEED INTAKE AND NUTRIENT DIGESTIBILITY OF WEANER RABBITS FED CASSAVA PEEL AS REPLACEMENT FOR MAIZE

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ABSTRACT

Twenty 8-week old crosses of New Zealand White X Chinchila weaner rabbits were used to assess the performance of rabbits fed diets with cassava peel replaced with maize on a graded level. Five diets were formulated, diets 1 (control), 2, 3, 4, and 5 in which maize was replaced with cassava peel at 0%, 25%, 50%, 75%, and 100%, respectively. The 20 rabbits were used in a completely randomized design with five treatments and four animal replicates per treatment. The trial lasted for 8 weeks. Parameters measured were feed intake, weight gain, feed conversion ratio and feed cost per kg. It was observed that there was no significant difference (P > 0.05) in the average daily feed intake of the rabbits fed diets 3, 4 and 5. However, diets 3, 4 and 5 had significantly higher (P < 0.05) intake than diets 1 and 2. Similarly, rabbits on diets 3, 4 and 5 had higher (P < 0.05) growth rates than those fed the control diet and diet 2. Feed cost per kg (N/kg) decreased from N35.33 in the control diet to N19.75 in diet 5. Cost of feed/kg live weight gain (N/day) decreased from N3.21 in the control diet to N1.29 in diet 5. It was concluded that maize supplementation in the diets of weaner rabbits could be replaced by cassava peels up to 100 % without any adverse effect. However, 75% cassava peel replacement was found to be the optimum and therefore recommended.

Keywords: Cassava peel, Nutrient digestibility, Growth rate, Feed intake, Rabbit

INTRODUCTION

Animal protein content in the diet of most Nigerians is very low because the animal production level has not been able to meet the animal protein needs of the populace (Oyenuga, 1968). To redress this deficiency syndrome in animal production and hence protein intake, two options were suggested. The first is the use of minilivestock like rabbits for meat production and the next is the adoption of feeding strategy that maximizes the use of under-utilized feed resources and wastes in animal production (Omole and Onwudike, 1982; Onwudike, 1995). Cassava peel is one of such by-product emanating from industrial processing of cassave into garri, chips and industrial starch. It offers a tremendous potential as a cheap and alternative feedstuff to maize. It however contains hydrogen cyanide that has been shown to be toxic to livestock and could limit its usage in the raw state as feed for livestock (Smith, 1988; Mc Donald et al., 1995). Detoxification of cassava peels has been made possible by sun drying (Tweyong and Katonga, 2002).

The conventional feed ingredients, particularly the energy sources used in feed formulation such as Maize, millet, sorghum are very expensive. A partial or complete replacement of maize with cassava peel would be a cost-saving step in the right direction. Onifade and Tewe (1993) and Agunbiade et al. (1999) recommended complete replacement of maize grain with maize offal in the diets of growing rabbits, thus reducing the expenditure on maize and utilizing the offals. Similarly, Uko et al. (2001) concluded that maize, millet and sorghum offals could replace 100 % maize grain in rabbit diets without adverse effects on animal performance.

It is against this background that this study was designed to assess the performance of weaner rabbits fed diets containing graded levels of cassava peel replaced for maize meals

MATERIALS AND METHODS

Study Area: The study was carried out at the Rabbitary Unit, Teaching and Research Farm, Department of Animal Production and Fisheries Management, Ebonyi State University, Abakaliki. The station is located between latitude 06o 21 N and longitude 08o 51 E. The annual rainfall ranges from 1500 to 1800 mm with a temperature range from 21o to 30o C (Ofomata, 1975).

Rabbit: Twenty 8-week old crosses of (New Zealand White X Chinchila) rabbits were used for the feeding trial which lasted for 8 weeks. The mean weight of the rabbits at the inception of the trial was 745 ± 2.5 g. The rabbits were housed individually in one tier hutch measuring 0.4 m2 , equipped with facilities for individual feeding and watering, and wire gauze underneath for feacal collection. The hutch floors were cleaned daily throughout the experimental period.

Table 1: Percentage and Proximate composition of rabbits experimental diets

PERCENTAGE COMPOSITION	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Maize	41.0	30.75	20.5	10.25	0.0
Cassava peels	0.0	10.25	20.5	30.75	41.0
Soyabean meal	20.0	20.0	20.0	20.0	20.0
Palm kernel cake	19.0	19.0	19.0	19.0	19.0
Wheat offal	15.0	15.0	15.0	15.0	15.0
Bone meal	3.0	3.0	3.0	3.0	3.0
Lime stone	1.5	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Feed cost per kg (₦/kg)	35.33	31.44	27.54	23.65	19.75
Cost of feed consumed (₦/day)	2.70	2.52	2.27	2.02	1.91
Cost of feed /kg LWG (₦/day)	3.21	2.65	1.78	1.43	1.29
PROXIMATE COMPOSITION					
Dry matter	89.93	89.85	89.96	89.87	89.81
Crude protein	17.58	17.76	18.08	18.34	18.47
Crude fibre	7.37	7.54	8.17	8.32	8.49
Ether extract	5.11	5.15	5.18	5.27	5.39
Ash	5.91	5.96	6.02	6.13	6.17
NFE	42.66	43.0	43.28	43.48	44.19
GE (kcal/g)	3.994	3.982	3.957	3.968	3.974

Diet 1 (control) = 0% Cassava peel residue (CPR); Diet 2 = 25% CPR; Diet 3 = 50% CPR; Diet 4 = 75% CPR; Diet 5 = 100% CPR; LWG = Liveweight gain.

Table 2: Feed intake, growth rate and nutrient digestibilities of weaner rabbits fed cassava peel as replacement for maize

Item	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Feed intake (g/d)	$76.39^{c}\pm 3.1$	$80.0^{bc}\pm 0.18$	$82.46^{ab}\pm 0.32$	$85.45^{a}\pm 0.17$	$86.21^{a}\pm 0.31$
Growth rate (g/d)	$11.77^{d}\pm 0.81$	$13.3^{c}\pm 1.31$	$17.82^{b}\pm 1.81$	$19.82^{a}\pm 0.57$	$18.53^{ab}\pm 1.06$
FCR	$6.64^{a}\pm 0.54$	$6.27^{a}\pm 0.7$	$4.8^{b}\pm 0.55$	$4.39^{b}\pm 0.33$	$4.7^{b}\pm 0.27$
DMD	$0.608^{ab}\pm 0.06$	$0.585^{b}\pm 0.03$	$0.659^{b}\pm 0.04$	$0.770^{b}\pm 0.04$	$0.562^{c}\pm 0.02$
CP digestibility	$0.608^{a}\pm 0.06$	$0.542^{c}\pm 0.02$	$0.576^{ab}\pm 0.02$	$0.657^{a}\pm 0.06$	$0.561^{b}\pm 0.04$
CF digestibility	$0.814^{c}\pm 0.04$	$0.809^{cd}\pm 0.01$	$0.849^{b}\pm 0.02$	$0.903^{a}\pm 0.01$	$0.786^{d}\pm 0.02$
EE digestibility	$0.905^{b}\pm 0.01$	$0.844^{c}\pm 0.04$	$0.915^{ab}\pm 0.01$	$0.936^{a}\pm 0.01$	0.799 ± 0.05

$^{a, b, c}$ Means in a row with common letter(s) superscript do not differ (P > 0.05). FCR = Feed conversion ratio; DMD = Dry matter digestibility; CP = Crude protein; CF = Crude fibre; EE = Ether extract.

The rabbits were allowed a one-week adjustment period during which they were treated against some common diseases (Coccidiosis and Mange) by administering prophylactic coccidiostat (Esb3 + terremycin chick formular) orally and ivermectin (20 g/kg body weight) subcutaneously against mange. They were randomly allocated to five treatments with four animal replications per treatment.

Feed Intake and Nutrient Digestibility: The five experimental diets were formulated with ingredients shown in Table 1. Cassava peel was collected from garri processing cottage industry. The cassave peel consisted of the white part of the fleshy tuber with the coat or brownish outer part of the cassava. The quantity collected after peeling was 800 kg. It was spread on a tarpaulin and sun dried, and turned 2-3 times daily during the process of drying. The dried peels was then stored, on a wooden bench so that it will not absorb moisture from the floor. Cassave peel residue (CPR) was incorporated at 0, 25, 50, 75 and 100 % levels in diets 1 (control), 2, 3, 4, and 5 respectively. CPR replaced maize quantity for quantity. Feed was offered daily at 0900 h and water provided ad libitum during the experimental period. The feed offered and refusals for each rabbit was weighed and recorded daily. Rabbits were weighed weekly and their growth rate determined. At the end of the trial, there was an 8-day collection period of daily feaces from each rabbit in addition to feed offered and refusals for the determination of nutrient digestibility.

Analytical Methods: Feed samples were ground in a hammer mill to pass a 1mm mesh sieve for proximate analysis according to the procedure described by (AOAC, 1990) Crude protein was calculated as N x 6.25. Samples of faeces were dried at 65 oC for 48 h, ground through a 1 mm diameter screen and were analysed for proximate composition (AOAC, 1990). Gross energy of feed and faeces were measured by bomb calorimetry using benzoic acid as a standard (26437 J/g) (Miller and Payne, 1959).

Statistical Analysis: Data generated were subjected to Analysis of Variance (Steel and Torrie, 1980). Means were separated using Duncan's Multiple range test (Duncan, 1955).

RESULTS

The composition of experimental diets and the chemical composition and gross energy content of the experimental diets is presented in Table 1. The

crude protein content of the diets were approximately 18 % crude protein (CP). The crude fibre (CF) levels of the diets increased with increasing levels of cassava peel residue (CPR), (7.37 - 8.49 %).

Feed intake, growth rate and nutrient digestibilities of weaner rabbits fed cassava peel as replacement for maize is summarised in Table 2. There were significant ($P < 0.05$) differences in the feed intake, growth rate, feed conversion ratio and nutrient digestibilities among the treatments. Rabbits fed diets 3, 4 and 5 had significantly higher ($P < 0.05$) daily feed intake than rabbits fed the control diet. There was however no difference in daily feed intake of rabbits fed diets 2 and 3. Similarly, rabbits on diets 3, 4 and 5 had a higher growth rate ($P < 0.05$) than those fed control and diet 2 respectively. A lower ($P < 0.05$) feed conversion ratio was observed in rabbits fed diets 3, 4 and 5 when compared with rabbits fed the control and diet 2.

Dry matter, crude protein, crude fibre and ether extract digestibility were significantly different ($P < 0.05$) among treatments. Rabbits fed diet 4 showed a consistently higher nutrient digestibility values ($P < 0.05$) than those fed diets 1, 2, 3, and 5. However, the dry matter digestibility, crude fibre and ether extract digestibilities of diets 3 and 4 were not significantly different ($P > 0.05$). Feed cost per kg (N/kg) decreased from N35.33 in the control diet to N19.75 in diet 5. Cost of feed/kg live weight gain (N/day) decreased from N3.21 in the control diet to N1.29 in diet 5.

DISCUSSION

The crude protein level of the diets were within the level of 18 % recommended for growing rabbits in a tropical environment (Omole, 1982). The crude fibre levels of the diets (7.37 – 8.49) were lower than the 14 % recommended by Ikurior and Kem (1998) for growing rabbits. The fat levels (5.11 – 5.39) of the diets were higher than the minimum level of 3 % desirable to provide the essential fatty acids and maintain glossy sleek hair (Cheeke et al., 1986). The gross energy values of the diets fell within the recommended range (2390 - 2500/kcal digestible energy) for optimum growth and performance in rabbit (Aduku and Olukosi, 1990).

The poor growth performance on the control diet may have been due to inadequate fibre in the diet. According to Champe and Maurice (1983) rabbit require crude fibre in excess of 9 % for normal growth. Reduced growth rates as observed in diets 1 and 2 may be due to decrease in dietary fibre (Bamgbose et. al., 2002). The mean weight gain recorded in this study compared favourably with the reports of Agunbiade et. al. (1999) and Schiere (1999). The increased mean weight gain of rabbits fed diets 3, 4 and 5 over those fed diets 1 and 2, respectively, could be attributed to the favourable effect of fibre, termed a “ballast” effect (Colin et al., 1976).

The daily feed intake and feed conversion ratio obtained in our study tally with the values reported by other workers (Onifade and Tewe, 1993; Agunbiade et al., 2002) who fed diets containing about 30 % of maize offal to growing rabbits. The low feed intake (76.39 – 86.21) g/day as per the value 131 g/d reported by Cheeke (1984) for rabbits reared in temperate countries may be due to the variation in ambient temperature. Felding (1991) reported that high ambient temperature has adverse effect on feed intake.

Apparent nutrient digestibility showed that the rabbits on diets 3 and 4 had better nutrient digestibilities than those on diets 1, 2, and 5, respectively. This may be the optimum range for efficient nutrient utilisation.

It was observed that total feed cost reduced as the level of the cassava peel meal increased, while the lowest cost/kg liveweight gain was observed in diet 5 (100 % cassava peel) replacement. The highest relative cost advantage observed in diet 5 was as a result of the lower cost of cassava peel compared to maize in the diets.

Conclusion: The result from this study showed that there is a great potential for improvement in feed intake, growth rate and nutrient digestibilities of weaner rabbits fed casava peels as replacement for maize. The results of the present study has shown that maize could be replaced by cassava peel meal up to 100 % without any adverse effect. However, the optimum performance was observed when 75 % cassava peel replaced maize in the diet.

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EFFECT OF CASSAVA VARIETIES ON OVIPOSITION AND DEVELOPMENT OF LARGER GRAIN BORER-*Prostephanus truncatus* HORN (COLEOPTERA: BOSTRICHIDAE)

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ABSTRACT

The influence of cassava varieties on the developmental biology of Prostephanus truncatus (Horn) was investigated. This beetle was reared on flour varieties of cassava, namely: Danwari, Nwugo, Aburu-Asua and Anti-Ota. More eggs were laid in Danwari (132.0 ± 6.1 egg) than in other cassava variety. The least number of eggs laid was in Nwugo ($118.3_{+-4.5)}$ in No-choice experiment. In Free-choice test, the highest number of eggs was recorded in Aburu-Asua (64.0 ± 1.7 eggs) and the lowest (41.6 ± 3.1 eggs) on Anti-Ota. The average total developmental period in, Aburu-Asua, Nwugo, Danwari and Anti-Ota were 32.5 ± 0.4, 30.6 ± 0.2, 28.5 ± 0.1 and 34.7 ± 0.1 days respectively. The low oviposition preference for Nwugo was attributed to the presence of oviposition deterrents in this variety, which might have protected it against the beetle attack.

Keywords: Cassava, Oviposition, Larger grain borer, Coleoptera, Bostrichidae

INTRODUCTION

Cassava (*Manihot esculentus* Kantz) is native to Latin America and was introduced into Africa during the last part of the 16th century, and adapted quickly into the traditional tropical African farming systems (Hahn *et al.*, 1980). In Nigeria, cassava production and utilization have increased tremendously in 2005, following the present government initiative on cassava production and utilization. Mpumechi (1993) observed that over 160 million people in sub-saharan Africa have cassava as their staple food.

Ingram and Humphries (1972) reported that cassava can be processed into dried products in a variety of ways in different parts of the tropical world, according to local needs, taste and traditions in order to retain a steady supply of food as well as service a trading system all the year round. IITA (1987) stressed that cassava tuber can be made into dry chips directly from tubers of low cyanide content otherwise varieties of medium cyanide content can be used for chips production by passing the flour through a dough-making and frying preprocess. Cassava flour can be used in baking industries for bread, biscuit and also serve as major component in compounding livestock feeds. A number of varieties are available as *fufu, garri, tapioca* and starch, while tubers from cassava cultivars considered sweet can be eaten simply boiled or baked (Dufour, 1987).

Inspite of Nigeria's position as the world largest producer of cassava, yet some factors militates against its production. It is observed that apart from disease, insect pest is a major biological constraint in cassava production and storage. Parker and Booth (1979) reported that cassava chips are heavily infested during sun drying and when in store by a number of stored product pests including the larger grain borer- *Prostephanus truncatus*. (GASGA, 1993)

It is against this background that this study was conducted on the oviposition preference and development of *Proptephanus truncatus* a cassava product pest on these cassava varieties – Danwari, Nwugo, Aburu-Asua and Anti-Ota. It is hoped that this study will add to our knowledge of this noxious pest on the cassava varieties under study, as the result will help to advice farmers on the most resistant varieties of cassava to cultivate.

MATERIALS AND METHODS

Clean, uninfected samples of cassava were heat-sterilized in an oven at 104^0C for one hour to make sure that there was non-contamination before any treatment. Insect colonies were raised by infesting the sterilized cassava chips in 150ml glass jar with 30 pairs of *Prostephanus truncatus* obtained from the infested cassava chips from Awka market. The glass jar was covered with fine nylon net held in place by a rubber band. The nylon net prevented the escape of the insects and at the same time permitted adequate aeration of the cassava chips. The set up was kept in the laboratory at the fluctuating temperatures of 25 ± 3^0C and relative humidity of 75 ± 5%. New generations of *Prostephanus truncatus* were raised from this stock and used for subsequent experiments.

Effect of Cassava Variety on Oviposition: No-choice and Free-choice experiments were conducted in studying oviposition on cassava chips by *Prostephanus truncatus*. In the No-choice test, five pairs of sexually mature adults were confined in Petri-dish containing 10g of Danwari. Nwugo, Aburu-Asua and Anti-Ota chips. There were four replicates per cassava cultivars. The cassava chips were examined daily under a dissecting microscope for eggs and the number found was recorded over a period of 21 days. In the Free-choice test, fresh tubers of the four cassava cultivars were processed into dry cassava

chips by the methods described by Ingram and Humphries (1972).

Ten pairs of 14 days old adults of *Prostephanus truncatus* were confined with equal size of cassava chips of the four cultivars in a Petri-dish that has been portioned with paraffin wax in to four equal compartments. Each cassava chips was placed at equidistant positions from the centre of the Petri-dish. Four treatment replicates were set up. The cassava chips were examined daily and egg counts made for a period of 14 days after which they were replaced after each day's observation.

Effect of Cassava Variety on Egg Incubation and Beetle Development: Five grams (5g) of cassava flour of each variety were weighed into Petri-dishes in four replicates per cassava variety. Newly emerged adult of *Prostephanus truncatus* were sexed according to Shires and McCarthy (1976) and paired beetles of opposite sexes were introduced into Petri-dish and covered with fine nylon net held in place by a rubber band. Each Petri-dish was observed daily for the number of eggs laid for a period o f 10 days using a binocular microscope. Developmental period of *Prostephanus truncatus* was studies on each cassava variety using one-day old larvae collected from sets of incubated eggs. Each larva was transferred into a separate Petri-dish containing 5g of cassava flour of the desired cassava variety and covered with fine nylon net held tightly in place by a rubber band. The number of days taken to complete development to adult was recorded and the numbers of larval molts were also noted.

Data Analysis: The data were subjected to the analysis of variance (ANOVA) and the means separated by the least significant difference (LSD) test.

RESULTS

Effect of Cassava Variety on Oviposition: The mean number of eggs laid by *Prostephanus truncatus* over a period of 21 days in chips of each variety in the No-choice test is presented in table 1.

From the results Danwari has the highest number of eggs (132.0 ± 6.1) while Nwugo had the least (118. 3 ± 4.5). The difference was significant at the P = 0.5. Significant differences were not detected among Nwugo, Danwari and Anti-Ota or among Danwari, Anti-Ota and Aburu-Asua. In Free-choice test, the beetle preferred Aburu-Asua for oviposition (64.0 ± 1.7) to any other cassava variety (Table 1), Nwugo and Anti-Ota were not significantly different as suitable cassava for oviposition.

Effect of Cassava Variety on Egg Incubation and Development: The data obtained on the development of *Prostephanus truncatus* on four cassava varieties are presented in table 2. Egg incubation period ranged between 6.4 days in Aburu-Asua and 7.3 days in Nwugo. The larval period ranged between 20 days in Aburu-Asua and 24 days in Anti-Ota. There was no significant difference in larval developmental period in Danwari and Nwugo when the LSD test was used.

However, the larval period were significantly longer in both Aburu-Asua and Anti-Ota compared to other cassava varieties.

The pupa stage lasted from 3.1 days in Danwari to 6 days in Aburu-Asua (Table 2. LSD test at P = 0.05 showed a significant difference in the papal period obtained in Danwari from other varieties. The mean development period from egg to adult was significantly longer on Anti-ota than on other varieties.

DISCUSSION

The high number of eggs of *P. truncatus* recorded for the four cassava varieties in No-choice test showed that they were acceptable media for oviposition. This observation explains the high levels of *P. truncates* infestation recorded on dried cassava chips in Awka market by Akunne (1998). Based on the Free-choice experiment, it is apparent that Aburu-Asua cultivar is most preferred cassava for oviposition of this beetle species, while Anti-Ota is the least preferred medium. However, in the No-choice experiment, the beetle oviposited freely on Danwari, thus suggesting that this variety could be of ecological significance in the survival of the insect when its normal cassava is not available.

Table 1: Effect of cassava variety on oviposition by *Prostephanus truncatus*

Cassava variety	*Mean number of eggs	
	No-choice test	*Free-choice test*
Aburu-Asua	124.0 ± 2.6[a]b	64.0 ± 1.7[c]
Nwugo	118.3 ± 4.5[a]	46.0 ± 3.2[a]
Danwari	132.0 ± 6.1[b]	50.0 ± 2.5[b]
Anti- Ota	127.0 ± 3.7[a]b	41.6 ± 3.1[a]

** Each value represents mean ± standard error of the mean of four replications. Means followed by the same letter(s) are not significantly different at P = 0.05 according to Duncan's multiple range test.*

Table 2: Effect of cassava variety on duration of development of *Prostephanus truncatus*

Cassava species	* Development period (days)			
	Egg incubation	Larval	Pupal	Total
Aburu-Asua	6.4 ± 0.2[a]	20.1 ± 0.2[b]	6.0 1 ± 0.1[b]	32.5 ± 0.4[a]
Nwugo	7.3 ± 0.1[a]	18.6 ± 0.2[a]	5.02 ± 0.3[b]	30.06 ± 0.2[a]
Danwari	7. 4 ± 0.3[b]	18.0 ± 0.1[a]	3.1 ± 0.2[a]	28.5 ± 01[a]
Anti-Ota	6.2 ± 0.2[a]	24. 0 ± 0.1[c]	4.3 ± 0.1[b]	34.7 ± 01[b]

** Each value represents a mean ± standard error of the mean of four replications. Means followed by the same letter(s) are not significantly different at P = 0.05 according to Duncan's multiple range test.*

The significantly higher preference for Aburu-Asua and Danwari as oviposition media may be due to differences in the chemical composition of the various cassava cultivars as earlier observed by Okeke *et al.,* (1989). In the Free-choice test, the low preference of Anti-Ota was traced to its high cyanide content as reported by Dufour (1987). Similarly, Daramola (1981) reported that the least preferred oviposition medium by the kola nut weevil, *Balangastris kolae* contained high caffeine content. Therefore, the low egg output on Anti-Ota is indicative of the presence of some oviposition deterrents in this cassava cultivar. Furthermore, the high starch content of the cassava might affect the oviposition preference of the beetle. The observed differences in the development periods of *P. truncatus* in these cassava cultivars is also indicative of nutritional value differences of these cassava cultivar as reported by Okeke *et al*., (1989).

Similarly, Detmer *et al.* (1993) noted that high breeding capacity of *Prostephanus truncatus* on several woody varieties of cassava depends on their high starch content. It is not surprising therefore that there was a preponderance of the beetle species studied which suggests that these cassava varieties offered decreased cassava resistance hence the increase suitable media for the oviposition of *P. truncatus* in the varieties.

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PREVALENCE OF BOVINE CYSTICERCOSIS IN JOS ABATTOIR, NIGERIA

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ABSTRACT

The prevalence of Cysticercus bovis at Jos abattoir during post mortem examination conducted on Fourteen thousand three hundred and seventy two (14,372) slaughtered cattle over a period of two years (January 1997 – Dec. 1999), using evagination method. Out of 14,372 carcasses examined 1924 (13.4 %) tested positive for C. bovis. The sites of the location of the larvae varied from one organ to another with the heart having the highest 48 (30.0 %) and the least affected were the visceral organs livers, lungs and esophagi. There is a positive correlation between the number of C. bovis cyst and the percentage frequency of the organ affected (P<0.05).

Keywords: Prevalence, Cattle, *Cysticercus bovis,* Jos abattoir

INTRODUCTION

Cysticercosis is a zoonotic disease with the adult worm (*T. saginata*) found in the small intestine of man and the cyst in tissues of cattle (Falake and Ogundele, 2003). The disease in man and cattle are enzootic in Africa with infection rate ranging between 1.0 % and 4.0 % (Belino, 1998; Onah and Chiejina, 1986). Cysticercosis is more important in the livestock industry because of the economic implication of down grading and condemnation of the affected carcasses (Feachem *et al.*, 1983). Berton (1976) reported low cattle production and thus low quantity of beef supply for Northeastern, Nigeria. According to him most of the beef have been condemned during post mortem due to prevalence of taeniads (adult) and cysticerci. As a result of this wastage the recommended 88 grams of animal protein intake per caput per day has not been met, the supply still stands at about 15 grams for developing countries (FAO, 1990). The purpose of the present study was to determine the prevalence rate of cysticercosis in slaughtered cattle at Jos abattoir.

MATERIALS AND METHODS

Study Area: Jos the state capital of Plateau is located in Northern part of the state in Jos North local government area. It is a tropical area with cool and windy climate. The mean ambient temperature ranges between a minimum of 18.7 ^{o} F and maximum of 51.7 ^{o} F. The annual mean rainfall is between 13.75 cm and 146 cm. The Plateau highland stands at an average of 1.2 m above sea level. It lies between latitude 7^{o} N and 11^{o} E.

Animal: Animals used in this study and were categorized according to breeds, ages, sexes and sources. There is only one modern abattoir in Jos state capital. On the average about 90 heads of cattle is being slaughtered per day in the modern abattoir and weekly 630 cattle were being slaughtered. Daily sample size was 75 animals and twice weekly was 150 animals. The size of the cattle slaughtered were averagely 250 kg per head i.e. equivalent to about 5 bags of cement. Their ages ranged from 2 years and to about 8years, generally, male animals were mostly slaughtered and breeds were mainly white Fulani, red Bororo and Sokoto gudali.

The post mortem meat inspection was performed by a team of veterinary surgeons and meat technologies. It was carried out via visual inspection, palpation and incision throughout the muscles of the arm, thigh, masseter, heart and internal organs of the carcasses (lungs, livers and tongues).

On incision, cyst found were excised and placed in sample bottles and classified either as viable, dead and necrotic cyst. Viability of the cyst was determined by fluid translucency with visible white scoleces and dead cyst as bluish-green caseous masses, necrotic cyst seen as dark patches (Thornton and Gracey, 1976).

Parasitological Examination: Viable cysts were placed in a Petri dishes containing normal saline, 30% of bovine bile was added and incubated at 37^{o}C for two hours. The evaginated scoleces were each examined for absence or presence of hooks and suckers thus confirming *C. bovis* as described (Falake and Ogundipe, 2003).

Data Analysis: The data in the study was analyzed using mean average and percentage frequency to know if, relationship exists between the age, sex, breed of the cattle and the prevalence of organ infestation by *C. bovis*. Prevalence is determined by the number infested by the total number of animals examined. Monthly distribution of *C. bovis* was determined by the frequency of occurrence of *C. bovis* over the carcasses examined. Not the sex, age, and breed of the distribution of *C. bovis* but those of the cattle studied.

RESULTS

A total of eighty six thousand four hundred cattle were slaughtered during the period under study.

Table 1 showed the distribution of the cattle slaughtered according to their source of supply and breeds of animals (from Jan. 1997 – Dec. 1999).

Table 1: Distribution of cattle slaughtered according to sources and breeds in Jos modern abattoir (1997 – 1999)

Sources	Breeds			Total
	WF	RB	SG	
Bauchi	5700	550	5100	16, 300
Benue	4900	6000	6700	17,600
Kaduna	5800	5900	5900	17,600
Nasarawa	6,300	4000	6,300	16,600
Plateau	6,500	7000	4800	18300
Total	29,200	28,400	28,800	86,400
Mean	5,480	5680	5760	17,280.

The mean prevalence rate of bovine cysticercosis at the slaughter in Jos modern abattoir (as represented in Table 2), over a period of twenty four months (Jan. 1997 – Dec. 1999) revealed 2.25 % of the total fourteen thousand three hundred and seventy two examined cattle, from Jan. 1997 – Dec. 1999, with a prevalence rate of 13.4 % (1924) positive to bovis cyst.

Table 2: Mean prevalence of bovine cysticercosis in Jos modern abattoir (1997 – 1999)

Year	No. cattle slaughtered	No. infected	Percentage (%)
1997	32,400	644	1.988
1998	28,800	641	2.225
1999	25,200	639	6.749
Total	86,400	1924	6.749
Annual mean	28,800	641.3	2.250

The age and sex distribution of the slaughtered cattle infected with *C. bovis* in Jos modern abattoir as shown in Table 3.

Table 3: Age and sex distribution of cattle slaughtered in Jos modern abattoir infected with *C. bovis*

Age (years)	Sex (% Frequency)		Total
	Males	Females	
< 2	50 (67.6)	24 (32.4)	74
2.5 – 4.5	250 (62.5)	150 (37.5)	400
> 5	1130 (77.9)	320 (22.1)	1450
Total	1430 (74.3)	494 (25.7)	1924

Generally males cattle greater than five years of age constituted the larger number of the slaughter rate and also were mostly infected than the young females' animals. The frequency and type of *C. bovis* obtained during meat inspection is presented in Table 4. Apparently viable cyst 72.5 % was most frequently recovered than the nonviable cyst. The frequency of distribution and occurrence of cyst in different organs of the carcasses. These were a positive correlation between the organs of infestation and the percentage infestation ($P < 0.05$). Generally musculatures of the heart and tongue are more infected than the visceral organs (lungs, livers, esophagi etc).

After post mortem of the slaughtered cattle 1400 (72.80 %) viable, 500 dead (26.0 %) and 24 necrotic cyst (1.20 %) were recovered, there was significant difference between viable and non viable cyst ($P < 0.05$). There was a positive relationship between the organ of the infestation and percentage infested (%).

Table 4: The frequency and type of C. bovis obtained during the meat inspection in Jos abattoir

Type of cysticerci	Number	% frequency of cysticerci recovered
Apparently viable	1400	72.8
Dead	500	26.0
Necrotic	24	1.20
Total	1924	13.4

Table 5: The frequency and occurrence of cyst in different organs/ part of the carcasses

Location of cyst	No. infested (X)	% infested (Y)
Heart	48	30.0
Tongue	40	25.0
Masseter	28	17.5
Muscles of the arm	16	10.0
Muscles of the thigh	8	5.0
Diaphragmatic pillars	8	5.0
Livers	4	2.5
Lungs	4	2.5
Esophagi	4	2.5
Total	160	100

DISCUSSION

The prevalence rate of 13.4% (1924) of the *Cysticercus bovis* in cattle slaughtered in Jos modern abattoir is of public health significance in Nigeria where gross inadequacy of ethical slaughters, meat inspection procedures and facilities exist of *C. bovis,* the consumer is undoubtedly exposed to the risk of infestation. The prevalence is lower than that reported by Belino (1980) as 16.0% in Northern Nigeria. The decrease in the rates could be due to possible an increase in sanitary measures in Jos abattoir. Also the results were higher than Ajogi *et al.* (1995). This might be attributed to the inefficiency and lack of integrity by meat inspectors. It is still lower than that recorded by Dada and Belino (1990) in Sokoto with a prevalence rate of 11.1%. The possible reason for the difference in the prevalence could be due to improved hygienic and sanitary measures in Sokoto abattoir as compared to Jos. The age and the sex distribution of the slaughtered cattle with *C. bovis* showed that aged male cattle were more affected than the females ($P< 0.05$). This could be due to the fact that females are generally kept in the herd for breeding, milk production and thus rarely being sent to market (Falake and Ogundipe, 2003). Most of the times older males are being culled because younger ones are kept to serve as herd replacement stock. Post mortem examination revealed 1400 (72.8%) viable cyst as compared to others.

There was significant difference between number of viable and non viable cysts ($P<0.05$). The frequency and occurrence of the cyst showed that the heart was most infected and there was significant difference ($P<0.05$) as compared with other organs. Also Belino (1980) reported that muscle had been mostly affected but heart had higher infection. The presence of viable cysts in all infected carcasses examined suggested a serious threat to the beef consumers who are at risk of contracting the disease. The average internal temperature of roasted meat locally called "suya" is 45.5^{o}C as reported by Falake and Ogundipe (2003). This implies that the heat is not enough to destroy the cysts in infected muscles and hence will constitute a source of human infection. The control measures to curtail zoonosis through the consumption of contaminated beef from infected animals by the public (meat handlers, processors and inspectors among others), must be enforced. *C. bovis* infestation might lead to death of both livestock and humans so must be ethically controlled in all abattoirs and slaughter slabs. This will lead to reduction in cattle death, carcass condemnation and higher protein availability for the teeming populace. In conclusion, the overall prevalence rate was lower than earlier studies which suggested an increase awareness of the public that has lead to improvement in personal hygiene, medical health of the animals, proper sewage disposal and better health care of animals. However, proper cooking of meat before consumption and improved environmental and personal hygiene will go along way in reducing and or eliminating bovine cysticercosis.

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BETTLE FAUNA OF AGRO AND FOREST ECOSYSTEMS IN A TROPICAL RAINFOREST HABITAT, NIGERIA

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ABSTRACT

An investigation was carried out to study the beetle fauna of a cultivated farmland and tropical rainforest plot at the Permanent. Site of Nnamdi Azikiwe University, Awka for a twelve-month period using the pitfall technique. Eight pitfall traps made up of plastic containers with mouth diameters of 9.80 cm and 6.20 cm deep were set monthly at random in the two sampling sites. The traps, which were filled to one third with 5 % formalin, serving a preservative, were recovered after twenty-four hours and the insects caught sorted and counted under a dissecting microscope. Species of beetle obtained from the cultivated plot were Macrocheilus labrosus, Hyparpalus sp., Carpophilus fumatus, Podagrica uniforma, Tetragonothorax sp., Chlaenius sp., Pheropsophus parallus, Silidas apicalis, Tenebroides mauritanicus, Heteroderes sp., and Heterorynchus licas while only Hyparpalus sp., and Mylabris sp., were obtained from the fallow plot. The result of Fisher's Least Significance Difference (F-LSD) test shows that the pitfall catches of beetles from the two sampling sites were significantly different at p-value of 0.0002 and mean difference of 3.417. The heterogeneity of the beetle species at the cultivated plot was traced to nature of vegetation and mode of life of the beetle species. The role of certain beetle families as faunal indicators was highlighted. Other factors, which influenced the beetle species at the arable plot and their non-trapping at the forest ecosystem, were also discussed.

Keywords: Beetle fauna, Arable plot, Secondary regrowth forest, Pitfall traps

INTRODUCTION

The terrestrial habitats are rich in terms of their insect fauna and floristic composition. At present, our knowledge of the vast majority of the insects in the Nigerian terrestrial ecosystems is far from being complete (Ewuim, 2004). New areas of vegetation are being cleared for farming and urban development and therefore the environment is continuously changing (Youdeowei, 1980; Ewuim, 2004).

The insects are the most numerous of all terrestrial animals both in terms of species and total abundance. However, only a small fraction is pestiferous (Ewuim, 2004). These insects are therefore strategic in the welfare of man through their activities. The beetles which constitute about two-thirds of all known insects, and about one-third of all known animal species invariably, participate in various activities, resulting' in several changes in the ecosystems. The beetles like other insects, often evolve and exists as components of communities of plants and other animals. Most of the species are terrestrial even though some are aquatic. In terms of food and feeding habits, many beetles are plant eaters; some are predacious with others being scavengers, while some of them are wood-borers. In terrestrial ecosystems many of these herbivorous forms constitute serious pests of crops and causing significant damage either directly or even transmitting diseases, even though some are known to be beneficial herbivores.

With destruction of natural habitats by man and in particular destruction of vast areas of forests for industrial, agricultural and urbanization purposes (Boorman, 1981), these beetle therefore constitute an interesting group to study in natural ecosystems. The study of the beetle species in the arable plot and a secondary regrowth forest will no doubt provide useful information on their distribution and abundance.

MATERIALS AND METHODS

Study Area: The study was carried out in two rather contrasting study sites a cultivated farmland and a secondary regrowth forest, all of which are located at the Permanent Site of the Nnamdi Azikiwe University, Awka. Awka is the capital of Anambra State of Nigeria and located in the lowland rain forest zone of Southern Nigeria (Keay, 1965; Charter, 1970).

The cultivated plot which measures 800 cm^2 in area is located between latitude 6.23782°N and longitude 7.12884°E. At the time of investigation and apart from the cassava, *Manihot esculenta* Kranz, planted in mounds, the plot had a variety of weeds which include *Sida acuta* Burm, *Aspilia africana* (CD), *Euphobia hirta* (L.), *Chromolaena odorata* (L.), *Emilia sonchifolia* (L.), *Tridax procumbens* (L.), *Mariscus alternifolus* Vahl., *Commelina benghalensis* (L.), and *Axonopus compressus* (S.W.) Also present was a shrub *Phyuanthus amarus* Schum and Thom.

On the other hand, the forest investigated can be described as a secondary regrowth forest. The study area lies between latitude 6.25774°N and longitude 7.11275°E. Alternatively it is located south east to east of the School of Postgraduate Studies and general south-east of Rufai Garba Square with an approximate bearing of 125° and a distance of 200 m from the center point of the Square.

Table 1: Pitfall Catches of Beetles Obtained from the Arable Plot and the Forest at Awka, Nigeria

Beetle family	Genus and Species	*Beetle Population in Sampling Sites	
		Cultivated plot	Forest
Carabidae	*Macrocheilus labrosus*	1	-
	Pheropsophus parallus	1	-
	Chlaenius sp.	2	-
	Hyparpalus sp.	11	-
Nitudilidae	*Carpophilus fumatus*	1	-
Curculionidae	*Tetragonothorax* sp.	1	-
Cantharidae	*Silidius apicalis*	1	-
Ostomatidae	*Tenebroides mauritanicus*	2	-
Elatridae	*Heteroderes* sp.	1	-
Scarabaeidae	*Heterorynchus licas*	1	-
Staphylinidae	*Mylabris* sp.	-	-
Unidentified Beetles		7	-

** Significant at probability level α > 95%; t-table = 2.201*

The size of the sampling plot is about 200m^2 in area. The herbaceous plants found at the fringe of the forest included *Chromolaena odorata* R. M. Kings and Robinson, *Panicum maximum* Jacq. In addition to shrubs like *Mallotus oppositifolius* Giezel. The trees included *Newbouldia laevis* P. Beauv., *Alstolia boonei* de Wild, *Diallum guineensis* L., *Alchornea cordifolia* Schum and Thonn., *Alstonia bonei* de Wild, *Ceiba pentandra* Linn., Gaertn., *Chlorophora exelsa* Welw. Benth., *Harungana madagascariensis* Lam and Pols, *Newbouldia laevis* P. Beauv., *Morinda lucida* Benth., *Pterocarpus milbraedii* Harrns, *Ricinodendron heudelotti* Baill., *Rauvolfia vomitoria* Afyel and *Fagara macrophylla* Engl.

Sampling Method: Eight pitfall traps made of plastic containers, with mouth diameters of 9.80 and 6.2 cm deep were set monthly in the two study sites for a twelve month period. The traps were filled to one-third with 5 % formalin. The traps were recovered after twenty-four hours, and the insects caught were sorted identified and counted under a dissecting microscope. Rainfall data was collected during the sampling period using the rain-gauge, while bulb -thermometer was used to measure aerial and soil temperature on each sampling occasion.

The insects and their larvae were identified using Insects of Nigeria - Check List and Bibliography (Medler, 1980). The identification of the specimens was verified in the Department of Crop Protection, Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The voucher specimens were also kept as reference point for further studies. The data was analysed using Fisher's Least Significant Difference (F-LSD) to ascertain whether or not statistical difference existed between the pitfall catches of beetle species, obtained from the cultivated and forest plots.

RESULTS

A total of 26 beetles were trapped using the pitfall technique during the twelve-month sampling, from the cultivated plot, with none obtained from the forest. The cultivated farmland had beetle species which included *Macrocheilus labrosus, Pheropsophus parallus, Chlaenius* sp., and *Hypapalus* sp., which belong to the carabid family. Single species collected from the cultivated farmland include *Carpophilus fumatus* (Nitudilidae), *Tetragonothorax* sp. (Curculionidae), *Silidius apicalis* (Cantharidae), *Tenebroides mauritanicus* (Ostomatidae) *Heteroderes* sp. (Elatridae), *Heterorynchus licas* (Scarabaeidae) and *Mylabris* sp. (Staphylinidae).

The result of t-test also showed that the pitfall catches of the beetles from the cultivated plot and the forest were significantly different ($p < 0.05$) with all catches obtained from the cultivated plot. The increased pitfall catches of beetles at the cultivated plot is an indication of higher activity-density of the beetle populations at this sampling site.

DISCUSSION

The heterogeneity in the distribution of the beetle species at the cultivated site is related to the efficiency and capture rate of the wandering species. Out of eight families of beetle trapped, Carabidae, Nitudilidae, Curculionidae, Cantharidae, Ostomatidae, Elatridae, Scarabaeidae and Staphylinidae were recorded in the cultivated plot only. In an earlier study, Ewuim (2004) associated members of Carabidae family with cultivation and complex relationship between wandering beetle, abundance and the frequency of vegetation cover (weed) have been established (Spreight and Lawton, 1976; Ewuim, 2004). The preponderance of beetles especially at the cultivated plot may be associated with the nature of the vegetation.

In earlier studies the relative abundance of the ground beetles was associated with nature of vegetation (Ewuim, 2004), while the curculionids have been associated with flower visiting and pollination (Sakai et *al.,* 1998; Ewuim, 2004). Weevils are plant eaters and thus are serious agricultural pests. The non-trapping of beetles at the forest plot might also be associated with dense litter cover and nature of environment which markedly impeded the locomotor activity of the beetles and thus their non-trapping. These observations are similar to those of Adis (1979) and Ewuim (2004) who observed that in the forest the depth of ground litter influenced pitfall sampling results. There is also evidence to suggest that the nature of the forest habitat might have also

influenced the trapping of these beetle species including the position of installment of these traps in a given habitat.

Apart from the possibility of evasion of traps by species depending on the nature of a habitat, Ewuim (2004) in an earlier study emphasized that the vegetation structure can also greatly influence pitfall captures. Vegetation structure can also, in turn affect the locomotory ability of the species in the habitat. Species also respond differently to continuous variation in environmental quality (Bell et *al.,* 2000; Ewuim 2004) hence the differences observed in the trapping the species at these sites. The zero counts observed for the beetle species at the forest may not necessarily reflect absence at the plot but in line with the observation of Schowalter and Ganio (1998) that large number of zero obtained for many taxa complicate statistical analysis of arthropod abundances which defy normalization using any transformation.

It has been observed that adult beetles are herbivorous during their surface life and constitute the most influential grazers hence their increased number in the cultivated farmland. This also explains the trend in the result of the F-LSD carried out in which there was significant difference in the trapped beetles with all trapped in the cultivated plot when compared with the forest plots (Ewuim, 2004). The alteration of vegetation structure in the non-forested plots studied therefore possibly influenced the spatial and temporal (spatiotemporal) variations in these species studied since in general; temporal dynamics of insect populations invariably take place within a spatial context. In the long run evidence abound from this study that the least stable and perhaps the least efficient community is the highly diverse one as observed for the cultivated plot. In fact, Ewuim (2004) have questioned the whole concept of increased diversity bestowing increasing stability and has demonstrated that the diverse community in more fragile. Disturbed systems like those of the cultivated farmland may be inherently more resilient (Ewuim, 2004) even in terms of the insect species as observed for agro-ecosystem.

In the final analysis, the significant difference observation in the trapping of the beetle species with a high population density for the cultivated plot is also a strong indication that the beetle families were particularly sensitive indicator taxa of land use (Ewuim, 2004) as confirmed by the increased density of the coleopteran species in the cultivated agro-ecosystem.

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ODONATA FAUNA OF CONTRASTING SEMI-AQUATIC AND TERRESTRIAL ECOSYSTEMS IN AWKA, NIGERIA

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ABSTRACT

The sweep net was used to study the Odonata fauna of the Permanent Site of Nnamdi Azikiwe University, Awka for a twelve-month period. The Odonata species collected from the marshy plot included Orthetrum chrysostigma, Ceriagrion glabrum, Platycnemis subaequistyla Fraser and Nesciothemis nigeriensis while Hemistigma coronata and Palpopleura lucia were obtained from the fallow plot. Only two species - Palpopleura lucia and Hemistigma albipuncta were collected from the cultivated plot. A statistical analysis of the collections of these insect species using Analysis of Variance (ANOVA) failed to show any significant differences at F-ratio of 0.458 and p-value of 0.6339, even though higher numbers of species were obtained at the wetland. Similarly the sweep net catches failed to show any significant difference using the Fisher's Least Significance Difference (F-LSD) test at 5% probability level. The higher catches of the odonates at the marshy plot was traced to the nature of the habitat. The role of these sub aquatic species as indicators of ecosystem quality was highlighted.

Keywords: Odonata fauna, Semi-aquatic ecosystem, Awka,

INTRODUCTION

The insects are strategic in the welfare of man (Ewuim, 2004), and constitute a major component of the earth's biodiversity with their species richness or diversity exceeding that of any group of extant organisms. The majority of arthropods, and indeed the majority of animals, is insects. Except in the sea where crustaceans hold sway, insects dominate the earth in terms of numbers and kinds and of such importance ecologically and economically, that we literally would not have reached our own place in nature without understanding something about them (Wallace *et al*., 1981). In insects alone account for 20,000 species (90.54%) with these group contributing significantly to the maintenance of life support systems, and 99.90% of the insect species being beneficial or neutral to man (Ivbijaro, 2003). These insects are abundant in a wide range of habitats including both terrestrial and aquatic ecosystems (especially fresh water), and including wetlands, either as aquatic or sub-aquatic species, even though they have never adapted to a typical marine environment.

The term wetlands have been described variously. The Ramsar Convention in Caspian in 1971 adapted the term wetland as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters. The definition focuses essentially on a specific type of ecosystem - wetlands. There are good reasons why shallow aquatic and wet terrestrial ecosystems should be grouped under the generic title of wetlands. A wetland has also been defined as a shallow seasonally or permanently water logged or flooded area, which normally supports hydrophytic vegetation (Wheeler and Proctor, 2000). This definition like most others have failed to include the variety of animal life which is important in maintaining ecosystem dynamics in the environment (Ewuim *et al*., 2001), and the influence of such a wetland on the nature of soil, in the area. Wetlands vary widely because of regional local differences in soil topography, hydrology, water chemistry, climate, vegetation and other factors including human disturbances (Cowardin *et al*., 1992).

Odonata is an order of aquatic palaeopterous insects with about 6500 extant species in just over 600 genera and are generally located at or near fresh water although some species roam widely and may be found far from their breeding sites. The odonates whose adults and nymphs are predatory spend majority of their life history in water, with the larvae or their nymphs taking one to five years to complete their development, while some species sometimes spend about one twelfth of a year as adults (Burton *et al*., 1974). The odonates even though their nymphs are aquatic, have generally been described as sub-aquatic species (Ewuim *et al.,* 2001).

Varieties of techniques have been developed in studying organisms in the wetland habitat. However no single method would be ideal for all habitats because of their characteristic advantages and limitations (Lewis and Taylor, 1979; Ewuim *et al*., 2001; Ewuim, 2004). The sweep net has been used in such studies and classified by Southwood (1996) as a relative method, which employs catch per unit effort. Majority of the relative methods require only comparatively simple equipment and serve to concentrate the animal and provide impressive collections of data from situations where few animals will be found by absolute methods. The size of relative population estimates is influenced by changes in population 'phase' of the animal, their activity and variation as well as the responsiveness of the

different sexes and species (Southwood, 1996). In this study the sweep net will be employed in studying a marshy habitat, a cultivated plot and a fallow farmland in Awka with a focus on the species of Odonata. It is envisaged that this study will help add to the paucity of information available on this fauna in Nigeria especially in the habitats under investigation.

MATERIALS AND METHODS

Study Sites: The investigation was carried out in three sampling sites viz. a cultivated farmland, fallow plot, and a marshy plot and a forest all of which are found at the Permanent Site of Nnamdi Azikiwe University, Awka. Awka is the capital of Anambra State of Nigeria and located in the lowland rain forest zone of Southern Nigeria (Keay, 1965; Charter, 1970). Awka is located between latitude 5° and 6°25' and longitude 7^0E and 8^0E with the town stretching for 8km in an East - West direction along the Enugu-Onitsha expressway and about 5km in a North-South orientation. The town is about 12,007 hectares in dimension.

The marshy habitat is located between latitude 6.23782^{0}N and longitude 7.12884^{0}E. Alternatively the bearing of this study site from Enugu 59 km/Onitsha 48 km milestones is 25° NW (or 335° Azimot) with a distance of 120m from the milestone. The plot is over 600 m^2 in area, and subject to seasonal flooding annually with the soil being sandy. The dominant plant in the habitat was *Scirpus mucronatus* L. - a sedge (family Cyperaceae) characteristic of swamps and streamsides (Lowe and Stanfield, 1974). Other common plant species in the site include *Setaria pallidefusca* Stapf and Hubb, *Panicum ribens*. L. and *Cynodon dactylon*, Pegs and *Petotis* sp., which are all grasses. The other herbaceous plants included *Chromolaena odorata* (L.) R.M. King and Robinson; *Imperata cylindrica* (L.), *Mariscus longibracteatus* Cherm., *Axonopus compressus* (Sw.) Beauv., *Mimosa pudica* L., *Waltheria indica* (L.) in addition to the shrub *Mallotus oppositifolius* (Geisel). The trees included *Bauhinia rufescence* Lam. *Combretum molle* R. Br. *Elaeis guineensis* Jacq., *Daniela oliveri* (Benn.), *Pentaclethra macrophylla* (Bentham), *Acacia nilotica* Mill., and *Vitex doniana* Sweet.

The cultivated plot was a cassava farmland. The farm had a previous history of five-year fallow before being cleared, and planted with cassava in the year of investigation. The plot is 800m2 in area. The cultivated plot is located between latitude 6.25054^{0}N and longitude 7.12141°E. At the time of sampling, and apart from the cassava, *Manihot esculenta* Kranz, planted in mounds, this farm had a variety of weeds. The weeds included *Sida acuta* Burm., *Aspilia africana* (Pers.) C.D. Adams, *Euphobia hirta* L. *Chromolaena odorata* (L.) R. M. King and Robinson, *Emilia sonchifolia* (L.) D.C., *Tridax procumbens L, Mariscus alternifolius* Vahl., *Commelina benghalensis L.,* and *Axonopus eompressus* (Sw.) Beauv., and a shrub *Phyllanthus amarus* Schum and Thorn.

The fallow farmland lies between latitude 6.25054^{0}N and longitude 7.12078°E. The plots have been left fallow for twelve years after the previous cultivation, and overgrown with plants and common weeds of fallows. Identified herbaceous plants included *Chromolaena odorata* (L.) R.M. Kings and Robinson, *Aspilia africana* (Pers.) C.D. Adams, *Tridax procumbens* L., *Axonopus compressus* (Sw.) Bc::auv., *Mariscus longibracteatus* Cherm., *Sida acuta* Burm. F., *Panicum maximum* Jacq. And *Vernonia ambigua* Kotchsky and Peyr. Trees found at the plot included *Pentaclethra macrophyla* (Bentham), *Chlorophora excelsa* (Welw.) Benth., *Mangifera indica* L., *Prosopis africana* L., *Combratum ghasalense* Engl. And Diels., *Combretum molle* R. Br., *Eleais guineesis* Jacq., *Newbouldia laevis* (P. Beauv.), *Terminalia ivorensis* A. Chev., *Anthonata macrophylla* (P. Beauv.) The fallow farmland is sandy loam and over 1000m^2 in area. It is separated from the cultivated farmland by a tarred road leading from the first gate of the Permanent Site of the Nnamdi Azikiwe University, Awka.

Sampling: Monthly sampling was carried out using the sweep net. One each sampling occasion, twenty-five sweeps were made across the vegetation with the bag carefully examined for insects after each sweep. The caught insects were deposited temporarily in a bottle which contained cotton and filter paper soaked in chloroform. The species of Odonata were identified using insect of Nigeria - Check List and Bibliography by Medler (1980). The identification of the specimens was verified in the Department of Crop Protection, Institute of Agricultural Research, Ahmadu Bello University Zaria, Nigeria. The voucher specimens were also kept as reference point for further studies.

RESULTS

Table 1 shows the species of Odonata obtained from the three study sites during the twelve-month sampling period from January to December 1998. Three families of Odonata were obtained including Libellulidae, Coenagriidae, and Platycnemididae and represented by seven species. *Orthethrum chrysostigma* Burm. and *Nesciothemis nigeriensis* Gambles were the only libellulids collected from the marshy plot with the two families of Coenagriidae and Platycnemididae represented by *Ceriagrion glabrum* Burm and *Platycnemis subaequistyla* Fraser respectively. The other libellulid species collected from the cultivated (cassava) plot were *Palpopleura lucia* Dry. and *Hemistigma albipuncta* Ramb. while *Palpoleura lucia* and *Hemistigma coronata* were collected from the fallow plot.

The ANOV A test for significant differences in the species of Odonata collected failed to show any significance at F-ratio of 0.458 and probability level (p) of 0.6334 even though relatively higher collection of the species was made at the fallow plot (Table 1). Similarly, in the use of the Fisher's Probability Least Significant Difference, mean differences of 0.146, 0.083 and 0.063 at p levels of 0.304, 0.351 and 0.304 respectively were obtained (Table 2).

Evidently, relatively higher catch was recorded for species of Odonata at the marshy plot than in other plots.

Table 1: Odonata Fauna of Contrasting Ecosystem in Awka Nigeria.

Odonata Family	Genus and Species	Populations of Odonata Sampling Site *			
		A	B	C	Total
Libellulidae	*Orthethrum chrysostigma*	3	-	-	3
	Nesciothemis nigeriensis	1	-	-	1
	Hemistigma coronata	-	-	2	2
	Hemistigma albipuncta	-	1	-	1
Platycnemididae	*Ceriagrion glabrum*	2	-	-	2
	Platycnemis subaequistyla	1	-	-	1
	Sum of Square	0.344			
ANOVA	Mean Square	0.172			
	F-value	0.458 (-)			
	Probability (p) value	0.6339 (-)			

** Sampling Sites: A - marshy plot; B - cultivated plot; C - fallow plot (-) F-value not significant at 5% probability level*

Table 2: Fisher's Least Significance Difference (F-LSD) of Odonates among contrasting ecosystems in Awka, Nigeria.

Study Sites *	Mean (-) Difference	Critical Difference	Probability (p) value
A,B	0.146 (-)	0.304	0.3434
A,C	0.083 (-)	0.351	0.6386
B,C	0.063 (-)	0.304	0.6841

A - marshy plot; B - cultivated plot C - fallow plot (-) Mean differences not significant at 5% probability level.

DISCUSSION

Out of a total number of 13 families of Odonata reported by Medler (1980) in Nigeria, three families represented by seven species were collected in this study. There was a preponderance of libellulid species represented by *Orthethrum chrysostigma, Palpoleura lucia, Nesciothemis nigeriensis, Hemistigma coronata* and *Hemistigma albipuncta with Orthethrum nigeriensis* collected from the marshy plot. The preponderance of these libellulids (Darter dragonflies) might be associated with their habit of repeatedly darting out on a brief flight from a favourite perch and then returning to it again, as noted from earlier observations (Burton et *al.,* 1974), which predispose them to capture. The only two species of Odonata - *Palpoplura lucia* and *Hemistigma albipuncta* obtained from the cultivated farmland have been noted as species whose adults are strong fliers (Boorman, 1981), Ewum, 2004} and many have been collected in the course of their exploratory predatory activities (Ewuim, 2004). The trapping of *Palpopleura lucia* and *Hemistigma coronata* at the fallow plot might also the associated with their predatory activities.

Four species of Odonata - *Orthetrum chrysostigma* and *Nesciothemis nigeriensis* both of which are skimmers (libellulids), *Ceriagrion glabrum* (the coenagriid) and *Platycnemis subaequistyla* (a platycnemid) were also collected from the marshy plot. It has been demonstrated by Ewuim *et al.* (2001) that this taxonomic group (Odonata) contains aquatic and sub-aquatic species, and serving as faunal indicator of this wetland represented by the marshy plot (Ewuim, 2004). The odonates are always noticed around water in West Africa (Boorman, 1981; Ewuim, 2004) and though predatory, their nymphs are aquatic (Ewuim 2004). Evidently from this study the wetland supported a higher population density of Odonata as a result of its aquatic status, but the paucity in the collection of the odonates from the three sampling sites is traceable to the strong flying capabilities of this group making them elusive to collection using sweep nets. In the [mal analysis and to a very large extent, the presence of species of Odonata may be regarded as an indicator of ecosystem quality and as aquatic predators beneficial to man in terms of their involvement in insect pest control.

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HUMAN *LOA LOA* (COBBOLD, 1864) (FILAROIDEA: ONCHOCERCIDAE) MORBIDITY DISTRIBUTION IN NORTHERN ENUGU STATE, NIGERIA: IMPLICATIONS FOR ONCHOCERCIASIS CONTROL

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ABSTRACT

A cross-sectional epidemiological investigation was conducted in Nsukka senatorial zone of Nigeria to evaluate the use of specific clinical signs/symptoms in the assessment of the endemicity, prevalence and morbidity of Loa loa infection in areas meso-endemic for onchocerciasis, and to evaluate the results in respect of the probability of occurrence of adverse reactions, post-treatment with ivermectin in areas presumed to be hypo-, meso-, and hyper endemic for Loa loa infection and morbidity. Standard questionnaire based on the key clinical manifestations of loiasis were administered and the microfilaraemic levels of respondents determined at both community and individual levels. The results showed that the clinical symptoms/signs were known in all the study communities. Altogether 22.0% of respondents (n=1600) positively indicated having experienced either Loa loa infection and/ or Calabar swelling. Based on the questionnaire indices, an intercommunity prevalence of 21.9% (range 17.50 - 27.50%) was established. An overall community median microfilaraemia (mf) prevalence of 19.4% (range 15.0 - 26.3%) was also recorded. A microfilaraemia prevalence >20% was however established in >35% of the study communities indicating the possibility of adverse reaction after ivermectin administration. More males (n=203, 12.7%) than females (n=109, 6.8%) were microfilaraemic. Linear logistic regression indicated that Loa loa infection was significantly associated with age (adjusted odds ratio: 1.12, 95% confidence interval: 1.00-1.14, p<0.001). The intercommunity mean intensity of microfilarial load varied (range 112 ± 25 – 205 ± 30).The best diagnostic performance was obtained for reported history of L. loa with a sensitivity of 100% and a specificity of 94.6%.

Keywords: Epidemiology, Loiasis, Onchocerciasis, Adverse reaction, Microfilaraemia, Implications for Control

INTRODUCTION

The filarial eye worm *Loa loa*, the aetiologic agent of human loiasis is well known for sometimes migrating across the conjunctiva of the eye, and its association with the transient oedema known as fugitive or Calabar swelling. The parasite which is transmitted to humans through the bite of females of the various species of the tabanid flies of genus *Chrysops* is known to occur in the forested areas stretching from west to central Africa including Benin Republic, Nigeria, Cameroon, Equatorial Guinea, Gabon, Central Africa Republic, Congo Democratic Republic, Republic of Congo and Sudan. For long, loiasis has been regarded as a benign form of filariasis and consequently has been little studied (Gordon *et al*., 1950; Kershaw, 1951). The current resurgence of interest in *L. loa* and its associated morbidity has been attributed to a number of factors including firstly, the disease being one of the primary causes (after malaria and respiratory infections) of medical consultation in endemic areas (Pinder, 1988). Secondly, it has been found that the filaricidal drug, ivermectin (Mectizan®), administered as a single dose brings about dramatic decrease in the microfilaraemia load and an improvement in some clinical signs related to the disease. (Carme *et al*., 1991; Hovette *et al*., 1994; Gardon *et al*., 1997b). Thirdly, in some areas where loiasis and onchocerciasis are co-endemic, community-directed treatment of onchocerciasis with ivermectin (CDTI) and hence onchocerciasis control, had virtually come to a standstill because of the risk of severe adverse reactions. The reactions occur in individuals heavily infected with *Loa loa* and include potentially degenerative effects in the brain (Gardon *et al*., 1997a; Twum-Danso, 2003). Systemic infections affecting other organs such as the heart and kidney have also been reported (Carme *et al*., 1991; Chippaux *et al.,* 1996; Gardon *et al.,* 1997a; Boussinesq *et al.,* 1998). The third factor becomes very poignant in view of the on-going ivermectin distribution programme against onchocerciasis in some African countries including many in areas where *L. loa* is co-endemic with *Onchocerca volvulus* infection.

Available data indicate that such areas at risk of ivermectin-induced severe adverse reactions appear to be restricted to the forested parts of Cross River, Abia, Imo, and Delta States of Nigeria. Also in Nigeria, the most loiasis-affected areas are south of latitudes 6º N, that is, the area around the Niger delta and between the delta and the boundary between Nigeria and Cameroon. At Sapelle, Kershaw (1955) recorded 22.2 % loiasis prevalence in the population while Duke and Moore (1961) reported reduced loiasis prevalence of 12.9% in the same area. Udonsi (1986) and Arene and Atu (1986) studied the endemicity of loiasis in the eastern parts of the Niger delta. In the south-eastern part of Nigeria, Emeribe and Chuks-Ejezie (1989) found a prevalence of 1.3% among blood donors in Calabar

municipality. In the south-west of Nigeria, epidemiological studies were conducted by Akinboye and Ogunrinade (1987) and earlier by Ogunba (1977). North of latitude 8º N, Ufomadu *et al.* (1991) conducted loiasis surveys in Plateau State while Akogun (1992) examined villagers in the then Gongola State where a 0.9% prevalence was recorded. Enugu State has been reported to be mesoendemic for onchocerciasis in areas potentially endemic for *L loa* (Nwaorgu *et al.,* 1994; Ivoke 2004). While it is not feasible to determine the intensity of loiasis infection for all individuals living in areas targeted for ivermetin treatment which may also be co-endemic for *L. loa*, Noireau *et al*. (1990) had suggested the usefulness of specific clinical manifestations to assess *L. loa* at the individual and community levels. An epidemiologic method that can be used to rapidly assess communities at risk of developing severe adverse reactions post-ivermectin treatment for onchocerciasis due to co-infection with *L. loa* was substantiated and validated in a WHO/TDR (2001) multi-country study using both parasitological and questionnaire methods.

The main objective of this study was to conduct a cross-sectional survey of the distribution of *L. loa* infection and disease at Nsukka area in order to identify communities where large scale distribution of ivermectin for onchocerciasis control should be programmed to incorporate careful monitoring of individuals to prevent the possible risk of occurrence of *L. loa*-induced post ivermectin treatment adverse reaction. Secondly, the study aimed also at investigating the relationship between the parasitological prevalence and the rapid assessment indices based on the clinical manifestations of *L. loa* morbidity. The implications of the study to the on-going onchocerciasis control program were also discussed.

MATERIALS AND METHODS

The Study Area: The study area consists of twenty (20) randomly selected communities from Nsukka, Udenu, Igbo Eze North, Igbo Eze South, Uzo Uwani, Igbo Etiti and Isi Uzo Local Government Areas (LGAs) all within Nsukka senatorial zone of Enugu State , Nigeria . The area lies between latitudes 6º 40' N to 7º 00' N and longitudes 7º 00' E to 7º 32' E with an estimated total population of 125,245 based on the 1991 Nigeria national population census figures and a WHO annual population growth projection of 2 ½ % . The entire study area is ecologically homogenous with the vegetation consisting of the guinea-savannah mosaic type with its characteristic grass-topped hills and dry valleys. For much of the year, the area experiences high temperatures (25ºC-30ºC) with two distinct seasons; - a rainy season of 7 months from April to October and a shorter dry season of 5 months from November to March. The annual precipitation is between 1200-3000 mm. Rivers are few but they are natural springs which serve as all-season sources of water. Subsistence agriculture and trading are the dominant occupations of the inhabitants with potatoes, yam, rice, maize, cassava, bananas, palm oil, groundnuts, pepper, citrus fruits, as the major crops (Ofomata, 1979).

Study Population and Data Collection: Administrative clearance was obtained in advance of the survey from the various local government administration offices. Health officials at the local government levels were also contacted and briefed on the objectives and expected outcome of the study.

Preliminary visits were made to the study communities to inform the villagers about the rationale of the study and to obtain their collective consent, and for the community leaders to mobilize their respective respondents before the arrival of the study group. Also during the preliminary trips, the community-level questionnaire eliciting information on the knowledge and local names of *L. loa* infection were administered to the village heads.

Based on reports of a pilot assessment of potentially *L. loa* endemic areas, 20 study communities were randomly selected in the zones earmarked for inclusion in ivermectin treatment campaigns for onchocerciasis. Assessment of the *L. Loa* endemicity at community level was done by the use of standardized questionnaire (based on the clinical signs of loiasis). For individual questionnaires, 80 individuals were randomly selected from each of 20 communities thus providing a sample size of 1600. Households were randomly selected and in each selected household all individuals aged ≥ 15 years and who had been resident in the community for at least 5 years, and who consented to participate, were included in the study. Individuals aged ≥ 15 years were selected because the initial reports of severe adverse reaction occurred in persons aged $\underline{>}$ 15 years (Boussinesq *et al.,* 1998).

Interview of eligible individuals in each household was conducted after explaining the objectives of the study and obtaining informed consent. Respondents were interviewed one at a time to ensure confidentiality and to avoid influencing the responses of other members of the household. The questions administered sequentially to each respondent are as follows:

a. Have you ever experienced or noticed worms moving along the white part of your eye?
b. Have you ever had the condition in this picture? (interviewee is guided to recognize a photograph of *L. loa* across the conjunctiva)
c. Have you ever experienced swellings under the skin that change position or disappear?
d. For how long did the swelling last?

Parasitological Examination: After informed consent, each respondent interviewed underwent a parasitological examination to determine the prevalence and intensity of *L. loa* infection. Blood samples (50 ml) were collected from each respondent by the nurses allocated to us by the senior medical officers in-charge of the general hospitals at Nsukka and Ogrute. Blood samples were obtained by the finger-prick method as described previously (Ivoke,

2000). The blood obtained between 1000 h and 1600 h was used to determine the intensity of microfilaraemia by preparing thick blood smear on an area (1.5 cm × 2.5 cm) of a grease-free glass slide. The smear was dried, dehaemoglobinized, using tap water for 5-10 minutes, dried again, fixed with methyl alcohol (1 minute), stained in Giemsa buffered with 8% phosphate (pH 7.2) and allowed to dry. The *L. loa* microfilariae were identified at ×40 magnification using the method of Ash and Orihel (1997). Counting the microfilariae was carried out using the technique of Denham *et al.* (1971)

Data Analysis: All data derived from the questionnaires and parasitological procedures were entered and analysed. Logistic regression analysis was performed to assess the most reliable reported symptoms/signs for predicting individual *L. loa* infection at 95 % confidence interval and to evaluate the association between *L. loa* infection and the best performing reported symptom. The prevalence of loiasis based on the questionnaires and parasitological methods were determined and their relationships evaluated. The intensity of mf was expressed as number of microfilariae per millilitre (mf/ml) of blood on individual level. At the community level the intensity of *L. loa* infection was expressed as mean microfilariae per millilitre (mf/ml) of blood. Based on the prevalence of microfilariae in the study group aged ≥ 15 years the study population was subsequently categorized according to the following age classes: 15 — 19, 20 — 29, 30 — 39, 40 — 49, 50 — 59 and ≥ 60.

The study communities were further classified, as follows into 3 endemic levels, as a proxy for transmission intensity; low endemicity (≤ 25 % mf prevalence), moderate endemicity (25 — 34.9% mf prevalence), and high endemicity (≥ 35 % mf prevalence).

Diagnostic performance of the questionnaires for identifying at-risk communities for adverse reaction post-ivermectin treatment for onchocerciasis was obtained by calculating the sensitivity, specificity, and predictive values including 95% confidence intervals. A threshold of 40 % prevalence of *L. loa* infection and 20 % microfilaraemia were used based on WHO/TDR (2001) recommendations.

RESULTS

A total of 20 communities were surveyed and 1600 respondents consisting of 785 (49.1 %) males and 815 (50.9 %) females were interviewed using *Loa loa* endemicity/morbidity assessment indices. *L. loa* (eye worm) was well known in all the study communities and had similar local terms in the linguistically homogeneous study area. The terminology for *L. loa* as used in all the study localities was descriptive of the appearance of the parasite across the conjunctiva, hence the local term "ari anya" meaning "worm of the eye".

Based on the questionnaire indices, 352 (22.0%) respondents of the study population (n=1600) positively indicated having experienced either history of the eye worm and/or the transient oedema (Calabar swelling) (Table 1). The between-community median age of the interviewees varied considerably from 24 to 36 years while the intra-community age also varied widely from 20-38 years in Abbi community to 15-56 years in Orba (Table 1). The overall between-community prevalence range was 17.5-27.5% while the overall median *L. loa* infection prevalence was 21.9%.

Specifically 248 (15.5%) respondents composed of 149 (9.3%) males and 99 (6.2%) females indicated having experienced the eye worm (confirmed by showing the interviewee a black and white photograph of the parasite across the conjunctiva). Only 104 (6.5%) of total respondents composed of 62(3.9%) males and 42(2.6%) females indicated having experienced Calabar swelling. Between-sex difference was not statistically significant ($p>0.05$). Most of the study communities had no local terms for Calabar swelling and the most commonly cited location for the swelling was, in sequence, upper extremities, lower extremities, the whole body. Calabar swelling appears less specific for the perception of *L. loa* infection and morbidity than the reported history of the eye worm. The age and sex distribution of *L. loa* microfilaraemia among the study population in the different communities is shown in Table 2. An overall microfilaraemia of 19.5% involving 312 microfilaraemia-positive respondents (203 males and 109 females) was established. The community median microfilaraemia prevalence of 19.4% was also recorded. The community microfilaraemia prevalence varied considerably (range 15.0-26.3%). The lowest prevalence was recorded for Nsukka urban and Opi where 12(15.0%) of respondents from each of the localities tested microfilaraemic. Further away from the urban setting, the prevalence of the microfilaraemia appeared to be much higher, ranging from 20.0% at Amaeze, Iheakpu, and Orba to 26.3 % at Owerre Eze-Orba. The results further indicate that 7(35 %) of the total study communities (n=20) fulfilled the parasitological threshold definition of high-risk communities (≥ 20% microfilaraemia prevalence) for adverse reaction post-ivermectin treatment. Other communities (n=13), (65.0 %) recorded microfilaraemia prevalence < 20% implying that community-directed ivermectin distribution could be conducted with considerable safety. Generally 18 (90.0%) of the study communities were of low *L. loa* microfilaria endemicity (≤ 25.0% mf prevalence) while 2 communities (10.0 %) of study localities were of moderate *L. loa* endemicity (25.0 - 34.9 % mf prevalence).

Loa loa microfilaraemia affected, to varying degrees, respondents of all the 6 age categories and appears to increase with age, peaking at the 30-39 years age range. Respondents (n=284) aged 15 - 49 years showed higher *L. loa* microfilaraemia rate (91.0 %) than those aged ≥ 50 years (n=28) that indicated a microfilaraemia rate of 9.0 %. Linear logistic regression indicated that an infection with *L. loa* was significantly associated with age (adjusted odds ratio:

Table 1: Locality, Gender and Age-distribution of Respondents to Questionnaires in *Loa loa* Endemic Communities of Northern Enugu State, Nigeria

Community	No. interviewed			Median age (range)	Assessment Indicators						Community	
					Positive history eye worm			Calabar Swelling			Total	Prevalence
	M	F	Total		M	F	Total	M	F	Total		%
Obukpa	30	50	80	29(16-45)	11	5	16	3	1	4	20	25.00
Iheakpu	42	38	80	33(18-50)	7	4	11	3	5	8	19	23.75
Abbi	35	45	80	24(20-38)	6	7	13	4	0	4	17	21.25
Adani	47	33	80	34(16-50)	7	9	16	3	3	6	22	27.50
Ibeagwa	41	39	80	30(15-45)	4	6	10	4	1	5	15	18.75
EnuguEzike	34	46	80	26(16-35)	10	2	12	1	2	3	15	18.75
Ovoko	46	34	80	31(17-45)	4	5	9	3	4	7	16	20.00
Ede Oballa	36	44	80	28(15-38)	9	6	15	2	2	4	19	23.75
Nsukka urban	38	42	80	24(18-35)	6	4	10	4	1	5	15	18.75
Ehalumona	43	37	80	35(15-55)	8	5	13	1	3	4	17	21.25
Opi	28	52	80	32(15-40)	5	6	11	3	0	3	14	17.50
Uzo Uwani	50	30	80	28(16-37)	11	5	16	3	1	4	20	25.00
Amaeze	41	39	80	30(16-48)	7	3	10	4	4	8	18	22.50
Aku	45	35	80	28(18-47)	6	7	13	2	1	3	16	20.00
Obimo	39	41	80	24(19-33)	8	4	12	4	2	6	18	22.50
Orba	42	38	80	35(15-56)	10	2	12	4	1	5	17	21.25
Nuru	33	47	80	30(17-42)	5	6	11	2	2	4	15	18.75
Obollo Afor	44	36	80	27(15-46)	7	4	11	5	3	8	19	23.75
Owerre Ezeoba	38	42	80	36(16-50)	8	5	13	4	5	9	22	27.50
Echara	33	47	80	35(19-46)	10	4	14	3	1	4	18	22.50
Total	748	815	1600		149 (9.3%)	99 (6.19%)	248 (15.5%)	62 (3.88%)	42 (2.63%)	104 (6.5%)	352	22.000

Key: M= Male; F= Female

Table 2: Age and Sex-Specific distribution of *Loa loa* Microfilaraemia among Inhabitants of Selected Communities in Northern Enugu State, Nigeria

Community	No examined	Age – group (yrs)												No. mf +ve	Prevalence
		15 - 19		20 - 29		30 - 39		40 - 49		50 - 59		≥60			%
		M	F	M	F	M	F	M	F	M	F	M	F		
Obukpa	80	3	1	4	2	2	3	2	1	0	0	0	0	18	22.5
Iheakpu	80	2	1	1	3	4	1	1	2	1	0	0	0	16	20.0
Abbi	80	3	3	2	3	4	0	0	0	0	0	0	0	15	18.8
Adani	80	2	2	4	0	2	2	3	1	2	0	2	0	20	25.0
Ibeagwa	80	2	0	2	2	3	1	2	1	0	0	0	0	13	16.3
EnuguEzike	80	2	2	3	1	2	3	0	0	0	0	0	0	13	16.3
Ovoko	80	3	0	2	2	2	2	1	2	0	0	0	0	14	17.5
Ede Oballa	80	4	0	3	2	3	1	0	0	0	0	0	0	13	16.3
Nsukka Urban	80	2	2	3	1	1	3	0	0	0	0	0	0	12	15.0
Ehalumona	80	2	1	1	2	2	0	2	2	2	0	0	0	14	17.5
Opi	80	1	1	2	1	3	1	2	1	0	0	0	0	12	15.0
Uzo Uwani	80	2	2	3	0	2	1	2	2	3	1	0	0	18	22.5
Amaeze	80	4	1	2	2	3	1	3	0	0	0	0	0	16	20.0
Aku	80	1	2	1	2	3	0	1	2	2	0	0	0	14	17.5

Obimo	80	2	2	2	1	2	2	2	1	1	1	1	0	17	21.3
Orba	80	2	1	0	3	2	1	3	0	3	1	0	0	16	20.0
Nguru	80	3	1	2	0	3	2	2	1	0	0	0	0	14	17.5
Obollo Afor	80	2	2	3	1	1	3	2	2	1	1	0	0	18	22.5
Owerre Ezeoba	80	3	2	4	0	3	2	3	0	4	0	0	0	21	26.3
Echara	80	3	1	2	2	3	1	4	0	2	0	0	0	18	22.5
Total (%)	1600	48 (3.0)	27(1.7)	46 (2.9)	30(1.9)	50 (3.1)	30(1.9)	35 (2.2)	18(1.1)	21(1.3)	4(0.3)	3 (0.2)	0(0.0)	312 (19.5)	19.5

Table 3: Distribution of *Loa loa* Microfilaraemia and Mean Intensities of the Individual and Community Microfilarial Loads among Microfilariae – Positive Respondents

Community	No. Blood smear examined	No. mf +ve (%)	Mean intensities ± SE	Median intensity	Range (mf/ml)
Obukpa	80	18	210 ± 56	148	(22 -306)
Iheakpu	80	16	205 ± 25	95	(40 -292)
Abbi	80	15	120 ± 38	82	(27 – 251)
Adani	80	20	125 ± 27	58	(39 – 273)
Ibagwa	80	13	200 ± 24	167	(32 – 303)
Enugu Ezike	80	13	160 ± 35	112	(49 – 224)
Ovoko	80	14	185 ± 25	145	(36 – 241)
Ede Oballa	80	13	190 ± 30	158	(62 – 210)
Nsukka Urban	80	12	185 ± 27	174	(50 – 198)
Ehalumona	80	14	210 ± 39	196	(26 – 233)
Opi	80	12	118 ± 32	88	(42 – 164)
Uzo Uwani	80	18	215 ± 14	175	(67 – 225)
Amaeze	80	16	112 ± 25	96	(38 – 182)
Aku	80	14	145 ± 36	68	(24 – 225)
Obimo	80	17	170 ± 40	111	(57 – 196)
Orba	80	16	235 ± 30	176	(42 – 244)
Nguru	80	14	210 ± 24	242	(22 – 249)
Obollo Afor	80	18	205 ± 30	182	(86 – 232)
Owerre Ezeoba	80	21	195 ± 27	104	(30 – 210)
Echara	80	18	213 ± 33	160	(22 – 243)
Total	1600	312	52±15	213	122-306

Table 4: Diagnostic Performance of Assessment Indices as Predictors of *Loa loa* Microfilariae – High Risk Communities

Questionnaire assessment indices	Interview threshold of high risk	Diagnostic Performance			
		Sensitivity %	Specificity % (range)	Positive predictive value % (range)	Negative predictive value %
History of eyeworm	>40% *L. loa* prev. > 20%	100	62.8 (47. 8 – 71.6)	55.7 (38.8 – 66.3)	100
History of eyeworm plus photograph of worm across eyeball	>40% *L. loa* prev. >20%	100	94.6 (63.7 – 98.8)	82.2 (53.2 -91.0)	100
History of Calabar swelling	>40% *L. loa* prev. >20%	80	55.0 (38.8 – 71.4)	53.5 (41.1 – 63.7)	100
History of Calabar swelling of 7 days duration	>40% *L. loa* prev. >20%	90.3	75.7 (49.3 – 89.2)	71.0 (56.2 – 83.4)	92.4

Key: *prev. = prevalence; figures in parentheses are 95% confidence intervals*

Table 5: Assessment of some Confounding Factors for Predicting *Loa loa* Infection

Variable	Adjusted Odds ratio	P-value
Reported history of eye worm	1.48 (1.32 – 1.68)	<0.001
Reported history of Calabar swelling	1.34 (1.12 – 1.55)	<0.001
Sensitivity to light	0.95 (0.64 – 1.17)	0.078
Nausea	0.69 (0.53 – 0.98)	0.037

Figures in parentheses are 95% confidence intervals.

1.12, 95% confidence interval: 1.00 - 1.14, p < 0.001). No such association was found for sex (adjusted odds ratio: 0.04, 95 %) confidence interval: 0.03-0.09, p < 0.01) although more males (n = 203, 12.7 %) than females (n = 109, 6.8 %) were microfilaraemic from the population.

Table 3 shows the distribution of *L. loa* microfilaraemic individuals and the mean intensity of the positive microfilarial loads for each of the 20 study communities. The inter-community mean intensity of microfilarial load varied from one community to another (range 112 ± 25 — 235 ± 30). Among the mf – positive respondents at Nsukka and Obollo – Afor, mean mf – intensities of 185 ± 27 and 205 ± 30 were recorded respectively._Although wide variations in the mean mf intensities were recorded generally (range 58 mf/ml – 182 mf/ml), the inter–community mean mf intensity difference was not statistically significant (p > 0.05). The diagnostic performance of the *L. loa* assessment indicators is shown in Table 4. All the assessment indices showed good sensitivity (the probability that a truly *L. loa* microfilaraemic individual will test positive (range 80.0% – 100%), and specificity, (the probability that a truly uninfected individual will test negative (amicrofilaraemic), (range 55.0% – 94.6%), and specificity. Reported history of the transient Calabar swelling was relatively low at 55.0% (range 38.8% - 71.4%). The best diagnostic performance was obtained for the reported history of eye worm confirmed with the photograph of *L. loa* across the conjunctiva which had a sensitivity of 100% and a specificity of 94.6% (range 63.7% – 98.8%). Comparisons between the interviewees" responses and their *L. loa* infection levels further revealed that the reported history of Calabar swelling of 7 days duration was a better predictor of *L. loa* infection (sensitivity, 90.3%; specificity, 75.7%) than the reported history of Calabar swelling alone.

The results indicate that the assessment indices based on simple questionnaires could be used to predict *L. loa* parasitological prevalence, and hence the risk of severe adverse reactions associated with ivermectin treatment in onchocerciasis control programme. The result further indicates that individuals infected with *L. loa* more often reported *L. loa* migration across the conjunctiva.

The result of the logistic analysis, carried out at the individual level to assess potential predictors of the association between *L. loa* infection and the reported symptoms is shown in Table 5. Reported history of eye worm and transient oedema of 7 days duration were identified as the symptoms/signs with the strongest association with *L. loa* infection at the individual level with adjusted odds ratios respectively as 1.48 (95% confidence interval: 1.32 – 1.68, p < 0.001) and 1.34 (95% confidence interval: 1.12 – 1.55, p < 0.001). No significant odds ratios were found between *L. loa* infection and sensitivity to light or nausea.

DISCUSSION

Although it has been established by earlier surveys that the most *Loa loa* endemic communities in Nigeria are located south of latitude 6ºN (Udonsi,1986; Arene and Atu, 1986), the present study further indicated that the disease was well known in the ecologically homogenous communities of the guinea-savannah belt north of latitude 6ºN. The result therefore confirmed earlier reports (Ufomadu *et al.,* 1991; Akogun, 1992).

The results obtained based on the questionnaire determinants of *L. loa* infection and morbidity indicate that while most of the study communities had no local terminologies for the transient *L. loa*-induced Calabar swelling, a substantial number 104 (6.5%) of the respondents (n= 352) positively indicated having experienced the oedema while 248 (15.5%) had actually reportedly experienced the infection The result further showed not only that loiasis is endemic in the study communities but also established a total prevalence of 22.0% (Table 1). The prevalence obtained was considerably lower than the WHO-recommended ≥40% threshold for identifying communities at high risk of *L. loa*-induced adverse reactions post-ivermectin treatment, indicating that, based on the questionnaire indices, ivermectin distribution for onchocerciasis control programme may be safely conducted in the study communities. The result indicates too that questionnaire predictors could be employed as useful tools in the rapid assessment of *L. loa* infection.

Loa loa microfilaraemia affected, to varying degrees, respondents of the different ages within the scope of study and appeared to be age-dependent (Table 2). Thus, respondents aged 15 – 49 years showed higher *L. loa* microfilaraemia rate (91.0%) than individuals aged ≥50 years. The result was further validated by logistic regression indicating the infection with *L. loa* was significantly associated with age (adjusted odds ratio; 1.12, 95% confidence interval: 1.00 – 1.14, p < 0.001). The age-dependent feature of the infection may be attributed to the degree of exposure to the bites of the haematophagous female tabanid vectors by the active segment of the population in endemic communities with the risk of exposure decreasing with age as more protective clothing are worn by the less active-aged individuals.

The overall microfilaraemia prevalence of 19.5% established differs from the result obtained in the selected villages of Cross River State where prevalence ranging from 0-1.7% (median prevalence 1.5%) were obtained (WHO/TDR, 2001).

The mean intensity of the community microfilaria loads showed much variation (range 112 ± 25—235 ± 30) with the urban and semi- urban centres recording low mean microfilarial intensities among the mf-positive respondents (Table 3).

Although wide variations of the mean and median community microfilaria intensities were prevalent in the rural community setting (range 58 mf/ml—182 mf/ml) of blood, the individual microfilaria load was very low (5.24±15 mf/ml) and substantially less then the 8000 mf/ml threshold above which severe adverse reactions may be anticipated. The result corroborates that obtained using the questionnaire indicators and implies that severe adverse reactions may not occur in individuals in any of the study communities.

The diagnostic performance of the questionnaire indices (Table 4) indicates that all the factors showed good sensitivity and specificity, while the negative predictive values were generally high. These high negative predictive values could be attributed to the absence of other confounding factors in the *L. loa* microenvironment. The overall performance of the questionnaire indices appears to provide a positive indication that the simple questionnaires could be used as determinants of *L. loa* prevalence in endemic communities. At the individual level, symptoms and/or signs with the strongest association with loiasis morbidity were the reported history of the eye worm followed by the history of the transient Calabar swelling. The result is in conformity with those of a multi-country study in which *L. loa* infection and morbidity were associated with oedema lasting for 7 days (WHO/TDR, 2001).

Implications for Onchocerciasis Control: Good quality diagnostic tests that are fit and provide accurate results are of paramount importance in reducing the burden of infectious diseases. The lack of access to good quality diagnostic tests for infectious diseases contributes to the enormous burden of ill health globally. Recent technological developments have led to the proliferation of new rapid diagnostic tests that hold promise for the improved management and control of infectious diseases. A confident diagnosis can sometimes be made on the basis of clinical signs or symptoms. In settings where access to diagnostic laboratory services is limited, the use of questionnaire tools has been in practice.

In loiasis many individuals do not present with microfilariae in their peripheral blood yet may prove to be infected because of previous history of subconjuctiva worm passage.

The use of questionnaire to screen communities at high risks of *L.loa* microfilaraemia and morbidity and subsequently to identify areas where serious adverse reactions may occur post-ivermectin treatment for onchocerciasis control has been highlighted in this study. The use of standard questionnaires have been successfully employed in parts of Africa to screen for infections due to *Schistosoma haematobium* with diagnosis at the community level as the main objective (Langeler *et al*., 1991; Ekwunife and Okafor, 2005). The use of questionnaire is therefore a promising alternative to the current invasive, and time-consuming parasitological methods. The methodology appears faster, less expensive and can be easily adapted for use in rural settings where efficient and adequate conventional parasitological diagnosis may not be readily available. The onchocerciasis control programme will get a boost in coverage.

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EFFECT OF REPLACING GROUNDNUT CAKE WITH UREA FERMENTED BREWER'S DRIED GRAINS IN BROILER CHICKS DIETS

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ABSTRACT

The effect of replacing groundnut cake with urea fermented brewer's dried grains at 0, 25, 50, 75 and 100 % graded levels in broiler chick starter diets was investigated. Five dietary treatments were formulated to be isonitrogenous and isocaloric to provide 23 % crude protein and 2900 kcal/kg metabolizable energy. One hundred and ninety – five day-old broiler chicks (Anak breed) were randomly allotted to five treatments replicated thrice with 13 chicks per replicate, fed and watered ad libitum in battery cages for 35 days. Means of body weight, weight gain, feed intake and feed: weight gain ratio of broiler chicks fed the control diet, 25 and 50 % urea fermented brewer's dried grains diets were significantly (P < 0.05) better than those fed 75 and 100 % inclusion levels. Nitrogen and lipid retention, crude fibre and dry matter digestibilities of broiler chicks followed the same trend with the weight performance. Mortality was zero. Economically, it was more profitable to use urea fermented brewer's dried grains in replacing groundnut cake in broiler chicks diets.

Keywords: Broiler chicks, Groundnut cake, Urea, Fermented, Brewer's dried grains

INTRODUCTION

The broiler chicken production is among one of the fastest means of producing animal protein because of their short generation interval (Babatunde, 1980). However, the cost of production of broiler meat has remained high due to high cost of feed. Groundnut cake (GNC) has been used as a protein supplement in broiler diets but its price has continued to increase in our markets. This has engineered the need for an alternative feed ingredient for groundnut cake as a protein supplement. Such an ingredient of choice in the diet of monogastrics must have the ability to supply required protein, amino acid profile, provides balanced energy: protein ratio and in addition possess the merit of easy storage, availability and low cost. Brewer's dried grain (BDG) is a possible alternative to groundnut cake (GNC) because of its nutritional qualities that are comparable to GNC. BDG is cheap and readily available and contributes to the protein, amino acids and energy content of formulated feeds. It also furnishes trace minerals, B-vitamins, Vitamin E, linolenic and significant percentage of essential fatty acids (McDonald *et al.,* 1995). Although its nutritional qualities have been evaluated in the diets of broilers and growing chickens with some success (Oluyemi and Harms, 1978; Barber and Lonsdale, 1980; Aduku, 1993; Uchegbu and Udedibie, 1998) it's maximum utilization as a plant protein source have been limited by its high fibre content. The need to further process BDG in order to reduce its fibre content by use of urea is imperative. Alkali treatment of various fibrous materials have been found to improve their nutritional qualities (McDonald *et al.*, 1995; O'Donovan *et al.*, 1997; Chenost and Kayouli, 1997; Faniyi *et al.*, 1997; Liu *et al.,* 1998; Lewis *et al.,* 1999; Faniyi and Ologhobo,1999; khuc *et al.,* 2001;Vipond *et al.,* 2001). Therefore, this study was conducted to determine the effect of replacing GNC with urea fermented BDG in broiler chick diets.

MATERIALS AND METHODS

Urea fermented BDG (as the test ingredient) was used to replace groundnut cake (GNC) at 0, 25, 50, 75 and 100 % levels in broiler chick starter diets on protein equivalent basis. The BDG used in this experiment was fermented for 7 days in 2 % urea concentration. To obtain 2 % urea solution, 400 g of urea (46 % N, fertilizer grade) was dissolved in 20 litres of clean water to produce 2 % urea solution containing 20 g urea per litre of water (Adeleye, 1988). Table 1 shows the chemical composition of groundnut cake and brewer's dried grains. The proximate compositions of the urea fermented BDG and the untreated BDG are presented in Table 2. Five dietary treatments were formulated to be isonitrogenous and isocaloric to supply 23 % crude protein and 2900 kcal/kg metabolizable energy. Diets were adequately fortified with vitamins and minerals. The compositions of the broiler chick starter diets are presented in Table 3.

Experimental Birds: One hundred and ninety-five (195) day-old broiler chicks (Anak breed) were randomly allotted to five equal groups and brooded in battery cages after a four day initial stabilization period on deep litter system. Each treatment was replicated thrice with 13 chicks per replicate giving 39 chicks per treatment. Food and water were provided *ad libitum* while necessary prophylaxis and

Table 1: Chemical Composition of Groundnut Cake and Brewer's Dried Grain

Chemical Component	GNC	BDG (Untreated)
Crude protein	45.00	27.90
Ether extract	9.16	7.40
Crude fibre	3.81	11.70
Ash	5.51	4.80
Calcium	0.20	0.30
Phosphorus	0.60	0.88
TDN	76.00	78.00
ME kcal/kg (Swine)	3185.00	2240.00
ME kcal/kg (Poultry)	2530.00	2513.00
Lysine	1.73	0.90
Methionine	0.44	0.60
Cystein	0.72	0.40
Arginine	5.00	1.30
Tryptophan	0.49	0.40

Source: *Aduku, (1993)*

Table 2: Proximate Analysis of Test Ingredient (Urea-Treated and Fermented BDG)

Parameters %	Treated BDG	Untreated BDG
Dry matter	88.76	93.34
Crude Protein	38.52	24.21
Crude fibre	4.49	11.20
Ether extract	4.87	3.69
Ash	5.99	8.04
Nitrogen free Extract	34.89	46.20
Organic Matter	82.77	85.30
Gross Energy kcal/g (calculated)	5.17	5.14

(Urea concentration used was 2%, 20g urea per litre of water)

vaccinations for broiler were administered. Data on weight performance, feed intake, feed: gain ratio and mortality were recorded on replicate basis weekly to 35 days of age. At the end of the 4th week, 9 broiler birds per treatment, 3 birds per replicate, were randomly selected from the five treatments for metabolic study. After an adjustment period of three days, dropping trays covered with aluminium foil paper were used for digestibility study. Feed intake over the three days of metabolic trials was also recorded. The faecal droppings from each replicate were oven dried at low temperature ranging from 60 – 80^{o} C to minimize loss of nitrogen. The total collection were pooled, weighed and ground, and representative samples together with experimental diets were taken for chemical analysis of their proximate composition (AOAC, 1990). Economic analysis of broiler chicks' production was based on the cost of the diets compounded from the prevailing market price of the ingredients at the time of purchase. This information was used to compute the cost of feed consumed/kilogramme weight gain for each diet, the cost differential and relative cost-benefit values of the diets in relation to the control diet. Data collected from the field and laboratory was subjected to analysis of variance using SAS (2000) package. Duncan's Multiple Range Test was used to assess significance of differences between treatment means (Duncan, 1955).

RESULTS

The results of the performance of broiler chicks (0 - 35d) are presented in Table 4. Mean body weight, weight gain, feed intake and feed: gain ratio of broiler chicks fed the control diet and up to 50 % replacement levels of urea-treated and fermented BDG diets were significantly ($P < 0.05$) better than those fed 75 and 100 % replacement level of urea-treated and fermented BDG diets. The results of the metabolism trial of broiler birds at 35 days of age fed the experimental starter diets are presented in Table 5. The nitrogen and lipid retention, crude fibre and dry matter digestibilities for broiler birds at 35 days of age showed a significant ($P < 0.05$) decrease as the levels of urea-treated and fermented BDG increased in the diets. The nitrogen retention rate of broiler chicks fed the control diet was similar ($P > 0.05$) to broilers fed 25 and 50 % level of urea-treated BDG diets but was significantly ($P < 0.05$) higher than those fed 75 and 100 % levels of urea-treated BDG diets. Lipid retention and dry matter digestibility of broilers fed the control diet at 35 days were significantly ($P < 0.05$) different from those fed diets with 50, 75 and 100 % inclusion levels while that of 25 % urea-treated BDG inclusion level was similar ($P < 0.05$) to the control diet. Broiler chicks fed the control diet were significantly ($P < 0.05$) better than all other treatment groups in crude fibre digestibility. The results of the cost-benefit analysis of the production of broiler chicks fed the experimental diets are presented in Table 6. There was significant ($P < 0.05$) reduction in the amount of total feed consumed per bird with increased levels of urea-treated and fermented BDG in the diets of broiler chicks. Cost of total feed consumed / bird was also significantly ($P < 0.05$) reduced with increased levels of BDG in all treatment groups. The cost of producing one kilogramme of live weight of each broiler during this stage was significantly ($P < 0.05$) reduced as the level of urea-treated and fermented BDG increased in the diets, except for the 100 % inclusion level that was most ($P < 0.05$) expensive. The cost differential and relative cost-benefit / kilogramme gain generally ($P < 0.05$) increased with increasing levels of urea-treated BDG in the diets in all treatments, except for the 100 % inclusion diet.

DISCUSSION

The average body weight, daily weight gain, feed intake and feed: gain ratio in Table 3 of broilers at 35 days of age showed that diets with 0, 25 and 50 % inclusions were similar, indicating that starter chicks can tolerate inclusions of urea-treated and fermented BDG up to 50 %, which is about 16.70 % of the diets. Broiler chicks fed BDG at 0, 25 and 50 % inclusion levels had significantly higher feed intake than those on 75 and 100 % inclusion levels, which means that 0, 25 and 50 % inclusion levels were equally acceptable to broiler chicks as they ate approximately the same quantity. However, the decrease in feed intake at the 75 and 100 % urea-treated BDG inclusion levels may be attributed to

Table 3: Composition of Experimental Broiler Starter Diets

Ingredients	Dietary Treatments				
	D_1(control)	D_2	D_3	D_4	D_5
Maize (Yellow)	56.20	55.00	53.75	52.37	50.90
Groundnut cake	28.50	21.38	14.25	7.13	-
Urea Treated BDG	-	8.32	16.70	25.00	33.50
Fish meal	2.50	2.50	2.50	2.50	2.50
Blood meal	5.00	5.00	5.00	5.00	5.00
Oyster shell	1.50	1.50	1.50	1.50	1.50
Bone meal	3.50	3.50	3.50	3.50	3.50
Palm oil	1.50	1.50	1.50	1.70	1.80
Premix (starter)*	0.50	0.50	0.50	0.50	0.50
Methionine	0.30	0.30	0.30	0.30	0.30
Salt	0.50	0.50	0.50	0.50	0.50
Calculated:					
Crude protein (%)	23.38	23.28	23.18	23.05	22.99
Metabolizable Energy (ME) kcal/kg	2986.89	2974.66	2961.96	2959.41	2954.36
Determined:					
Dry matter	90.12	89.88	91.08	90.55	91.55
Crude protein	23.13	23.44	23.48	23.62	23.85
Crude fibre	4.24	4.47	5.40	5.69	6.30
Ether extract	2.45	2.85	3.02	2.93	3.17
Ash	3.26	7.07	8.16	8.33	8.62
Nitrogen free Extract	56.86	52.03	51.02	49.93	49.61

Vitamin-mineral premix provided the following vitamins and minerals per kg of diet: A, 15,000 I.U; D3, 3000 I.U; E,30 I.U; K, 2.5mg, B_1, 2.0mg; B_2, 6.0mg; B_6 4.0mg; Niacin, 40mg; B_{12}, 0.02mg; Pantothenic, 10mg; Folic, 1.0mg; Biotin, 0.08mg; choline Cl 500mg; Antioxidant, 125mg; Mn, 6mg; Zn, 60mg; Fe, 24mg; Cu, 6mg; I, 1.4mg; Se 0.24mg; co, 0.4mg. Product of Agricultural Technologies Nigeria Ltd. Marketed by S&D Farms Abeokuta.

Table 4: Performance Characteristics of Broilers Fed Experimental Starter Diets

Replacement levels (%)	00UTBDG 100GNC	25UTBDG 75GNC	50UTBDG 50GNC	75UTBDG 25GNC	100UTBDG 00GNC
Initial weight	137.18	142.31	138.97	138.46	137.18
Average Body weight (g) 35th day	1175.25±14.79^a	1158.97±8.41^a	1141.54±10.25^a	992.67±1.34^b	820.52±8.25^c
Weight gain/bird/day (g) 35th day	46.15±0.84^a	42.13±0.66^a	41.56±0.06^a	37.01±2.99^b	29.82±0.70^c
Feed Intake g/bird/day 35th day	84.35±0.83^a	84.57±0.00^a	85.37±0.00^a	74.58±0.37^b	75.82±0.00^b
Feed: Gain ratio 0-35 days	1.84±0.07^a	1.94±0.07^{ab}	2.05±0.08^{ab}	2.14±0.09^b	2.66±0.14^c
Mortality (birds/treatment) 0-35 days	Nil	Nil	Nil	Nil	Nil

a,b,c Means with different superscripts letters in the same row are significantly different (P<0.05); UTBDG: Urea fermented brewer's dried grains

bulkiness and probably a problem of acceptability of the feed associated with high BDG levels as compared to GNC. The observed body weights and daily weight gains are related to the feed intake pattern of broiler chicks, which means the inclusion levels of 25 and 50 % urea-treated and fermented BDG were able to furnish adequate nutrients for tissue synthesis to record an enhanced growth rate comparable to the control diet that do not have any BDG. The 50 % replacement level which has 16.70 % of the diet as BDG exceeded the 10 % level of dietary inclusion achieved by Ademosun (1973) and Lopez and Carmona (1981) with untreated BDG in chicks diets. Thus the higher inclusion level achieved in this experiment is attributable to the urea fermentation of BDG, which resulted in fibre breakdown and reduction in fibre content, and the release of locked up nutrients which encouraged a good performance of broiler chicks even when fed a diet with higher inclusion level of 16.70 %. The performance may also be as a result of a better complementary role of nutrients (1:1 and 1:3 ratios) at this level of urea fermented BDG: groundnut cake mix. This might have encouraged better nutrient release and availability for enhanced tissue synthesis, leading to improved growth rate, a kind of synergistic effect in chicks. The lower weight gain obtained by broiler chicks fed the 75 and 100 % levels of urea fermented BDG diets at 35 days may have resulted from nutrient intake restriction precipitated by lower feed intake or nutrient dilution effect of crude fibre and bulkiness of feeds. This result is supported by previous reports on the implication of restricted feed intake (Oluyemi and Harms 1978; Leeson and

Table 5: Nutrient Digestibility and Retention of Broiler Birds at 35 Days of Age Fed Experimental Starter Diets

Parameters	00UTBDG 100GNC	25UTBDG 75GNC	50UTBDG 50GNC	75UTBDG 25GNC	100UTBDG 00GNC
Nitrogen retention (%) at 35th day	81.50±0.05[a]	80.50±0.38[ab]	79.78±2.59[ab]	74.87±1.06[b]	63.74±0.61[c]
Ether extract/Fat Retention (%) at 35th day	95.39±0.16[a]	94.64±0.30[ab]	94.10±0.46[b]	90.21±0.33[d]	92.97±0.06[c]
Crude fibre digestibility (%) at 35th day	20.05±0.72[a]	17.79±0.42[b]	17.79±0.09[b]	13.18±0.59[c]	13.27±0.62[c]
Dry matter digestibility (%) at 35th day	81.73±0.09[a]	80.6±0.34[ab]	77.74±2.47[b]	60.19±1.02[d]	65.09±0.57[c]

a,b,c,d Means with different superscript in the same row are significantly different (P<0.05) UTBDG: Urea fermented brewer's dried grains

Table 6: Economic Analysis of Broiler Birds Fed Experimental Diets from 0-35 days of Age

Replacement level (%)	00UTBDG 100GNC	25UTBDG 75GNC	50UTBDG 50GNC	75UTBDG 25GNC	100UTBDG 00GNC
Total feed consumed (kg/bird) 0-35 days	1.94±0.01[a]	1.91±0.01[b]	1.90±0.01[b]	1.74±0.00[c]	1.74±0.00[c]
Cost of Total feed consumed/bird(₦) 0-35 days	82.61±0.38[a]	77.62±0.23[b]	73.66±0.22[c]	64.66±0.12[d]	61.27±0.12[e]
Cost per Kg weight (₦) 0-35 days	113.43±1.30[b]	112.07±1.00[bc]	113.85±0.70[b]	109.02±1.02[c]	122.42±1.34[a]
Cost Differential per Kg gain (₦) 0-35 days	-	1.34±0.84[b]	-0.42±0.84[b]	4.41±2.07[a]	-8.99±1.63[c]
Relative Cost Benefit/Kg gain (%) 0-35 days	100.00[b]	101.20±0.78[ab]	99.63±0.81[b]	104.08±1.95[a]	92.68±1.27[c]

a,b,c,d,e Means with different superscripts in the same row are significantly different (P<0.05). Cost per Kg feed (₦): Starter-Diet 1 ₦42.51; Diet 2, ₦40.64; Diet 3, ₦38.77; Diet 4, ₦37.09; Diet 5, ₦35.28.

Summers, 1980; Fattori *et al.,* 1991; Ubosi, 1998; Mench, 2002; Erakpotobor and Umeh, 2005) on growth rate and body weight performance. The feed: gain ratio of broiler chicks followed the same pattern with the feed intake and daily weight performance and showed that the replacement of up to 50 % GNC with urea fermented BDG had no detrimental effects on performance of broiler chicks up to 35 days of age. The incorporation of urea fermented BDG into diets of broiler chicks significantly influenced the retention of nutrients since it has higher fibre content than GNC. Nitrogen retention (NR) for broiler chicks at 35 days of age fed the dietary treatments showed significantly decreasing nitrogen retention as the levels of urea fermented BDG increases in the diets. The downward trend in NR observed in this study is associated with the increase fibre loading of the diets with increase BDG inclusion levels. Fibre has been reported to absorb amino acids and peptides as well as preventing their absorption from the gastro intestinal tract (GIT). The extent of decrease in NR due to fibre is further linked to the degree of lignification of the fibre. Therefore, the downward trend observed in this study has been confirmed in previous reports (Mitaru and Blair, 1985; Sauer *et al.,* 1991; Nworgu *et al.,* 2000). The NR of broilers at 35 days followed the same trend with the daily weight gain performance of the period which implies that the weight gain was a true reflection of efficiency of nutrient retention and utilization. The similarity between 0, 25 and 50 % diets implies that broiler birds at 35 days of age will effectively utilize urea fermented BDG in place of GNC up to the 50 % (16.70 % of the diet) replacement levels without loss in efficiency. The improved level of replacement of GNC or incorporation of urea fermented BDG in broiler starter diets at 16.70 % of the diet instead of the 10 % recommended by Ademosun (1973), means that urea fermentation of BDG did improve its nutritive value, and therefore, higher levels of inclusion into broiler chicks diet. The lipid retention at 35 days of age followed the same trend as that of nitrogen and this indicate that broiler chicks lipid retention and utilization is not adversely affected by inclusion of up to 50 % urea fermented BDG in place of GNC in broiler chick diets. The poor lipid retention at 75 and 100 % inclusion levels is not unconnected with the increase in crude fibre content as the urea fermented BDG inclusion increases in the diets. Cherry and Jones (1982) and Janssen and Carre (1985) had earlier reported that high fibre level in diets causes increased faecal excretion of lipids in birds and encourages increased rate of food passage through the digestive tract and consequently low digestibility and retention. The crude fibre digestibility of broilers at 35 days of age was generally low and is an indication that broiler chicks at this age are ill-equipped to handle fibrous feeds and, therefore, cannot utilize much of the available crude fibre. Dry matter digestibility at 35 days of age was observed to decrease with increasing level of urea-treated BDG in the diets, indicating that increased use of urea-treated BDG will increase crude fibre content and, therefore, decrease in the ability of broilers to retain nutrients for utilization with its attendant decline in feed efficiency. Several authors have reported inverse relationship between dietary fibre digestibility coefficients and, or bio availability of nutrients (Mitaru

and Blair, 1985; Longe, 1985; Sauer *et al*., 1991; Nworgu *et al.,* 2000). The zero percent morality recorded in the experiment is an indication that the product is not toxic to the chicks when incorporated into their diets. Thus, the use of urea for treatment of BDG at the level used is considered safe for the chicks.

There was gain in financial margin in production cost with the inclusion of urea fermented BDG as part replacement for GNC in broiler chicks diets, except at the 100 % inclusion level which was least. The computed cost differential per kilogramme gain for diet with 75 % inclusion was the highest. It was found to be more profitable to produce broilers at the starter phase with 75 % urea-treated BDG than GNC, even when lower weight gain was observed as urea-treated BDG levels increased in the diets. This is because the cost of producing urea-treated BDG was much lower than the cost of purchasing GNC. Furthermore, the use of the urea fermented BDG in this experiment did not adversely affect the performance of the broiler chicks. It is thus expected that cost of production would be reduced. The highest significant savings (₦4.41)/ kilogramme weight gain of cost differential was obtained from dietary treatment with 75 % urea fermented BDG inclusion during the experimental period.

Urea fermented BDG can replace up to 50 % GNC (16.70 % of the diet) as a plant protein source in broiler starter diets. The zero percent mortality of broiler chicks fed the urea fermented BDG based diets is a proof that the product is safe as a feed ingredient. Based on the cost of production / kilogramme weight gain, the used of urea fermented BDG is more profitable than GNC in broiler starter diets, with inclusion not exceeding the 75 % level.

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MUSHROOM FLORA AND ASSOCIATED INSECT FAUNA IN NSUKKA URBAN, ENUGU STATE, NIGERIA

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ABSTRACT

The mushroom flora and associated insect pests of mushrooms in Nsukka urban was studied. The abundance of mushrooms from sampled communities is indicated with the family, Agaricaceae predominating "out of home" environment yielded more mushrooms (4.62) than the homestead environment (3.26). Insect pests associated with different mushrooms were Megasiela aganic Musca domestica Pygmaephorous stercola Paychybolus ligulatus and Drosophilla melanogester among others.

Keywords: Mushroom, Pest, environment

INTRODUCTION

Total dependence on wild mushrooms entirely, for food should be regarded as a means of harnessing the resources associated with mushroom as a crop. In recent times specific mushrooms are cultivated for their food Mushrooms are valuable health foods low in calories, high in vegetable proteins chitin iron zinc fibre essential amino acids, vitamins, and minerals, such as copper that help the body to produce red blood cells (Esminger and Esminger 1986). Most mushrooms in Nigeria which are edible are *Volvariella esculenta, Psathyerella atrombanata, Pleurotus sp, Lentinus subrudus, Schiyzophyllum commune* and others. They are wild and seasonal (Adejoye *et al.,* 2007). The invaluable use of mushrooms as part of the diet and in medicine has been highlighted by Kidd (2000). Bringing wild mushrooms to our tables at regular times means that they have to be cultivated. This limits users to chances of collecting mushrooms from the wild with the attendant chances of collecting poisonous ones. Some individuals because of this risk shy away from eating mushrooms no matter what is known about such mushrooms (Zoberi, 1978).

Based on the invaluable importance of mushrooms, their abundance in any environment should be well known as a prelude to encouraging users in any such environment. A mushroom collector normally looks for mushroom in habitats that are very likely to favour its growth. Such habitats should include wood, soil, manure, grass and wood land areas (Rogers, 1991). A mushroom collector normally looks for mushrooms when the temperature is low and the relative humidity is as high as between 70 – 90 % (Kadiri, 2006).

Fairly wet environment with decomposing organic matter of leaves or wood favours its growth and fructification. Conversely mushroom pests also abound in such environment. The issues of mushroom diseases caused by bacteria, fungi, viruses are well known. Pests such as insects, mites and nematodes are associated with mushrooms. Gbolagade (2006) while highlighting some pests of Nigerian mushrooms listed such insects as *Megasiela agaric, Megasiela boresi, Scaria fenestralis,* mites such as *Pygmaeophorus stercola, Tryophus sp* and the nematode *Ditylenchus*. These are pests even when they are not known to cause any physical damage to the mushrooms. Through their association, it is possible that they introduce prepagules of mushroom pathogens. Nsukka is a derived savanna (Agwu, 1997). It has all the potentials favouring the growth of both poisonous and edible mushrooms as well as potential for thriving of animal pests of mushrooms.

With the current emphasis on mushroom domestication, knowledge of which mushrooms, when and where to get it is well as their associated pests is vital. It is against the background that this work is based.

MATERIALS AND METHODS

Study Area: Nsukka is a sub-urban town located on a Plateau at an elevation of 419.4m above sea level (Agwu at el 2004). Nsukka is bordered to the south by plains and highlands of Udi area and to the north by Nkalagu and Okutu plains (Agwu, 1997).

Nsukka climate is tropical with mean monthly temperatures fluctuating between 24 ^{0}C and 29 ^{0}C with a range of about 10^{0}C during the year (Inyang, 2000). During the rainy season at Nsukka the tropical maritime air mass dominates and the humidity is usually 65-85% (Agwu and Osibe, 1992). The high humidity condition favours mycelia formation and fructification of mushrooms (Rogers, 1991).

Mushrooms Collection: The sample communities in Nsukka were Isi Uja, Alor Uno, UNN compound and Obukpa. In each of these communities five spots were designated as "homestead environment" while

Table 1: List of Mushrooms by Families in Nsukka Urban

Families	Mushrooms	Number	% Composition
Agaricaceae	***Inocybe fastigiata*** [P] ***(Schaeff. ex Fr)***	15	7.6
	Pholiota malicola [P] ***(Kaufman ex) Smith***	10	4.7
	Lentinus volpinus [ENK] ***(Fr.) fr***	7	3.3
	Pholiota terrestris [P] ***(Overholts)***	8	3.8
	Agaricus campestris [E] ***(Fr)***	20	10
	Clitocype robusta [P] ***(Pk).***	3	1.4
	Leocoprinus birnbaumu [P] ***(Corde)***	10	4.7
	Clitocybe dilatata [P] ***(Pers)*** **Karsten**	12	5.7
	Pleurotus tuber regium [E] **Fries singer**	15	7.7
	Pleurotus oestreatus **Jacq** [P] ***. Ex. Fr.*** **Kummer**	10	4.7
Polyporaceae	***Ganoderma lucidiuni*** [P] ***(*****Curt. Ex. Fr*** ***)***	5	2.4
	Polyporous melanopus [P] **Fr**	3	1.4
	Tramatos versicolor [P] ***(*****L. ex Fr*** ***)***	5	2.4
Lycoperdaceae	***Lycoperdon germinatium*** [E] ***(*****Batssch*** ***)***	10	4.7
	Clavatia cythiforms [E] ***(Bosc)*** **Morgan**	1	0.5
Boletaceae	***Boletus eludes*** [E] **Bull ex Fr.**	1	0.5
Clavariaceae	***Clavaria vermicluris*** [P] **Michel. Fr.**	6	2.0
Coprinaceae	***Psythrella hydrophilla*** [E] **(Fr) maire**	15	7.7
	Coprinus commatus [E] ***(*****Fr) S. F. Gray**	12	5.7
Lactariaceae	***Lactarius indigo*** [E] **(Sch w.) Fr.**	1	0.5
tricholomalaceae	***Tricholoma aurantium*** [P] ***(Fr)*** **Richen.**	2	1.0
	Marasimus siccus [ENK] **(Sch w) Fr**	4	1.9
Amanitaceae	***Amanita verna*** [P] **(Schaeff) Per**	10	4.7
Xylariaceae	***Xylaria polymopha*** [P] **(Pers. Ex meraf) Grev.**	3	1.4
Laccariaceae	***Laccaria laccatus*** [E] **(Scop. Ex Fr) cke**	6	2.9
Cantharellaceae	***Cantharellus infundbuliformis*** [E] **Fr.**	3	1.4
Helvellaceae	***Verba bohemica*** [ENK] ***(*****Kromh) Schroet**	2	1.0
Russlaceae	***Russula emetica*** [E] ***(*****Scheff) S. F. Gray. Fr**	1	0.5
Hygroghoraceae	***Hygrophorous conicus*** [ENK] ***(*****Fr).**	7	

E-Edible, Enk- Edibility not known, P-Poisonous

Table 2: Mean Number of Edible Mushrooms from Sampled Communities in Nsukka Urban

Communities	Environment	
	Homestead	Out of Home
Isi-Uja		
Pholita terrestris	1.8	2.8
Agaricus campestris	2.6	3.0
Pleurotus tuber-regium	1.9	0.0
Lactarius indigo	3.0	1.2
Psytherella hydrophila	3.0	4.6
Pleurotus oestreatus	5.0	6.3
Alor Uno		
Lycoerdon germinatum	6.3	9.2
Pleurotus oesteatus	9.3	5.2
Cantherella infudiformis	3.8	10.1
Lactarius lacaria	2.6	41
UNN Compound		
Pleurotus tuber regium	3.6	3.7
Pholiota terrestris	00	1.0
Obukpa		
Boletus infundibulis	3.2	4.0
Calvation cythiformis	3.2	3.0
Coprnus commatus	1.2	0.0

the other five spots were designated as “out of home environment”. Between the months of June-August 2006, survey trips and inventory of mushrooms in these areas were taken at seven day intervals. Mushrooms were collected using a medium sized hand trowel or matchet for obtaining part of the substratum (wood) on which mushrooms may be growing. Mushrooms were packaged in labelled cellophane bags and taken for identification. Identification was done after the methods of Enst, (1964), Christensen (1970), Zoben, (1978), Roger, (1991).

Associated insect pests were collected and preserved in 4% formalin. Identification of the insects to species level was after NRI (1996). Accuracy of identified insects was done by a taxonomist in the museum for natural history Dept of Zoology, University of Nigeria, where voucher specimens were kept.

Both edible and inedible mushroom abound in Nuskka Urban (Table 1) Predominance of the family Agaricaceae is indicated out of the fifteen families encountered. Edible and non-edible mushrooms are found in the same environment. Mushrooms encountered were previously reported in Nigeria (Kadiri, 1990).

Such mushrooms as *Pleurotus tuber regium, Pleurotus oestreatus, Coprinus commatus*, *Agaricus campestris* are collected from the wild and are currently employed in research works involving their cultivation (Singh *et al*., 1993).

The homestead environment had fewer number of mushrooms than out of home (Table 2. Around the homes unlike out of home environment human disturbances as a result of continuous cropping are popular in relation to most of farms outside the home, which have been on shifting cultivation from up to four years. When an environment is left undisturbed for years more mushrooms are observed (Rogers, 1991). Constant human disturbances affect mushroom growth cycle (Akins, 1966).

Table 3: Insect Pests Encountered on Mushrooms from Nsukka Urban; Relative % Abundance and Shannon Weiner Index

Mushrooms	Associated insects	Number of insects	Relative % abundance	Shannon Weiner Diversity index
Pholota terrestris	***Drosophila melanogaster***	37	18.1	0.11
	Megasiells agaric	10	4.9	0.003
Agaricus campestris	***Pachybolus ligulatus***	3	1.5	0.009
	Drosopluila melanogater	22	10.8	0.0066
	Megasrella agaric	6	2.9	0.018

The menace of pest is not felt on photosynthetic plants alone. Non photosynthetic plants such as mushrooms are greatly prone to insect. Insect pest encountered in association with mushrooms were *Musca domestica, Megasiela agaric, Pygmaemophorus stercola, Pachybolus liguiatus, and Drosophila melanogaster* (Table 3). They were regarded as mushroom pests even when they may not cause physical damage but for the possibility of their transporting pathogen propagules onto mushrooms.

The decay of a single mushroom stand attracts many insects which also climb healthy mushrooms and in this way it is regarded as a pest. Gbolagade (2006) reported the presence of *Megasiela agaric, Megasiela beresli, Scaria fenestralis* as mushroom pathogens in Nigeria. *Scaria fenestralis* and *Megasiela agaric* are reported to be associated with *Pholita sp* and many other mushrooms while the *Pygmaephorus stercola* is recorded as a great pest of many other mushrooms.

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PREVALENCE OF INTESTINAL HELMINTHS INFECTIONS AMONG SCHOOLING CHILDREN IN TROPICAL SEMI URBAN COMMUNITIES

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ABSTRACT

Prevalence of intestinal helminths infections among school children in Igbo-Eze South Local Government Area, Enugu State, Nigeria were studied between July and December 2005. Significant differences (P < 0.05) were recorded among the 1,296 school children (ages 4 – 15) randomly sampled and examined for intestinal helminthes. The prevalence of intestinal helminths varied significantly among schools sampled (P < 0.05). Central School, Ovoko had the highest percent prevalence for Ascaris lumbricoides (9.3 %), hookworm (6.0 %) and Trichuris trichiura (2.3 %). The least per cent prevalence of A. lumbricoides was recorded in Community Primary School, Iheakpu-Awka (2.3 %), while the least per cent prevalence of hookworm occurred in Community Primary School 3, Itchi. T. trichiura was not recorded in community primary schools in Itchi, Unadu and Iheakpu-Awka. Similarly, the prevalence of these parasitic helminths varied significantly among the age groups (P < 0.05), with age groups 4 – 6, highly infected with A. lumbricoides (7.0 %), 13 – 15 with hookworm (3.7 %) and 7 – 9 with T. trichiura (1.2 %). T. trichiura was absent in stool samples of 4 – 6 and 13 – 15 age groups. The prevalence of these intestinal parasites also varied significantly between the sexes, with females having comparatively more A. lumbricoides (5.4 %), hookworm (3.2 %) and T. trichiura (0.8 %) than males. Our study indicated that intestinal helminthiasis was prevalent in the area, and as such, control measures such as chemotherapy, provision of adequate sanitary facilities and potable drinking water, improved personal hygiene and health education should be the focus of non-governmental and governmental health institutions in Nigeria.

Keywords: Prevalence, Intestinal helminths, *Ascaris lumbricoides*, Hookworm, *Trichuris trichiura*, Helminthiasis Schooling children

INTRODUCTION

Intestinal helminths infections are among the most common infections occurring throughout the developing world (Agbolade *et al.,* 2004). Between 500 million and one billion people are estimated to be infected annually (WHO, 1987). There are an estimated 280 million hookworm infected children, 478 million with *Ascaris lumbricoides* and 347 millions with *Trichuris trichiura* in the world (Michael *et al.,* 1997). In sub-Saharan Africa alone, there are 41 million hookworm-infected school-age children (Albonico *et al.,* 2002). In Nigeria, the occurrence of human intestinal helminthiasis is high (Nwosu, 1981; Udonsi, 1984; Obiamiwe and Nworsi, 1991). Other reports on the prevalence of intestinal helminthiasis are those of Holland *et al*. (1989), Awogun *et al.* (1995), Nwaorgu *et al.* (1998), Taiwo and Agbolade(2000) and Adeyeba and Akinlabi (2002). Intestinal worm infections thrive in communities without better housing, sanitation, water supplies, health care, education and low income (Crompton, 1999). In Nigeria, intestinal helminths infections have continued to prevail because of low levels of living standards, poor environmental sanitation, and ignorance of simple health-promoting behaviours (Nwosu, 1981; Udonsi, 1984). The burden of disease associated with worm infection is enormous. School-age children (0 – 15 years of age) harbour heavy intestinal parasites and thus are a good study group; they are the group most responsible for contaminating the environment and transmitting these infections (Albonico *et al.,* 2002).

In view of the negative socio-economic impact of these parasitic infections on children, there is a need for the development of good preventive and control measures adaptable for the tropics. This cannot be done effectively without baseline data on the occurrence of parasitic infections in a particular area. The occurrence of intestinal helminth infections among school children in Nigeria, particularly in Igbo-Eze South Local Government Area (LGA) of Enugu State, which is largely unreported, was our concern. Thus, the results of this study will be useful to both researchers and health authorities in diagnosis, planning and implementing control programmes for intestinal helminths infections in the area.

MATERIALS AND METHODS

Study Area: The study was carried out in Igbo-Eze South Local Government Area (LGA) of Enugu State (Figure 1). The various communities in Igbo-Eze South LGA include Ibagwa-Aka, Iheakpu-Awka, Uhonowerre, Iheaka, Ovoko, Nkalagu Obukpa, Itchi, Alor-Agu and Unadu. The headquarters is at Ibagwa-Aka. There are three development councils in the area; Igbo-Eze South Central, Ekete and Udeze.

Igbo-Eze South LGA is located between latitudes $7^0 19^{/}$ East and $7^0 28^{/}$ East, and longitudes $7^0 00^{/}$ North and $6^0 53^{/}$ North (Igbo-Eze South LGA, 2005). The area is in the guinea savannah forest mosaic zone of Nigeria. The study area has two main seasons; the rainy and dry seasons. The rainy season usually starts in April and ends in September. The dry season usually starts in October and ends in March. The inhabitants of this area are mainly subsistent farmers and traders. There are seventeen health centres in the area, with a General Hospital at Itchi. There are forty-four primary schools in the area. There are 14,994 pupils in the study area; 8,860 males and 6,134 females (SUBEB, 2005). The total population of people in the study area is 75,368 (NPC, 1991).

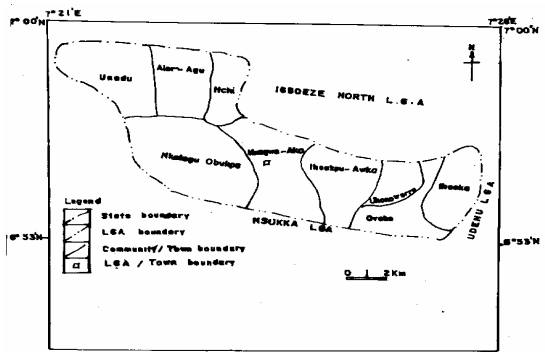

Figure 1: Map of Igbo-Eze South Local Government Area showing the sampled sites.

Selection of Schools: Six schools were used for this study. Primary schools in the study area were listed out and two schools were selected from each developmental council using random sampling technique. The schools selected for this study were Township School 1, Ibagwa, Community Primary School, 3, Itchi, Central School, Ovoko, Central School, Iheaka, Community Primary School 1, Unadu and Community Primary School, Iheakpu-Awka. Table of random numbers was used for the random sampling.

Collection and Examination of Faecal Samples: From each of the six schools selected, thirty-six pupils were selected and sampled using random sampling technique. Table of random numbers was again used for the random sampling. Six pupils were selected from each class (classes 1 – 6) to make up a total of 36 pupils. A total of 1,296 pupils were sampled at the end of six months. Faecal samples were collected monthly for a period of six months. Each of the selected pupils was given a small bottle in which they collected their faeces. The bottles were labeled with the pupil's name, age and sex. . At the end of the exercise, the age and sex of the selected pupils were recorded.

On collection of the faecal samples, they were taken to the laboratory for examination. At the laboratory, a drop of fresh physiological saline was placed on a slide. Using a piece of clean stick, a small amount of faecal sample was mixed with the saline.

In order to concentrate the parasites in the faeces, formol-ether concentration technique was employed. Using a stick, about 1g of the faeces mixed with physiological saline was put in a screw-cap bottle containing 4ml of 10 % formol water. The bottle was capped and mixed by shaking for about 20 seconds. Thereafter, the faeces were sieved, and the sieve suspension collected in a beaker. The suspension was transferred to a tube and 3 ml of ether was added. The tube was stoppered and mixed by shaking for one minute. Thereafter, the stopper was removed and centrifuged immediately at 3000 rpm for one minute. After centrifuging, four layers were evident; the top layer of ether, thin layer of debris, formalin, and sediment in bottom with parasites. An applicator stick was used to loosen the layer of faecal debris from the side of the tube. The ether, debris and formalin were then carefully poured off. The sediment was mixed, transferred to a slide and covered with a cover glass. The slide was examined under the microscope using first, the 10x objective followed by 40x objective to identify the eggs (Ash and Orihel, 1997). The number of pupils infected with intestinal helminths, and the type of intestinal helminths observed were recorded.

Data Analysis: Differences in the prevalence of infection between ages and sexes were determined using the χ^2 tests from the contingency tables. The analysis was done using the Epi Info Database Package (Centre for Disease Control and Prevention, Atlanta, GA) and SPSS (Statistical Package for Social Sciences) version 11.0.

RESULTS

Prevalence of Intestinal Helminths Infections among School Children: The intestinal helminth parasites observed in this study were *T. trichiura*, *A. lumbricoides* and hookworm (Figure 2). Of the 1,296 school children examined for intestinal parasites, 64 (4.9 %) were infected with *A. lumbricoides*, 33 (2.5 %) with hookworm, and 9 (0.7 %) with *T. trichiura* (Table 1). From Table 1, it can be seen that *A. lumbricoides* had the highest prevalence (4.9 %) while *T. trichiura* had the lowest (0.7 %). There were significant differences in the prevalence of the parasites ($P < 0.05$).

Prevalence of Intestinal Helminths Infections in the Different Schools Sampled: Out of the 1296 school children examined, 216 were from each of the six different schools. Central School, Ovoko had the highest prevalence for *A. lumbricoides* (9.3 %), hookworm (6.0 %) and *T. trichiura* (2.3 %) infections (Table 2). There was significant difference between the prevalence of infections among the schools sampled ($P < 0.05$).

Age Distribution and Prevalence of Intestinal Helminths Infections among School Children: School children between the ages of 4 – 15 were sampled.

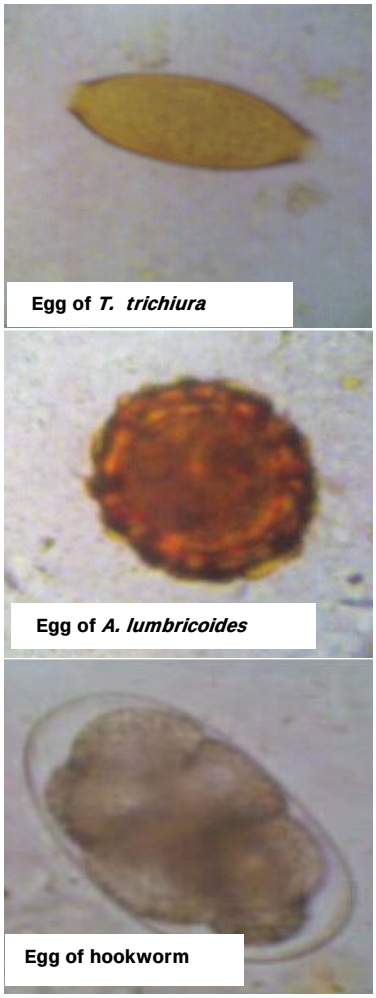

Figure 2: Intestinal helminth eggs associated with sampled school children from a community in Southeastern Nigeria

Table 1: Prevalence of intestinal helminths infections among school children in Igbo-Eze South, South eastern Nigeria

Parasites found	Number examined	Number infected	Prevalence (%)
A. lumbricoides	1296	64	4.9_b
Hookworm	1296	33	2.5_c
T. trichiura	1296	9	0.7_d
Total		376	28.9

Different letters indicate statistically different percentages (P < 0.05)

Children between the ages of 4 – 6 had the highest prevalence of *A. lumbricoides* (7.0 %) infections (Table 3). Hookworm was most prevalent in the 13 - 15 age group (3.7 %) while *T. trichiura* was most prevalent in the 7 - 9 age group (1.2 %) (Table 3).

The differences in prevalence between the different age groups were not statistically significant for *A. lumbricoides*, hookworm and *T. trichiura* infections (P > 0.05).

Sex Distribution and Prevalence of Intestinal Helminths Infections among School Children: Out of the 1296 school children sampled, 648 were males and 648 were females. Out of the 648 males examined, 29 (4.5 %) had *A. lumbricoides* infections, 12 (1.9 %) had hookworm infections and 4 (0.6 %) had *T. trichiura* infections (Table 4). Out of the 648 females examined, 35 (5.4 %) had *A. lumbricoides* infections, 21 (3.2 %) had hookworm infections and 5 (0.8 %) had *T. trichiura* infections (Table 4). From Table 4, it can be seen that the females had the highest prevalence of *A. lumbricoides* (5.4 %), hookworm (3.2 %) and *T. trichiura* (0.8 %) infections. There were no significant differences between sex and the prevalence of *A. lumbricoides*, hookworm or *T. trichiura* infections (P > 0.05).

Interaction Between Sex, Age Group and the Prevalence of Intestinal Helminths Infections Among School Children: The analysis of the interaction of sex, age group and the prevalence of parasites showed that females (4 - 6 years old) had the highest prevalence of *A. lumbricoides* infections (8.8 %), ma1es (13 - 15 years old) had the highest prevalence of hookworm (4.2 %), while males (7 - 9 years old) and females (7 - 9 years old) had the highest and equivalent prevalence of *T. trichiura* infections (1.2 %) (Table 5).

Seasonal Distribution of Intestinal Helminths Infections among School Children: 216 school children were sampled monthly from July to December for intestinal helminths infections. There was a gradual decrease in the prevalence of intestinal helminths infections from July through December. July had the highest prevalence while December had the lowest prevalence for all the parasites observed (Table 6). There were significant differences between monthly prevalence of *A. lumbricoides*, hookworm and *T. trichiura* infections (P < 0.05).

DISCUSSION

Prevalence of Intestinal Helminths Infections among School Children: Our study has shown the overall prevalence of *A. lumbricoides* (4.9 %), hookworm (2.5 %) and *T. trichiura* (0.7 %) infections (Table 1) among school children in Igbo-Eze South LGA, Enugu State. *A. lumbricoides* had the highest prevalence (4.9 %), followed by hookworm (2.5 %), while *T. trichiura* had the least (0.7 %). The higher prevalence of *A. lumbricoides* infection than that of hookworm infection and *T. trichiura* infection is consistent with the reports of Taiwo and Agbolade (2000) and Adeyeba and Akinlabi (2002), but disagrees with that of Nwaorgu *et al.* (1998). The high prevalence of *A. lumbricoides* infection may be attributed to high level of unhygienic practices among the pupils which enhanced transmission. The presence of *T. trichiura* infections in the study area was not unexpected since it is known that similar conditions which influence the endemicity of *A. lumbricoides* also influence its endemicity (O'Larcain and Holland, 2000). It is also known that *A. lumbricoides* infections are rarely found alone in human communities (Crompton, 1994).

Table 2: Prevalence of intestinal helminths in the different schools sampled in Igbo-Eze South LGA, Enugu State

Schools	Number examined	Prevalence (%) *A. lumbricoides*	Hookworm	*T. trichiura*
Township School 1, Ibagwa	216	7.9_g	3.2_m	1.4_s
Community Primary School 3, Itchi	216	2.8_h	0.5_n	0.0
Central School, Ovoko	216	9.3_i	6.0_o	2.3_u
Central School, Iheaka	216	4.6_j	0.9_p	0.5_v
Community Primary School, Unadu	216	2.8_k	2.9_q	0.0
Community Primary School, Iheakpu-Awka	216	2.3_l	1.9_r	0.0
Total	1296	4.9	2.5	0.7

Different letters represent significantly different percentages (P < 0.05)

Table 3: Age distribution and prevalence of intestinal helminths infections among school children in Igbo-Eze South LGA, Enugu State

Age groups (years)	Number Examined	Prevalence (%) *A. lumbricoides*	Hookworm	*T. trichiura*
4 – 6	228	7.0	2.2	0.0
7 – 9	508	5.7	3.0	1.2
10 – 12	478	3.1	2.1	0.6
13 – 15	82	4.9	3.7	0.0
Total	1296	4.9	2.5	0.7

Different letters indicate statistically different percentages (P < 0.05)

Table 4: Sex distribution and prevalence of intestinal helminths infections among school children in Igbo-Eze South LGA, Enugu State

Sex	Number examined	Prevalence (%) *A. lumbricoides*	Hookworm	*T. trichiura*
Male	648	4.5	1.9	0.6
Female	648	5.4	3.2	0.8
Total	1296	4.9	2.5	0.7

Different letters represent significantly different percentages (P<0.05)

Table 5: Interaction between sex, age group and prevalence of intestinal helminths infections among school children in Igbo-Eze South LGA, Enugu State

Sex	Age groups (years)	Number examined	Prevalence (%) *A. lumbricoides*	Hookworm	*T. trichiura*
Male	4 – 6	115	5.2	0.9	0.0
	7 – 9	248	6.5	2.0	1.2
	10 – 12	237	2.1	1.7	0.4
	13 – 15	48	4.2	4.2	0.0
Female	4 – 6	113	8.8	3.5	0.0
	7 – 9	260	5.0	3.8	1.2
	10 – 12	241	4.1	2.5	0.8
	13 – 15	34	5.9	2.9	0.0
Total		1296	4.9	2.5	0.7

Table 6: Seasonal distribution of intestinal helminth infections among school children in Igbo-Eze South LGA, Enugu State

Months	Season	Number examined	Prevalence (%) *A. lumbricoides*	Hookworm	*T. trichiura*
July	Wet	216	9.7_g	7.9_m	2.3_s
August	Wet	216	8.3_h	3.7_n	1.4_t
September	Wet	216	4.2_i	1.9_o	0.0
October	Dry	216	3.2_j	1.9_p	0.5_u
November	Dry	216	2.8_k	0.5_q	0.0
December	Dry	216	1.4_l	0.0_r	0.0
Total		1296	4.9	2.5	0.7

Different letters indicate statistically different percentages (P<0.05)

Generally, the occurrence of intestinal helminths infections in the area was not unusual because the area is in a rural area. Parasitic diseases are known to be common in rural areas because of poverty, ignorance and low sanitary conditions (Ukoli, 1992).

Prevalence of Intestinal Helminths Infections in Schools Sampled: This study revealed that the prevalence of intestinal helminths in the different schools was generally low. There were significant differences in the prevalence of parasitic infections

among the schools. The differences are probably a reflection of population densities. The differences in the different schools sampled could also be related to the local environmental factors inherent in the different schools' location. Central School, Ovoko also had the highest prevalence of *A. lumbricoides*. This may be because of the nature of the soil which is clayey. *Ascaris* eggs are known to develop best in less permeable clay soils, with survivability increasing with their soil depth (Crompton, 1989). Clay soils are believed to prevent egg dispersal by water (Mizgajska, 1989). Thus, the eggs would have been more concentrated in the soils found in this area leading to higher rates of infection. Wetter areas are usually associated with increased transmission of *A. lumbricoides,* hookworm and *T. trichiura* eggs (Brooker and Michael, 2000). Central School, Ovoko, which had the highest prevalence of parasitic diseases, is located in a semi-urban environment with poor sanitation. The correlation of parasitic diseases with poor environmental sanitation and unhygienic practices has been established (Crompton and Savioli, 1993).

Age Distribution and Prevalence of Intestinal Helminths Infections among School Children: In our study, it was found that children between the ages of 4 and 6 had the highest prevalence of *A. lumbricoides* infections (Table 3) compared with the other age groups. This may be due to the fact that at this age, their immunity to parasitic infections has not been fully developed (Stephenson *et al.,* 2000). This observation was in line with that of Angyo *et al.* (1996) who recorded higher prevalence of parasitic infections in younger children. The prevalence of parasitic infections has been found to reduce with age (Bundy *et al.,* 1992). Furthermore in this study, older children (13 - 15 years) had the highest prevalence of hookworm, (Table 3). These observations confirmed the reports of Asaolu *et al.* (1992) and Mafiana *et al*. (1998) which attributed higher prevalence of hookworm infections in older children to changes in behaviour as one gets older. The prevalence of parasitic infections among the different age groups was significant ($P < 0.05$), indicating that the occurrences of these infections were age dependent.

Sex Distribution and Prevalence of Intestinal Helminths Infections among School Children: Our study also indicated that intestinal helminths infections were more common in the female than in the male subjects (Table 4). There were significant differences between the prevalence of parasitic infections and the sex of those examined. This indicated that the prevalence of the studied parasitic infections were sex-dependent which was in conformity with Narain *et al*. (2000) had earlier observed that these differences may be related to levels of exposure.

Interaction between Sex, Age Group and Prevalence of Infections among School Children: In this study, *A. lumbricoides* infection had the highest prevalence in females, ages 4 - 6 (Table 5). This may be attributed to their less developed immune systems. Also, *Ascaris* infection is considered higher among females compared with males, regardless of age (Crompton, 1989). Males (13 - 15 years) had the highest prevalence of hookworm infections. This may be so because of their older ages. Hookworm infection is said to increase as a person progresses in life (Crompton, 2000).

Seasonal Distribution of Intestinal Helminths Infections among School Children: The prevalence of intestinal helminths infections among school children in Igbo-Eze South LGA, Enugu State decreased progressively from July when the study started through December when it ended (Table 6). July had the highest prevalence of parasitic infections while December had the least. The months, July, August and September fall within the rainy season, while October, November and December fall within the dry season. From Table 6, it was seen that the prevalence of parasitic infections was more in the rainy season than in the dry season. During this season, sources of drinking water may become easily polluted due to runaway water and erosion contaminated with eggs of intestinal helminths. Thus, on taking in water, persons become infected with eggs of intestinal helminths. Moreover, during rainy season, conditions are wet and warm and these are ideal for the survival and embryonation of helminths' eggs (Crompton, 1987).

Conclusion: This study has shown that intestinal helminths infections are prevalent among school children in Igbo-Eze South LGA, Enugu State. Thus, the public health and economic implications of these findings should not be overlooked.

Given the growing concern about the public health importance of intestinal helminths infections, chemotherapeutic control of intestinal helminths infections in children should also be undertaken. Even though child-targeted treatment can never be more effective than treatment of the total population, Guyatt and others found, in a follow-up analysis of the same data source, that because children tend to have higher intensities of infections, child-targeted treatment can be more cost-effective than population treatment in reducing the number of disease cases (Guyatt *et al.,* 1995). Also, there is a need for concerted periodical health education and mass treatment to effectively control intestinal helminth infections in the area. In the long term however, the prevention and control of parasitic diseases will be dependent upon economic development with consequent improvements in water supplies, sanitation, health education and socio-economic status. Further studies on control of parasitic diseases should be carried out and these should be coordinated with and integrated into epidemiological research so that the maximum benefits can be derived.

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ANIMAL TRYPANOSOMIASIS IN AFRICA: AETIOLOGY AND EPIDEMIOLOGY

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ABSTRACT

The aetiology and epidemiology of African trypanosomiasis in bovine species are comprehensively presented. In addition, a critical review of the history and transmission of the disease is exhaustively discussed. The mystery of other epizootiological factors associated with bovine trypanosomiasis is highlighted. Four major elements were identified as important in the epizootiology of African animal trypanosomiasis namely the trypanosome, the tsetse fly, the mammalian host and the environmental factors. It was concluded that the phenomenon of high rate of resistance referred to as trypanosotolerance has genetic correspondence.

Keywords: Trypanosomiasis, Aetiology, Epidemiology, Haemoprotozoan, Trypanosotolerance, *Trypanosoma*

INTRODUCTION

Animal trypanosomiasis is an economically devastating disease and a major constraint to livestock production in tropical Africa (Esievo and Saror, 1991). Trypanosomiasis is a parasitic disorder caused by haemoprotzoan belonging to the genus, *Trypanosoma* of the family Trypanosomatidae, that multiply in the blood stream, lymphatic vessels and tissues including the cardiac muscles and the central nervous system. This highly fatal protozoan disease is virulent, inoculable but not contagious (except dourine, a venereal trypanosomiasis of equines). Trypanosomes are pathogenic, not only for animals but also for man where they cause sleeping sickness. Most species of domestic animals are to some degree susceptible to trypanosomsiasis transmitted by various haematophagous insects, mainly Glossina species commonly known as tsetse flies. These are considered to be the true intermediate hosts of these parasites.

Tsetse flies occur exclusively in Africa over an area approximately 10 million km^2, extending on both sides of the equator from 15^{0}N to 30^{0}S. They are of primary importance in the spread and epidemiology of this economically and socially important disease (Houre, 1976; Ilard, 1989; Anene *et al.,* 2000). Despite all efforts and some impressive achievements, the problem of trypanosomiasis persists and in some respects is unchanged (Wilson *et al.,*, 1968). The total area occupied by tsetse fly (one third of Africa) has reduced the areas of the continent which would otherwise support additional 125, 000, 00 heads or more of cattle and double the present number of cattle kept in Africa and cited by Killick-Kendrick and Geofrey (1963). If cattle in these areas are naturally challenged by this parasite, they come down with symptoms of the disease with corresponding impairment of performance in varying degrees. In particular, the *Bos taurus* cattle of West Africa are reputably less susceptible than *Bos indicus (*Zebus) introduced much later to Africa - and the European *Bos taurus* breeds. The low susceptibility is defined as trypanotolerance. Ndama, Boule, Ghana shorthorn, Somba and Muturu belong to trypanotolerant breeds with unusual natural resistance to trypanosomiasis. On the other hand, the zebu and European breeds are considerably highly susceptible to natural infection with trypanosomiasis, often giving rise to catastrophic morbidity and mortality making the rearing of these breeds difficult if not impossible in trypanosomiasis endemic regions of Africa (Epstein, 1975). The aim of this study is to pool together relevant and current information on aetiology and epizootiology of animal trypanosomiasis with particular emphasis on bovine trypanosomiasis to guide future investigation.

MATERIALS AND METHODS

A comprehensive literature search was made from the Internet and serial materials of Nnamdi Azikiwe Library, University of Nigeria, Nsukka. Various journal articles, proceedings of learned societies of veterinary parasitology, WHO documents and textbooks were consulted vis-à-vis of the aetiology and epidemiology of animal trypanosomiasis in Africa.

RESULTS AND DISCUSSION

Aetiology: The morphology of African trypanosome has been described in details (Leeflang, 1975; Ugochukwu, 1983). Trypanosomes are unicellular, microscopic and elongated protozoa that move by the help of a single flagellum at the base of which is found a characteristic structure known as kinetoplast. They are obligatory parasites usually having two hosts, they multiply in the body fluids especially blood vertebrate host (Table 1) and live in the digestive tract of invertebrate host which is generally a biting insect (Houre, 1976; Ilard, 1989).

The pathogenic trypanosomes have been classified either as Stercoraria (posterior station trypanosomes) *Trypanosoma theleria* which is mildly pathogenic to domestic and 20 wild ruminants (Table 1) and Salivaria (anterior station trypanosomes which is pathogenic to both domestic and wild animals (Table 1).

Table 1: Distribution of *Trypanosoma* Species among Vertebrate Host

Species	Host	Area	Reference
T. congolense	Goats	Nigeria	Ugochukwu (1983)
T. vivax	Cattle, Sheep, Goats, Horses	Nigeria East Africa	Roderick *et al.* (2004)
T. simiae	Pigs, Monkeys	Nigeria	Killick Kendrick and Geoffery (1963)
T. gambiense	Man	West Africa	ILARD (1990)
T. rhodesiense	Man	East Africa	ILARD (1990)
T. brucei	Dogs, Cats, Ruminants Monkeys	West Africa East Africa	Mulligan and Potts (1969) Nantulya (1990)
T. suis	Pigs	Nigeria	Killick, Kendrick and Geoffery (1963)
T. evansi	Camels, Horse	West Africa	Mulligan and Potts (1963)
T. equiperdium	Horse	West Africa East Africa	Mulligan and Potts (1963) Nantulya (1990)

Species of the genus, *Trypanosoma* are found in a wide variety of vertebrates. The majority are not pathogenic but some species are of considerable economic importance causing disease in man and animals. These trypanosomes mainly belong to three subgenera Trypanozoon, Dutonella, and Nanomas. The subgenus Trypanozoon contains *T. brucei*, two species of which *T. brucei gambiense* and *T. brucei rhodesiense* are responsible for sleeping sickness in man in Africa and one subspecies *T. brucei brucei* for infection in domesticated animals. *T. evansi* which is found in many parts of the world in a wide variety of animals. Also *T. equiperdiun* and *T. suis* in the subgenera Nanomas *T. congolense* and *T. simiae* are the important members. The most important African trypanosomes species include: *T. vivax, T. congolense* and *T. brucei.* The important species causing diseases in cattle are *T. congolense, T. vivax* and *T. brucei* (Epstein, 1975; Clarkson, 1976; Obidike *et al.,* 2005).

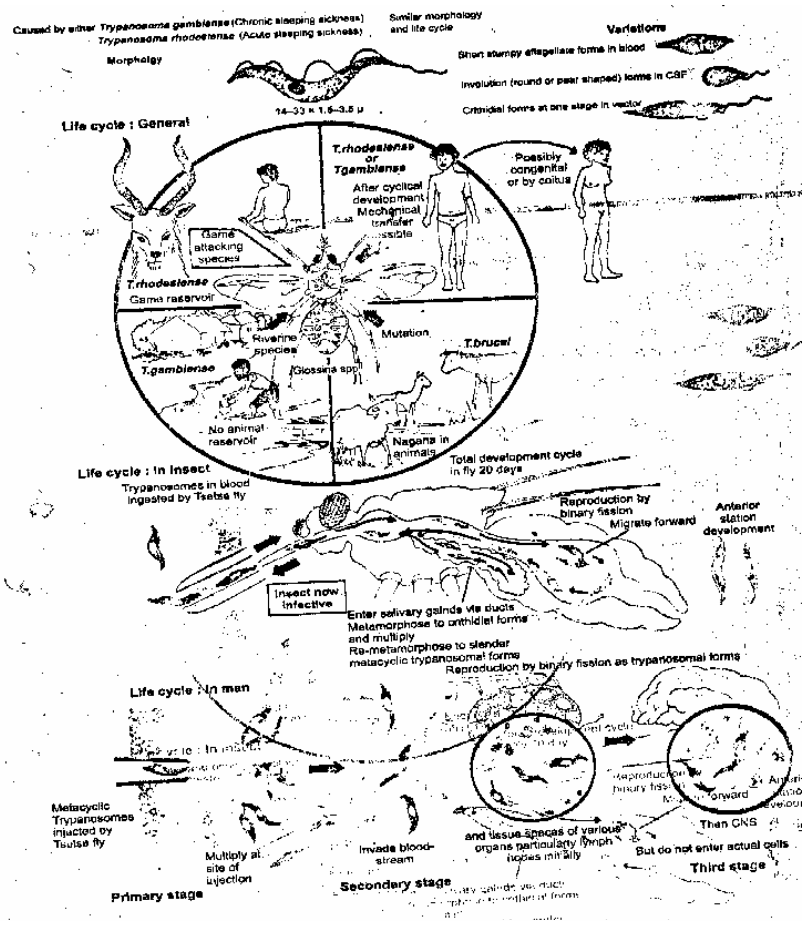

Figure 1: Life cycle of Trypanosomiasis (Sood, 2006)

Transmission: Animal trpanosomiasis has a sylvastic transmission cycle (Figure 1). The disease is maintained in ecological system which includes tsetse flies, woody vegetation and game or wild life. It is only when livestock is introduced into this system that tsetse fly will use the livestock as their food source and infect them with trypanosome. Trypanosomes except *T. equiperdium*, and *T. evansi* are transmitted cyclically by tsetse fly. Additionally, it is believed that biting flies including Tabanidae and Stomoxys also transmit the parasite mechanically. This activity is responsible for the persistence of *T. vivax* in areas of Africa free from tsetse flies as well as in several South American countries like Brazil, Colombia, and Guyana. For instance, two fatal outbreaks of bovine trypanosomaisis due to *T. vivax* were described in Maiduguri and Wadara both in Nigeria in closed herds maintained in the tsetse free Sahelian region (Maxie *et al*, 1979). Also in Tanzania, pseudo-lumpy skin disease and acute *T. vivax* infections occurred simultaneously in a dairy herd which had no previous history of trypanosomiasis.

Where as tsetse fly might have introduced *T. vivax*, the failure to trap tsetse and the presence of large number of biting flies (*Stomoxys* and *Tabanus taenicola*) strongly suggested that in the outbreak both aetiologial agents were transmitted mechanically (Conner and Mulkangi, 1986). The trypanosomes that cause disease in livestock and humans also infect some wild species which serve as a reservoir of infection that may in turn infect domestic animals and people. Many wild animals carry trypanosomes with no apparent ill-effect, in humans and most domestic livestock. However where such a harmless relationship with trypanosome, and their vector has not evolved, the pathogenic effects of infection are severe (Desowitz, 1960; Conner and Mulkangi, 1986). Wild life plays an important role as natural reservoir of trypanosome infection for domestic animals and man. It is generally believed that game animals can harbour trypanosomes and hardly suffer from the disease and the mechanism of this is unknown, although differences in the electrophoretic pattern of serum protein have been described (Desowitz, 1960). A similar tolerance is possessed by certain breeds of cattle, notably Ndama and Muturu which can be maintained in endemic areas where it is impossible to keep zebu cattle (ILARD, 1989). Blood meal analysis of tsetse flies caught in the wild shows that they feed on a wide variety of wild life host including primates (baboons, monkeys), suids, warthog, bush pig, red river hog, and giant bush pig) and various bovidae especially antelopes. Other studies have shown that pathogenic trypanosomes including. *T. vivax*, *T. congolense* and *T. brucei* have been isolated from wild life in East Africa (Ashcroft, 1959; Anosa and Isoun, 1983).

However, various game animals such as red-buck, giraffe, bush pigs, kudo and bush buck are known reservoir hosts of pathogenic Africa trypanosome. Transmission is by bite of flies in the wild life. The trypanosome undergoes cyclical development in flies lasting 12 -35 days before they become infective. Though all species of tsetse fly ate capable of cyclically transmitting trypanosomes, their importance as vectors depends on feeding habit, relative infectivity and distribution in relation to domestic stock. Additionally, it is believed that biting flies including tabanids and stomoxys also transmit the parasite mechanically. This is by direct transmission of infection by blood contaminating the mouth part of biting flies which are distributed during feeding.

The life cycle of the single-celled trypanosome is complex in both the tsetse fly vector and mammalian host, trypanosomes undergo a series of transformations into different forms As flies feed on animals infected with the parasite, they take up blood containing trypanosomes which then completes the life cycle (Houre,1976; ILLARD, 1990).

Prevalence and Epidemiology: Large areas of Africa, approximately 4 million km^2 have been rendered unsuitable for livestock production by trypanosomes.

Climate and vegetation play a major role in the distribution of Tsetse fly. Other factors include presence of wild-life for food, types of soil for breeding, presence of predators and diversity of human population (Davis, 1977). The behaviour of tsetse flies varies from species to species in the same vegetational zone. The knowledge of tsetse ecology is important in the control measures most adopted in a particular zone or locality. Some workers have shown that as one moves from the north to the south, the feeding pattern of *G. tachinoides* changed from preference for man to one for domestic and wild animals. The genus, Glossina can be divided according to their habitat into (a) the forest species (Fusca group) comprising, of 12 species, (b) The riverine species (palpalis group) consisting of 5 species and (c) the savanna (the mortisan group) consisting of 5 species. The group name already give an indication of their distribution, the forest species are found in 500 km^2 wide coastal belt of tropical rainforest which stretches from Guinea Bissau to Nigeria in West Africa and further to the Cameroon, the central African Republic, large regions of Zaire and Angola as well as Congo, Gabon and Equatorial Guinea (Figure 2). The distribution of riverine species on one hand coincides, with that of forest flies, but on the other hand it clearly goes beyond the North and South along rivers on gallery forest, and even beyond the distribution of savanna species. Savanna species appear in the savanna belt which links up with the forest species region to the North and east especially, but primarily in the south-east.

The four most important species of Glossina in Nigeria are *G. palpalis, G. tachinoides, G. mortisans* a submortisans and *G. longipalis* (Davis, 1977). Surveys have shown that there is a wide geoecological distribution of animal trypanosomiasis in Nigeria stretching from the mangrove forest to the Sudan savanna, owing to the presence of tsetse flies in these areas (Davis, 1977). Only about $1/5^{th}$ of the northern Sahel savanna and the plateau of Mambilla, Jos and Obudu are free from testes fly (Davis, 1977; ILARD, 1990). However, cases of Trypanosomiasis have been reported on the Jos plateau (Anene *et al*, 1991) and in the Sahel around Maiduguri (Maxie *et al.*, 1979). These unusual occurrences of animal trypanosomiasis have been attributed to movement of cattle from tsetse fly infested to tsetse fly free areas (Anene *et al.*, 1999).

Conclusion: Four major elements influence the epizootiology of African animal trypanosomiasis namely the trypanosome, the tsetse fly, the mammalian host and the environmental factors. Cattle are the primary victim of trypanosomiasis in West and East Africa and in South America. Sometimes outbreaks also occur in other species: horses, goat, dog, sheep and camel (Anosa, 1989). The phenomenon of high rate resistance to trypanosomiasis is termed trypanotolerance. Trypanotolerance has a genetic correspondence since crosses between trypanotolerant cattle and susceptible cattle show a high level of trypanotolerance (Anosa and Obi, 1980).

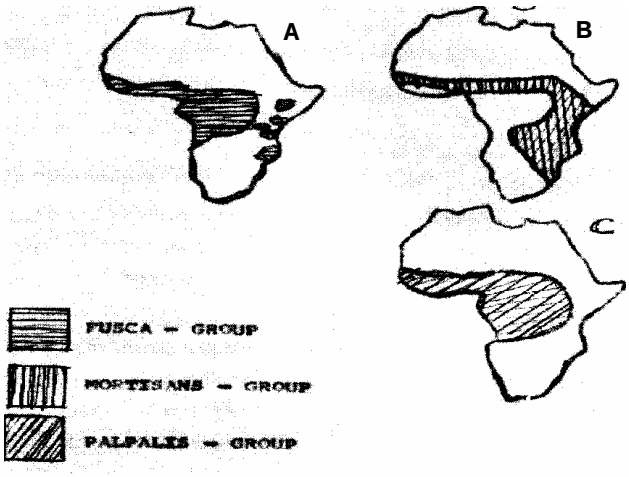

Figure 2: Testse fly occurrence in Africa

Trypanotolerance is however not absolute and in a sense represents only a potential, thus typanotolerant adults raised in tsetse fly free areas and subsequently infected by trypanosome have been shown to develop severe disease comparable to that shown by susceptible breeds (Desowitz, 1960; Ndoutamia *et al.,* 1993; Tabel *et al.,* 2000). Other factors which influence the prevalence of the disease in animal are age and individual factors. Thus, young cattle are less frequently affected than older cattle. A study showed that prevalence decreased progressively from cattle over two years old 1 to 2 years, 9 months to 1 year, and under 3 months. Similarly, it has been shown in several experimental studies with mice, sheep, goats, cattle and monkeys that individual animals of the same breed and age exposed to the strain of trypanosomiasis show considerable variation in severity of disease (Mulligan and Potts, 1969; Henson and Noel, 1979; Anosa and Obi 1980; Anosa and Kaneko, 1983b). In conclusion, further work is anticipated to unravel the mystery of other epizootiological factors associated with bovine trypanosomiasis in the African continent in particular and animal trypanosomiasis in general.

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EFFECT OF NUTRITION ON THE RED BLOOD CELLS OF TRYPANOSOME-INFECTED FEMALE RATS

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ABSTRACT

Trypanosomiasis is of great interest to farmers in Sub-Saharan Africa. It is a disease that retards agricultural development in general and needs urgent attention. It has been noted that it causes aneamia in its host which often may lead to death. Many researches showed that dietary supplement can enhance trypanotolerance in various hosts. Diet is important in modulating the severity of its pathophysiological effects and can also influence the rate of recovery. Using a control diet (Diet 1)) was only chicks' mash. this research was conducted to determine the effect of moderate protein (mixture of 250 g of corn meal, 240 g of soyabean meal and 10 g of crayfish meal in chicks' marsh (Diet 2)), high dietary protein (mixture of 400 g of caseinogen and 300 g of soyabean meal in chicks' mash (Diet 3)) and high dietary carbohydrate (mixture of 400 g of dextrose and 300 g of corn meal in chicks' mash (Diet 4)) supplementation on rodent trypanomiasis. Diet 1 was used to feed rats in Cage A, Diet 2 was used to feed rats in Cage B, Diet 3 was used to feed rats in Cage C while Diet 4 was used to feed rats in Cage D. At the end of the experiment, it was observed that rats fed with Diet 2 (moderate protein diet) had the highest and significantly different (P < 0.05) red blood cell count than other treatments. This indicated that adequate nutrition reduces the effect of trypanosome and hence trypanotolerance in rats since trypanosome is known to attack red blood cells and vascular endothelium.

Keywords: Nutrition, Red blood cells, Trypanosome-infected female rats, Trypanomiasis, Pathophysiology

INTRODUCTION

Red blood cells are derived from haemopoietic stem cells (HSCs) (Rotti *et al.*, 1989). In foetal mammals, HSCs are found in the liver, spleen and bone marrow, but after birth and throughout adult life, they are found only in the bone marrow. The HSCs give rise to four major cell lineages. These are: erythriod (erythrocytes), megakaryocytiod (platelets), myeloid (granulocytes and monocytes) and lymphoid (lymphocytes) (Rotti *et al.,* 1989).

The embryonic development of an individual is influenced by many factors in which nutrition and disease are not left out. Good maternal nutrition is vital for the health and reproductive performance of women and the health, survival and development of their children (Mora and Nestel, 2000). It has been suggested that a brief period of under-nutrition may result in permanent alterations in growth that may be translated into pathology in later life (Barker, 1995).

Trypanosomiasis as a disease affects embryonic and adult development of an individual. An estimated 60 million people living in rural parts of East, West and Central Africa between latitude 14°N and 29°S are at risk of contracting the disease with an estimated 300,000 cases diagnosed and treated each year (WHO, 1998). Human African trypanosomiasis constitutes a major health problem in the African region. Given the resurgence of both human and animal trypanomiasis from the 1970s to the present, the epidemic potential, the high fatality rate, and significant impact on socioeconomic development, many countries requested more active support from WHO for the control of the disease (WHO, 2005).

Trypanosomiasis is one of the most important livestock diseases in sub-Saharan Africa (Morrison *et al.,* 1981). It affects both man and livestock (Siegmund *et al.,* 1979; Vaclav, 1980). The protozoan parasite that causes it is *Trypanosoma* species and is transmitted by tse tse flies (*Glosina* species) (Vaclav, 1980). The disease known as *nagana* retards livestock production (Stephen, 1986). It is caused by *Trypanosoma brucei*, *Trypanosoma congolense* or *Trypanosoma rhodesiense.*

Trypanosome is known to attack red blood cells and vascular endothelium. It concentrates more in the peripheral circulation (Jackson, 1979). The parasite causes tissue damage by utilization of metabolites, excretion of toxic substances, mechanical damage to the host's tissue and immune mediated injuries. Trypanosome infection is associated with anaemia, pyrexia (hyperthermia), cochexia, loss of appetite, reproductive disorders including abortions in pregnant animals and eventually death (Shaw and Dusanic, 1973; Ogwu *et al.,* 1980; Ogwu and Nuru, 1981; Tizard, 1985; Stephen, 1986). Improvement on host's nutrition is important in moderating the severity of pathophysiological effect of trypanosomiasis and also influences the rate of recovery (Katungka-Rwakishaya, 1996). It was also discovered that

supplementary feeding significantly reduces the severity of trypanosomiasis (Agyemang *et al.,* 1990; Little *et al.,* 1990). In line with this, the research was conducted to determine the effect of dietary supplementation of moderate protein diet, high protein diet and also high carbohydrate diet on the red blood cells of trypanosome infected female rats, using chicks' mash as control diet.

MATERIALS AND METHODS

Twenty 120-day-old female rats were used for this experiment. The rats were marked for identification and held in stainless wire-rats-cages in clean experiment animal house. The rats were placed five per cage and the cages were labeled A to D corresponding to four diets (treatments) given to each group. Diet 1 was given to rats in cage A (Treatment 1) which is the control. Diet 2 (Treatment 2) was given to rats in cage B. Diet 3 (Treatment 3) was given to rats in cage C and Diet 4 was given to rats in cage D (Treatment 4). These diets contained different levels of protein and carbohydrate – a control diet (Diet 1) of only chicks' mash, moderate dietary protein (mixture of 250 g of corn meal, 240 g of soyabean meal and 10 g of crayfish meal) in chicks' marsh (Diet 2), high dietary protein (mixture of 400 g of caseinogen and 300 g of soyabean meal) in chicks' mash (Diet 3) and high dietary carbohydrate (mixture of 400 g of dextrose and 300 g of corn meal) in chicks' mash (Diet 4). The diets were analysed for proximate composition by the method of Windham (1996). Each experimental set up was replicated three times. The rats were allowed unlimited supply of clean water.

The female rats were infected with 8000 trypanosomes per 1 ml of blood. At the end of the experiment, the total red blood cell count was taken. The data were analysed for significant differences by descriptive statistics and analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS) computer package. Multiple comparisons of significant difference were done using least significant difference (LSD) and the Duncan's Multiple range Test post hoc tests (Steel and Torrie, 1980).

Table 1: Nutrient and Proximate Composition of Diets fed to trypanosome-infected rats

Diets	Ingredient composition		Proximate composition	
	Ingredient	Weight (g)	Ingredient	%
Diet 1 (Control)	**Chicks' mash**	1000	Moisture	10.90
			Protein	18.39
			Ash	8.40
			Fibre	10.25
			Fat	10.25
			Carbohydrate	41.81
Diet 2	**Chicks' mash**	500	Moisture	16.25
	Corn meal	250	Protein	13.70
	Soyabean meal	240	Ash	20.01
	Crayfish	10	Fibre	13.40
			Fat	3.95
			Carbohydrate	32.69
Diet 3	**Chicks' mash**	300	Moisture	14.65
	Caseinogen	400	Protein	29.95
	Soyabean meal	300	Ash	10.75
			Fibre	15.20
			Fat	11.50
			Carbohydrate	17.95
Diet 4	**Chicks' mash**	300	Moisture	12.25
	Corn meal	300	Protein	10.39
	Dextrose	400	Ash	11.05
			Fibre	10.25
			Fat	5.55
			Carbohydrate	50.51

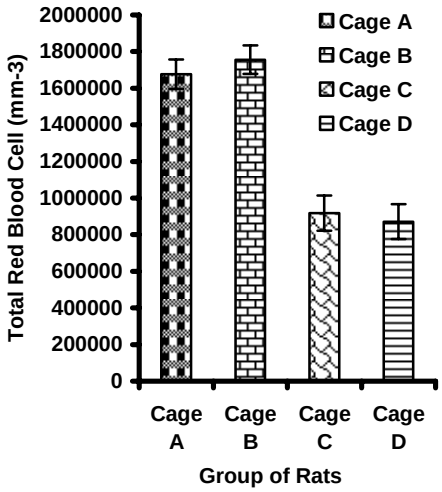

Figure 1: Mean of Total Red Blood Cell Count of trypanosome-infected female rats fed various protein-enriched diets

RESULTS

The ingredient and proximate compositions of the diets are shown in Table 1. There were significant differences ($P < 0.05$) among all the groups of rats in their total red blood cell count (Figure 1). On comparing the total red blood cell counts of all the rats fed different diets, there was no significant difference ($P > 0.05$) between the rats in Cage B (fed with Diet 2) and rats in Cage A (fed with Diet 1) and also between rats in Cage C (fed with Diet 3) and rats in Cage D (fed with Diet 4). However, it was observed that there was significant difference ($P < 0.05$) between rats in Cage A and those in Cages C and D and also between rats in Cage B and those in Cages C and D.

DISCUSSION

From the above result, it was observed that rats fed with Diet 2 had the highest total red blood cell count when compared with rats fed with Diets 1, 3 and 4. This indicated that adequate nutrition enhanced trypanotolerance. This agreed with Katungka-Rwakishaya (1996) observation that improvement on

host's nutrition was important in modulating the severity of pathophysiological effect of trypanosomiasis and also influenced the rate of recovery. The above result showed that balanced diet suppressed the aneamia caused by trypanosomiasis. Aneamia during trypanosomiasis has been reported by Shaw and Dusanic (1973), Ogwu *et al.* (1980), Ogwu and Nuru (1981), Tizard (1985), Stephen (1986). This also corresponds to the statement of Mora and Nestel (2000) that good maternal nutrition is vital to the health and reproductive performance of pregnant rats and the health, survival and development of the offspring. It is therefore inferred that Diet 2, a balanced diet having 20.1% crude protein produced the highest red blood cell count, showing the best suppression of aneamia in trypanosome-infected pregnant rat.

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PERFORMANCE RESPONSE AND EGG QUALITIES OF LAYING BIRDS FED ENZYME SUPPLEMENTED PALM KERNEL CAKE (PKC) BASED DIETS

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ABSTRACT

The performance response and egg qualities of laying birds fed enzyme supplemented PKC diets as replacement for maize was investigated with 210, 20 week old laying pullets of Dominant Black strain at the Teaching and Research Farm of the Delta State University, Asaba Campus, Nigeria. The birds which just come into lay were randomly allotted into seven dietary groups of 30 each in three replicates. The experiment was conducted for 11 weeks. Dietary treatments significantly (p<0.05) affected feed intake, Hen day percent, Egg weight, Feed efficiency (Kg feed: Kg eggs) and cost of feed per egg. Final live weight and body weight gains at end of the experiment were similar (p<0.05) among treatments. On egg qualities, only Haugh unit was significantly (p<0.05) improved with increased level of PKC which appeared to be better as rate of enzyme supplementation increases. The differences observed in the experiment on performance parameters appeared not to have established a consistence trend to strongly assert a conclusion but are indicative of the possibility of replacing maize with PKC in a laying birds diet up to 40 % when supplemented with Hemicell® enzyme. Other enzyme application methods may be investigated to see if better performance response trend can be achieved.

Keywords: Performance response, Egg qualities, Laying birds, Palm kernel cake, Enzyme

INTRODUCTION

There is no doubt that the animal protein need of Nigerians will continue to increase. The need to increase animal production aggressively is an understatement if the already shortfall in protein intake of the average Nigerian and the continuous increase in the nation's population are considered. Increased animal production may only be possible with adequate nutritional provision for the livestock of which poultry is very significant. Adequate nutrition with conventional feedstuffs (maize, soyabean meal, and fishmeal) is extremely expensive and could make animal products unaffordable. Therefore, alternative feed sources which are cheap, biologically qualitative or that can be enhanced and did not form food for man are the interest of nutritionist. Palm kernel cake, a bye- product of oil processing has adequate energy and protein content and is readily available. It however contains high level of fiber (12%) with a β-mannanqase concentration of 30% which is regarded as a powerful antinutritive fiber (McDonald *et al.,* 1995; Chot, 2006). In addition, the total Non-Starch Polysaccharide (NSP) level reaches 70%. These factors in PKC seem to affect its utilization in monogastrics especially in poultry feeding.

The use of enzymes has however been credited with possible enhancement of feed ingredients and improving performance of livestock to which they are fed (Sundu *et al.,* 2006). This however is not always the case. The appropriateness of enzyme to the ingredient is an important factor in the effectiveness of the enzyme. Linden (2005) reported that the utilization of Hemicell a β-mannanase/xylanase improved the performance equivalent of at least 100Kcal/kg increase in ME and uniformity was also improved. Since PKC contains a substantial concentration of β-mannan and high level of total NSP, the supplementation of PKC diet with Hemicell is expected to illicit improved utilization of the ingredient and improved performance.

Hemicell® supplementation of graded levels of PKC as replacement for maize with 0.05% enzyme level did not achieve an expected improvement in a broiler experiment (Akpodiete *et al.*; 2006). A higher level of enzyme supplementation was suggested. Hence this experiment was carried out to considered three enzyme (Hemicell®) supplementation levels on two PKC replacement levels in laying pullets diet.

MATERIALS AND METHODS

Site of Study: The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of the Delta State University, Asaba Campus, Delta State, Nigeria. The farm is located on longitude 60º 45´ E and latitude 60º 12´ N with an annual rainfall range of 1800mm to 3000mm and maximum day temperature of 27.5º C to 30.9ºC. Experimental Animals, Design and Management: A total of two hundred and ten 20 weeks old pullet birds of "Dominant black" were used for the study. They were divided into 7 groups of 30 birds in three replicates assigned into a completely randomized design. The birds were managed in deep litter system in a standard tropical open sided poultry house partitioned into 21 spaces with wire mesh to prevent mixing up. Normal management procedures as outlined for the tropics by Oluyemi and Roberts (2000) for laying birds were adopted. The experiment lasted for 11 weeks.

Experimental Diets: three based diets were formulated to contained 0%, 20% and 40% PKC as

replacement for maize in layer diet. The 0% PKC diet served as control. Three enzyme levels; 50g, 60g and 70g per 100kg of feed were supplemented to the 20% and the 40% PKC diets respectively. Thus, the 20% and the 40% PKC based diets now have 3 diets each diets respectively differing only by their enzyme concentrations giving a total dietary units of 7 (Table 1). Each of the dietary units was assigned to feed the seven groups of birds. The diets were formulated to supply 2600Kcal/kg ME and 17% crude protein.

Data Collection and Statistical Analysis: The birds were weighed at the beginning and end of the experiment to obtain the body weight and weight gains. Feed consumption was taken at the end of each week by subtracting the amount of feed left-over from the pre-weighed feed and divided by the number of birds per replicate. Egg production records were collected as the number of eggs laid per replicate, weighed and used to calculate the Hen day percent and egg weight for the period. Feed efficiency in term of egg was calculated per Kg weight of eggs and cost of feed per egg was computed from the prevailing market prices as at the time of the experiment. Internal qualities of egg were determined weekly for the four last weeks of the experiment on replicate basis and poled for the average values. Albumen weight and height, yolk weight, length and breath used for yolk index calculation; shell weight and thickness were measured and egg shape index, egg shape index (ESI), was calculated as egg breath divided by egg length. Haugh unit was calculated from the expression: $Hu = 100\log (H+ 7.57 – 1.7W^{0.37})$ where H = height of albumen (mm), W = weight of egg (g); shell surface area (SSA) was determined according to Lewis and Perry (1987) as $EW^{0.667} \times 4.67$ while yolk colour was subjectively scored by three persons using the Roche Colour Fan for the 4 weeks and the average recorded. All data were obtained on replicate basis. The obtained data were subjected to analysis of variance using IRISTAT statistical package. Means were separated using LSD at 5% probability level.

RESULTS AND DISCUSSION

The results of the performance characteristics are presented in Table 2. The initial live weight, final live weight and weight gains of birds fed the different dietary treatments were not significantly (P> 0.05) different among treatment means. Feed intake, hen-day production, egg weight, feed efficiency per Kg eggs were all significantly ($P < 0.05$) affected by the dietary treatment. Feed intake was highest ($P < 0.05$) for birds in treatment 3 where 20% PKC replacement level was supplemented with 60g of Hemicell® enzyme when compared with the 50g and 70g enzyme supplementation of same PKC replacement level but all other treatments were not differently ($P > 0.05$) affected. The response of the pullets to feed intake which was expected to increase with increase PKC inclusion levels (Ezishi and Olomu, 2004; Sundu *et al.,* 2005) did not follow suit. In fact, pullets fed the PKC diets with the exception of the treatment 3 group tend to eat less ($P > 0.05$) than the control with no PKC inclusion. This perhaps might be as a result of the enzyme supplementation which may have enhanced the quality of the PKC. However, there was no indication to whether increased enzyme supplementation levels improve the PKC utilization at the two levels of replacement. Nevertheless, the similarities in the weight gains of all treatment groups indicated that pullets effectively utilized the PKC diets even at 40% replacement level comparatively to the control diet. Hen-day production appeared to decline with increase PKC inclusion level which was significantly ($P < 0.05$) reduced in treatments 3, 5 and 7. Hen-day production of pullets was poorest in treatments 5 and 7 with 73% hen-day when 40% PKC was included in the diets. Treatment 6 which also had 40% PKC but 60g enzyme supplementation was closest to control diet in hen-day production with 88% compared to 92%. These were not significantly ($P > 0.05$) differently. While the results tend to show a poorer performance index with PKC utilization, the exceptional higher performance recorded for treatment 6 could hardly be explained. It can not be specifically attributed to enzyme supplementation. This is because hen-day production did not established any trend strongly tied to enzyme inclusion. At 20% PKC inclusion level, hen-day for pullets in the group supplemented with 60g enzyme was lower than those on 50g and 70g per 100Kg feed supplementation. Nonetheless, the general performance on hen-day production falls within the range reported in the tropics (Oluyemi and Roberts, 2000).

The results of the egg weights of pullets fed the experimental diets were not significantly ($P < 0.05$) different among all treatment means. This implied that nutrients supply from PKC diets are comparably utilized by pullets in all treatments as nutrient deficiency especially protein and methionine will affect egg size (Oluyemi and Roberts, 2000). Feed efficiency was significantly ($P < 0.05$) affected but did not follow any trend attributable to either PKC inclusion levels or enzyme supplementation rate. Feed efficiency for birds fed T2 and T4 (which had 20% PKC) but 50g and 70g enzyme supplementation respectively) and T6 (which had 60g enzyme supplementation at 40% PKC inclusion level) were similar ($P > 0.05$) to control but were significantly ($P<0.05$) better than other groups. Onifade and Babatunde (1998) and Sundu *et al.* (2005) had reported a decreased feed digestibility, apparent nitrogen retention and apparent calcium retention with increased level of PKC in broilers. The decreased feed digestibility was suggested to be due to broiler chickens limited ability to digest dietary fiber, such as β-mannan because of the absence of mannan degrading enzyme in their digestive tract (Sundu *et al.,* 2006). Therefore, the feed efficiency obtained for birds in this experiment in which there were comparable results even at 40% PKC inclusion may not be unconnected with the enzyme supplementation in these diets.

The cost of compounding a Kg of feed and cost of feed consumed per bird decreased ($P < 0.05$)

Table 1: Composition of Experimental Layer Diets

Ingredients(%)	0% T1	20% T2	20% T3	20% T4	40% T5	40% T6	40% T7
Maize	53.30	42.64	42.64	42.64	31.98	31.98	31.98
Soyabean meal	18.00	16.00	16.00	16.00	14.00	14.00	14.00
Palm kernel cake	—	10.64	10.64	10.64	21.32	21.32	21.32
Wheat Offal	14.50	13.50	13.50	13.50	12.30	12.30	12.30
Bone meal	3.00	4.50	4.50	4.50	6.00	6.00	6.00
Oyster shell	7.50	9.00	9.00	9.00	10.70	10.70	10.70
Fixed ingredients	3.70	3.70	3.70	3.70	3.70	3.70	3.70
Enzyme(Hemicell)	—	+	++	+++	+	++	+++
Calculated composition							
Energy(MEKcal/Kg)	2673	2573	2573	2573	2257	2257	2257
Crude Protein (%)	17.34	17.25	17.25	17.25	17.13	17.13	17.13
Calcium (%)	3.90	3.91	3.91	3.91	3.93	3.93	3.93
Phosphorus (%)	0.87	1.16	1.16	1.16	1.45	1.45	1.45
Methionine (%)	0.55	0.50	0.50	0.50	0.58	0.58	0.58
Lysine (%)	0.90	0.87	0.87	0.87	0.85	0.85	0.85
Fibre (%)	3.50	4.35	4.35	4.35	5.18	5.18	5.18

Fixed ingredients: Fishmeal, 3%; methionine, 0.25; salt, 0,20; premix, 0.25; Premix(Agricare-Mix): Vit. A, 10000i.u; Vit.D_3, 2000i.u; Vit.E, 5i.u; Vit.K, 2mg; Vit. B_2,4.2mg; Vit.B_{12}, 0.01mg; nicotinic acid, 20mg; folic acid, 0.05mg; choline,3mg; Mg,56mg; Fe,20mg; Cu,1.0mg; Zn,5.0mg; Co,1.25mg; Iodine,0.8mg. +(50g), ++(60g), +++(70g) Hemicell enzyme levels/100kg of feed.

Table 2: Performance Characteristics and Cost Analysis of Laying Pullets Fed Experimental Diets

Parameter	0% T1	20% T2	20% T3	20% T4	40% T5	40% T6	40% T7	SEM	Level Of Sig
Initial Lwt/bird(Kg)	1.52	1.53	1.53	1.53	1.53	1.46	1.48	0.08	n.s
Final Lwt/bird (Kg)	1.67	1.63	1.63	1.63	1.71	1.58	1.56	0.12	n.s
Weight gain/bird{Kg)	0.14	0.10	0.10	0.10	0.18	012	0.08	0.04	n.s
Feed Intake/bird/wk(Kg)	0.85^{ab}	0.80^{b}	0.87^{a}	0.80^{b}	0.82^{ab}	0.81^{ab}	0.82^{ab}	0.07	*
Hen-day Prod. (%)	92.18^{a}	84.01^{ab}	76.59^{bc}	82.35^{ab}	73.96^{c}	88.30^{a}	73.04^{c}	3.44	*
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Egg weight(g)	58.10	57.67	56.25	56.86	56.68	57.05	57.25	0.67	n.s
Feed efficiency/Kg egg	0.32^{a}	0.30^{a}	0.25^{b}	0.29^{a}	0.26^{b}	0.31^{a}	0.26^{b}	0.12	*
Cost/Kg feed (₳)	41.12^{a}	45.79^{b}	45.89^{b}	45.94^{b}	42.47^{c}	4257^{c}	42.67^{c}	0.48	*
Feed cost/bird/wk (₳)	41.75^{a}	36.63^{c}	39.83^{b}	36.77^{c}	34.95^{d}	34.40^{d}	34.83^{d}	0.48	*
Cost of feed/egg (₳)	6.96^{ab}	6.54^{b}	7.90^{b}	6.57^{b}	6.96ab	6.08^{c}	6.65^{b}	0.05	*

abc, Means within a row with different superscripts are statistically(P < 0.05) different.

Table 3: Egg quality of Laying Pullets Fed Experimental Diets

PKC Level Parameter	0% T1	20% T2	20% T3	20% T4	40% T5	40% T6	40% T7	SEM
Egg weight(g)	58.10	57.67	56.25	56.86	56.63	57.05	57.25	0.65
Haugh unit	72.67^{bc}	75.05^{ab}	74.24^{b}	76.57^{a}	76.28^{a}	76.68^{a}	75.52^{a}	0.67
Yolk weight(g)	17.91	16.78	17.09	17.03	16.85	17.33	17.28	0.39
Yolk index	0.30	0.30	0.30	0.31	0.31	0.31	0.31	0.06
Yolk colour	5.40	5.20	5.07	5.73	5.53	5.20	5.60	0.22
Albumen weight(g)	33.37	32.86	31.75	32.00	32.50	33.27	32.83	0.59
Albumen height(mm)	5.40	5.68	5.51	5.84	5.79	5.87	5.68	0.29
Egg shell weight(g)	5.93	5.99	5.87	5.95	5.90	5.93	5.92	0.13
Egg shell thickness(mm)	0.34	0.35	0.35	0.34	0.35	0.35	0.36	0.25
Shell surface area(SSA)	70.15	69.80	68.65	69.15	68.95	69.30	69.45	0.59
Egg shape index	0.71	0.70	0.70	0.71	0.70	0.69	0.70	0.07

abc, Means within a row with different superscripts are significantly(P< 0.05) different.

with increased inclusion level of PKC even with enzyme supplementation. The cost of feed per egg also appeared to decrease with increased inclusion of PKC in the diet although there were some exceptions. The cost of feed per egg was lowest (P < 0.05) for treatment 6(T6). In spite of the exceptions, the results are generally indications of possible gains realization for farmers with the use of PKC in the diets of pullets even at 40% inclusion level when supplemented with enzyme. Sundu *et al* (2005) had attributed low performance of birds fed PKC diets to imbalance of amino acids especially methionine and lysine. Although these amino acids are low in PKC, the most important factor affecting nutrient utilization in PKC is that high proportion of its nitrogen or protein is located inside the cell wall. Thus, the application of enzyme in this study falls within the two possible ways suggested by Sundu *et al.* (2005) for coping with the problems of PKC in feed formulation.

The results of the egg quality characteristics are presented in Table 3. All the external and internal egg qualities considered were not significantly (P > 0.05) affected by the dietary treatments with the

exception of the Haugh unit. The Haugh unit was significantly ($P < 0.05$) improved with increase inclusion level of PKC in the diets. This also tends to increase with increased enzyme supplementation rate at the two levels of PKC inclusion considered. The non-significant mean values obtained for almost all egg quality parameters in the treatments implied that nutrients were similarly and effectively utilized from all diets. This may have been realised by the application of enzyme to the PKC diets which compared favourably with the control diet. More so, the higher Haugh unit values obtained for the PKC-enzyme supplemented diets is an indication of better protein utilization as haugh unit is an index of protein utilization. High haugh unit is also an indication of the quality of the egg. The sustenance of body weight which even slightly appreciated comparably in all dietary treatments is a corrobotion of good nutrient utilization in all the diets. Thus, the use of PKC at the 20 and 40% inclusion levels as a replacement for maize in laying birds diet did not adversely affect their performances and the egg qualities appeared to be slightly improved with PKC diets. The application of enzyme may have led to the realization of these results. However, apart from Haugh unit, the effect of increasing the rate of enzyme supplementation is not properly defined as to whether higher supplementation rate will contribute to better performance. Nevertheless the experiment thus supports the use of enzyme in supplementing PKC diets and this can encourage PKC inclusion level up to 40%. Perhaps a better way of applying the enzyme to the PKC rather than incorporation to the whole diet may enhance the utilization of PKC nutrients to achieve a better result

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AMINO ACID DYNAMICS IN URINE OF *S. haematobium* PATIENTS IN ISHIELU LOCAL GOVERNMENT AREA OF EBONYI STATE, NIGERIA

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ABSTRACT

The Amino acid dynamics in urine samples of Schistosoma haematobium patients were studied. The study was to evaluate the possibility and validity of using amino acid patterns recorded in highly, lightly and uninfected urines as diagnostic tool for rapid screening of Schistosomiasis. Paper chromatography was used to separate the different amino acids in the urine samples. The chromatographic method used in this study revealed the existence of 9 essential and 7 non-essential amino acids in the urine samples. It equally showed that histidine, glutamine, serine and proline were absent in all the urine samples. Furthermore the presence of two marker amino acids can be used to identify individuals with heavy infection (cystein) and no infection (methionine).

Keywords: Amino acids, Rapid diagnosis, Schistosomiasis, *S. haematobium*, Ebonyi State

INTRODUCTION

Studies on amino acid pattern in different diseases and in different areas can be found in literature. In a similar study, the amino acid pattern in plasma and urine of Bilharzial Egyptian patients with different degrees of complications were investigated. The result obtained showed that in mansoniasis, accumulation of amino acids in the circulation was due to derangement in liver function which retards the utilization of amino acids in protein synthesis particularly in advanced stage of the disease (EL-Shobacki *et al.,* 1980). The amino acid profile of adult infected with *Brugia malayi* from 2 different endemic areas (Dushan and Libo) showed that both endemic areas contained 17 amino acids. The Dushan area contained serine but not tryosine and the Libo area lacked serine but contained tryosine (Cui *et al.,* 1996; Barus et al., (1995) analyzed amino acid spectra for crude protein (CP) of *Lingula intestinalis, Rutilus rutilus, Abramis brama and Blica bjoerkna* from 5 localities in South Moravia, Czech Republic. There was considerable similarity in the quantitative rankings of both essential amino acid (EAA) and non essential amino acids (NEAA). Amino acid profiles of *Anguillicola crassus* and *Philometra ovata* were reported consisting of seventeen amino acids (11 – essential and 6 non-essential) (Barus *et al.,* 1998a). Quantitative differences between the 2 species were statistically significant for 9 essential and 4 non essential amino acids (Barus *et al.,* 1998b).

MATERIALS AND METHODS

Urine samples were collected from secondary schools students in Ishielu Local Government Area of Ebonyi State. After the preliminary examination of the urine samples for *S. haematobium* egg using centrifuge filtration technique, 6 urine samples were used for amino acid pattern analysis, 2 each from highly infected individuals (>50 eggs/10ml urine), lightly infected individuals (<50 eggs/ 10ml urine) and uninfected individuals (O egg/10ml urine) respectively.

In the analysis, the method of Harbone (1973) was used. Using micro-pipette, 0.25ml of each urine sample was spotted on the chromatography paper and allowed to dry. The papers were ran twice to ensure better separation in a tank containing two solvent system (Phenol-water; 30/g of phenol and 10/ml of water). The chromatograms were brought out and allowed to dry in fume cupboard after each run.

The standards were prepared by dissolving 0.1/g each of standard amino acid and made up to 100/ml with water. They were spotted on prepared chromatography papers and allowed to dry and ran in the solvent after which they were dried in the fume cupboard. The whole chromatograms were sprayed with Ninhydrin and allowed for colour development in the oven for 5 minutes at 110^0c. The distances moved by the solvent and that moved by amino acids in each sample and each standard amino acid were noted. Their R_f values were found and by comparing the R_f values of the standard amino acids and that of each sample were noted. Each spot was excised and eluted with 5/ml of n-propanol water (7:10) solvent in test tube by continuous shaking for 5 minutes. The extract was filtered through whatman No.1 filter paper and absorbance of both the different amino acids in the samples as well as those of the standard amino acids were read in the spectrophotometer at 530/nm. Calculation of the concentration of each amino acid present in each sample was done using Beer Lambert Law as described by Plummer (1979). The differences in the common amino acids between males and females in highly, lightly and uninfected urine samples were tested for significance using student's t-test; difference was accepted at the probability level of $P<0.05$.

Table 1: Amino Acid Patterns and Concentrations of the Various Amino Acids in Urine of People with Different Grades of Infection with *S. haematobium*

Samples	Sex	Amino acid present	R_f value	Absorbance	Concentration mg/100/ml
1	**M**	**Aspartic acid**	0.21	0.04	40.00
Highly Infected		**Asparagine**	0.37	0.015	3.33
		Glutamate	0.42	0.04	32.00
		Threonine	0.54	0.025	1.67
		Valine	0.71	0.03	5.00
		Tryptophan	0.78	0.015	23.08
		Tryosine	0.63	0.02	23.53
		Glycine	0.48	0.015	7.69
		Cystein	0.32	0.12	120.00
2	**F**	**Asparagine**	0.37	0.115	25.56
Highly Infected		**Aspartic acid**	0.22	0.035	35.00
		Cystein	0.27	0.001	10.00
		Glycine	0.47	0.125	64.10
		Lysine	0.51	0.07	11.11
		Tryptophan	0.77	0.005	7.69
		Leusine	0.84	0.09	40.91
		Isoleucine	0.89	0.015	21.43
		Valine	0.74	0.03	5.00
		Arginine	0.70	0.045	75.00
		Phenylalanine	0.80	0.015	4.17
3	**M**	**Aspartic acid**	0.73	0.05	50
Lightly Infected		**Alanine**	0.57	0.025	13.89
		Valine	0.73	0.02	3.33
		Tryptophan	0.76	0.1	15.38
		Leusine	0.86	0.03	13.64
		Asparagine	0.38	0.055	12.22
		Glycine	0.45	0.14	71.79
		Lysine	0.50	0.01	1.59
		Tryosine	0.63	0.03	35.29
		Arginine	0.69	0.01	16.67
4	**F**	**Aspartic acid**	0.23	0.05	50
Lightly Infected		**Glutamate**	0.42	0.06	48
		Threonine	0.56	0.04	2.67
		Asparagine	0.37	0.06	13.33
		Tryosine	0.62	0.08	94.12
		Alanine	0.59	0.03	16.66
		Phenylalanine	0.82	0.017	4.72
		Leusine	0.85	0.04	18.18
5	**M**	**Aspartic acid**	0.26	0.05	50.00
Uninfected		**Tryptophan**	0.77	0.02	30.77
		Asparagine	0.37	0.05	11.11
		Glutamate	0.41	0.015	12.00
		Tryosine	0.62	0.04	47.00
		Arginine	0.69	0.02	33.33
		Valine	0.74	0.04	6.67
		Methionine	0.90	0.015	4.84
6	**F**	**Aspartic acid**	0.22	0.038	3.8
Uninfected		**Threonine**	0.55	0.04	26.67
		Glycine	0.44	0.065	33.33
		Alanine	0.57	0.004	2.22
		Tryptophan	0.78	0.01	15.38
		Phenylalanine	0.83	0.005	1.39
		methionine	0.92	0.025	8.06

RESULTS

The chromatographic method used in this investigation revealed the existence of 9 essential and 7 non-essential amino acids in urine. The 9 essential amino acids were arginine, tryptophan, leusine, valine, isoleucine, threonine, methionine, lysine and phenylalanine. The 7 non-essential amino acids were aspartic acid, asparagine, cystein, glutamate, glycine, tryosine and alanine (Table 1).

The different amino acids in the urine samples of highly, lightly and uninfected (male & female) separated in the different chromatography papers (Figures 1 – 6).

In highly infected urine samples, the male and female had aspartic acid, asparagine, valine, tryptophan, glycine and cystein in common but in different concentrations except for valine where they had the same concentration (5/mg/100/ml) (Table 1).

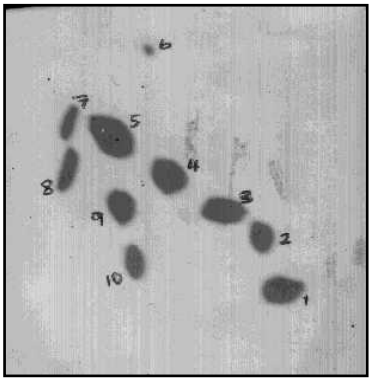

Figure 1: Amino acid profile of highly infected urine samples (male).
Key: 1 = Aspartic acid, 2 = Asparagine, 3 = glutatamate, 4 = threonine, 5 = Glycine, 6 = ----, 7 = Tryptophan, 8 = Tyrosine, 9 = glycine, 10 = Cystein

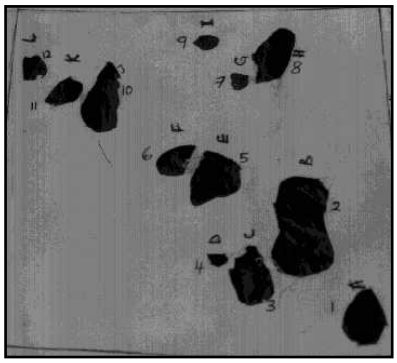

Figure 2: Amino acid profile of highly infected urine samples (female).
Key: 2 = Asparagine, 3 = Aspartic acid, 4 = Cystein, 5 = Glycine, 6 = Lysine, 7 = Tryptophan, 8 = Leusine, 9 = Isoleucine, 10 = Valine, 11 = Arginine and 12 = Phenylalanine

Figure 3: Amino acid profile of lightly infected urine samples (male).
Key: 1 = Aspartic acid, 2 = Alanine, 3 = Valine, 4 = Tryptophan, 5 = Leusine, 6 = Asparagine, 7 = Glycine, 8 = Tyrosine, 9 = glycine, 10 = Arginine

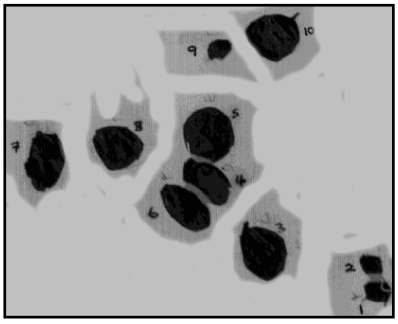

Figure 4: Amino acid profile of lightly infected urine samples (female)
Key: 1 = ----, 2 = ----, 3 = Aspartic acid, 4 = Glutamate, 5 = Threonine, 6 = Asparagine, 7 = Tryosine, 8 = Alanine, 9 = Phenylalanine, 10 = Leusine

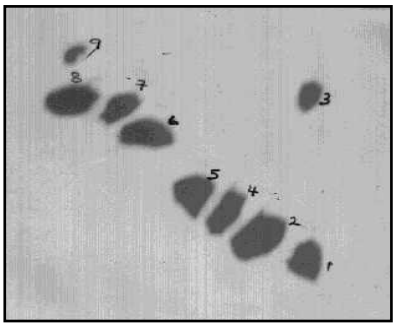

Figure 5: Amino acid pattern of uninfected urine samples (male)
Key: 1 = ----, 2 = Aspartic acid, 3 = Tryptophan, 4 = Asparagine, 5 = Glutamate, 6 = Tryosine, 7 = Arginine, 8 = Valine, 9 = Methionine

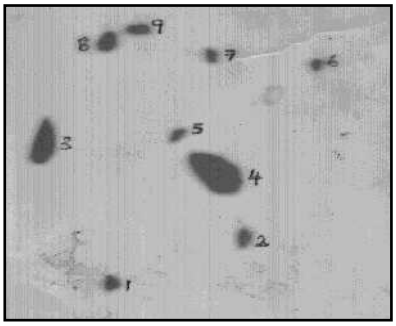

Figure 6: Amino acid pattern of uninfected urine samples (female)
Key: 1 = ----, 2 = Aspartic acid, 3 = Threonine, 4 = Glycine, 5 = Alanine, 6 = Tryptophan, 7 = Phenylalanine, 8 = Methionine, 9 = ----.

Glutamate, threonine and tryosine were seen in the male but not in the female urine while lysine, leusine, isoleusine, arginine and phenylalanine were seen in the female but not in the male urine (Table 1). In lightly infected urine samples, the common amino acids for both male and female were aspartic acid, alanine, leusine, asparagine and tryosine in different concentrations except for aspartic acid where a concentration of 50/mg/100/ml was recorded in both male and female. Valine, tryptophan, glycine, lysine and arginine were seen in the male but not in the female urine while glutamate, threonine and phenylalanine were seen in the female but not in the male urine (Table 1). In uninfected urine samples, aspartic acid, tryptophan and methionine were common to both male and female. Asparagine,

glutamate, tryosine, arginine and valine were seen in the male but not in the female while threonine, glycine, alanine and phenylalanine were seen in the female but not in the male urine (Table 1) T-test showed that there was no significant difference in the common amino acids between males and females in highly infected, lightly infected and uninfected urine samples ($P > 0.05$).

Qualitatively, aspartic acid, arginine, glutamate, glycine, tryptophan, tryosine, valine, threonine, phenylalanine and asparagine were present in highly infected, lightly infected and uninfected urine samples. Lysine and leusine were only seen in highly and lightly infected urine samples (Table 1) Alanine was only seen in lightly and uninfected urine samples. Histidine, glutamine, serine and proline were absent in all the urine samples. The amino acids that can be said to be the marker amino acids for highly infected and uninfected individuals are cystein and methionine respectively being only present in highly infected and uninfected urine samples respectively.

DISCUSSION

Four of the 20 amino acids, histidine, glutamate, serine and proline were absent in the urines with different grades of infection and also in uninfected urine samples. Their absence is not well understood but being essential amino acids, may have been reabsorbed by the kidney. A striking difference between infected and uninfected urine samples was the presence of methionine in uninfected urine samples and its absence in both highly and lightly infected urine samples. This may mean that the parasite, *S. haematobium* thrives on it so leading to its depletion and complete absence in both highly and lightly infected urine samples.

The presence of cystein in only highly infected urine samples may be that in high infection, *S. haematobium* promotes excess secretion of cystein and inhibits its reabsorption at the kidney level. The difference in the concentration of the amino acids in highly, lightly and uninfected urine samples which is not statistically significant may be that the dietary protein intake of the students in the endemic area is similar as most of them are from poor families.

Using this study, it can be safely said that two amino acids can be used as marker amino acids to quickly identify people with heavy infection (cystein) and no infection (methionine).

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REASSESSMENT OF ONCHOCERCIASIS PREVALENCE IN ETTEH, NIGERIA, AFTER A DECADE OF MASS MECTIZAN CHEMOTHERAPEUTIC INTERVENTION: PRELIMINARY REPORT

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ABSTRACT

A reassessment of the prevalence of onchocerciasis was carried out in Etteh community in Igbo-Eze North Local Government Area of Enugu state, Nigeria. The community has been known to be highly endemic for onchocerciasis. The assessment of endemicity was based on Rapid Assessment Method (RAM), which involved the use of two onchocercal indices namely the presence of palpable nodules and depigmentation (Leopard skin). Out of the 716 individuals examined consisting of 327 males and 389 females, the overall prevalence of palpable onchocercal nodules was 51.4%. The females had insignificantly (P>0.05) higher rate of onchocercomata (51.9%) than males (44.0%). The anatomical distribution of nodules in descending order of occurrence was pelvic region (26.3%), head and neck region (20.6%), thorax and lumbar (15.7%), upper limbs (14.5%), lower limbs (12.4%) and others (abdomen and shoulders, 5.9%). It is obvious that in spite of the decade-long, annual free distribution of Mectizan in the area, onchocerciasis prevalence is still high.

Keywords: Onchocerciasis, Mectizan, Reassessment, Nodules, Chemotherapy

INTRODUCTION

Human onchocerciasis is a filarial multisystem disease caused by infection with the nematode – O*nchocerca volvulus*. Onchocerciasis is the cause of clinical and epidemiological dermatologic, ophthalmologic, lymphatic and systemic manifestations with blindness and impaired vision as the most dangerous disabilities associated with the disease. The disease has also been implicated in cases of musculo-skeletal pain, epilepsy, inguinal hernias, secondary amenorrhea, spontaneous abortion, lactation difficulties, infertility and sterility, although some of these have not been proved (Okuliez *et al*, 2007). Onchocerciasis is a disease of considerable socio-economic and public health importance with a lot of implications.

The disease is endemic in 37 countries in Africa, Latin America and Yemen, where an estimated 123 million people are at risk of contracting the disease and 17 – 18 million are already infected. Approximately 95% of all infected people live in Africa (WHO, 1995; Okuliez *et al*., 2004), especially in the sub-Saharan region. The disease, therefore, constitutes a major public health problem and an obstacle to socio-economic development in the sub-region (Nwoke, 1990). Edungbola (1991) reported that out of over 80 million Nigerian population, as at that time, an estimated 40 million were at the risk of infection with about 7 million suffering from onchocerciasis; so of all the countries of the world, Nigeria has the greatest number of persons with onchocerciasis.

Etteh community has been identified as an onchocerciasis endemic area (Amazigo and Obikeze, 1991). Mass distribution of Mectizan in Etteh started in 1996 alongside other endemic communities of Enugu State, Nigeria as part of the African Programme for Onchocerciasis Control (APOC), launched by the World Bank in 1995 with the goal of eliminating onchocerciasis, as a public health problem.

It therefore became necessary to reassess the prevalence of onchocerciasis in Etteh community in order to establish the effectiveness or otherwise of Mectizan distribution in this area and to suggest reasons for continued endemicity, if the prevalence is still high. The survey would also lay down complete parasitological data on the disease in the community because the pre-treatment survey by Amazigo and Obikeze (1991) examined adolescent girls only.

MATERIALS AND METHODS

Study Area: The study area is Etteh located in the Northern part of Igbo-Eze North LGA of Enugu State and about 100 kilometers north of Enugu, the capital city of Enugu State.

Etteh is shares land borders with Olomaboro LGA of Kogi State to the east and Igala mela/ Adoru LGA of Kogi State to the west. The people therefore have a lot of cultural affinity with the Igala and Idoma speaking people of Kogi State, although geo-politically located in Enugu State. The languages spoken are Igbo, Igala and Idoma.

Table 1: Age and sex-related prevalence of onchocerciasis nodules and leopard skin depigmentation among Etteh population, Enugu State

Age Group (Yrs)	No. Examined			No. Positive for Nodules			No. Positive for Leopard Skin		
	M	F	Total	M	F	Total	M	F	Total
≤ 10	46	48	92	12 (27.3%)	14 (29.2%)	26 (28.3%)	1 (2.3%)	2 (4.2%)	3 (3.3%)
11-20	76	87	163	22 (28.9%)	26 (29.9%)	48 (29.4%)	3 (3.9%)	7 (8.0%)	10 (6.1%)
21-30	73	67	140	34 (46.6%)	26 (38.8%)	60 (42.9%)	13 (17.8%)	14 (20.9%)	27 (19.3%)
31-40	45	69	114	30 (66.7%)	45 (65.2%)	75 (65.8%)	13 (28.9%)	23 (33.3%)	36 (31.6%)
41-50	48	68	116	36 (75.0%)	50 (73.5%)	86 (74.1%)	17 (35.4%)	25 (36.8%)	42 (36.2%)
≥ 51	41	50	91	32 (78.0%)	41 (82.0%)	73 (80.2%)	20 (48.8%)	30 (60.0%)	50 (54.9%)
TOTAL	327	389	716	144 (44.0%)	202 (51.9%)	386 (51.4%)	67 (20.5%)	101 (26.0%)	168 (23.5%)

Table 2: Nodule rate, nodule load and anatomical location of onchocercal nodules among residents of Etteh, Nigeria

Age Group (Years)	Nodule rate	Nodule load	Distribution (%)					
			Head and Neck	Upper Limb	Lower Limb	Thorax and Lumbar	Pelvic Region	Others
≤ 10	37(40.2)	46	16 (34.8)	8 (17.4)	4 (8.7)	5 (10.9)	8 (17.4)	5 (10.9)
11-20	48(29.4)	67	20 (29.9)	11 (16.7)	7 (10.4)	9 (13.4)	13 (19.4)	7 (10.4)
21-30	60(42.9)	73	17 (23.3)	10 (13.7)	8 (11.0)	12 (16.4)	20 (27.4)	6 (8.2)
31-40	84(73.7)	95	19 (20.0)	14 (14.7)	13 (13.7)	16 (16.8)	26 (27.4)	7 (7.4)
41-50	73(62.9)	100	17 (16.8)	16 (15.8)	15 (14.9)	18 (17.8)	30 (29.7)	4 (4.0)
≥51	66(72.5)	110	12 (13.3)	12 (13.3)	14 (15.6)	17 (18.9)	32 (35.6)	13 (11.8)
TOTAL	368(51.4)	491	101 (20.6)	71 (14.5)	61 (12.4)	77 (15.7)	129 (26.3)	42 (5.9)

Etteh lies in the forest-savanna mosaic and guinea savanna transitional zones. Most of the people's farmlands are located on the extensive stream network of the Anambra River system which itself is a major tributary of the lower Niger River situated between latitude 6° 00´N and 7º 35´N and longitude 6º 43´ and 7º 42´W (Amazigo and Obikeze, 1991). The main occupation of Etteh people is farming and petty trading.

Subjects and Methods: A total of 716 subjects from 10 out of the 14 community clusters that constitute Etteh were chosen for the survey by purposive sampling (Ngomou and Walsh, 1993). All the community members who were eligible for Mectizan chemotherapy were eligible. These included individuals 5 years and above or height above 90cm or able to touch the opposite ear (Okoye *et al.*, 2006).

The enlisted subjects were examined by the Rapid Assessment Method (RAM) as detailed by Ngomou and Walsh (1993). The height and weight of each subject was taken to determine the appropriate dosage of Mectizan to be administered. A standard survey questionnaire was used to obtain further information towards achieving the research objectives.

RESULTS

Out of the 716 individuals examined consisting of 327 males and 389 females, the overall prevalence of palpable onchocercal nodules was 51.4 %.

The females had insignificantly ($P > 0.05$) higher rate of onchocercomata (51.9 %) than males (44.0 %) (Table 1).

The anatomical distribution of nodules in descending order of occurrence was pelvic region (26.3 %), head and neck region (20.6 %), thorax and lumbar (15.7 %), upper limbs (14.5 %), lower limbs (12.4%) and others (abdomen and shoulders, 5.9 %). The location of palpable nodules on the head and neck regions was highest amongst the ≤10 years age group (34.8 %), the frequency decreasing with age. The location on the upper limbs showed a similar pattern. On the contrary, location of nodules on the lower limbs, thorax/lumbar and pelvic regions increased with age (Table 2).

Leopard skin prevalence was 23.5 %. Females had a higher infection rate of 26.0 % than the males (20.5 %). The difference in infection rates between the sexes was not significant ($P>0.05$). Age-related prevalence of leopard skin showed that the prevalence of infection increased with age for both sexes.

DISCUSSION

The results of the reassessment of the prevalence of onchocerciasis in Etteh show that the community is still highly endemic for the disease after 10 years of mass distribution of Mectizan in the Local Government Area in particular and Enugu State in general. In 1990 – 1991, Amazigo and Obikeze (1991) conducted a survey in the community among the adolescent girls. The results of the survey showed that 87(36.6 %) out of the 238 adolescent girls

examined had onchocerciasis (shown by skin snip examination) while 110 (46.2 %) of the girls had onchodermatitis. This established Etteh as an endemic community since usually males and adults are expected to have higher prevalence than the adolescent girls. About 16 years after the Amazigo and Obikeze (1991) survey and 11 years after the onset of mass Mectizan distribution, it was found that Etteh community still has a high prevalence of onchocerciasis. The indices used for measuring endemicity are those recommended in the Rapid Assessment Method (RAM) (Edungbola *et al.,* 1993). These are the presence of palpable nodules and leopard skin (LS).

The prevalence rate of palpable nodules was 51.4 %, 51.9 % in females and 44.0 % in males. It is common for males to have higher rates of onchocerciasis indices but in this study, it was found that the females had an insignificantly higher nodule rate ($P > 0.05$) than males. This may be due to relatively similar exposures of males and females. Table 1 actually shows that from age ≤ 10 to age ≥ 51, there were no significant differences between the nodule rates in males and females. Sex related differences are usually attributed to occupational differences between males and females right from childhood. It is, therefore, possible that in this community, occupational differences are not pronounced.

Age related prevalence of nodules in Etteh appears to be more pronounced, as there is a consistent increase from age ≥ 10 to age ≥ 51 as shown in Table 1. This is in line with some other works. Okuliez *et al*. (2007) reported that the prevalence of onchocerciasis is lowest in individuals aged 0-10 years. Afterwards, the prevalence sharply increases, with a peak in individuals aged 20-30 years.

On the anatomical distribution of nodules, the pelvic region was found to harbour the largest number of nodules (26.3 %), followed by head and neck region (20.6 %), thorax and lumbar region (15.7 %), upper limbs (14.5%), lower limbs (12.4 %) and others (abdomen and shoulders, 5.9 %). This agrees with previous results in West African region that the highest numbers of nodules are found in the pelvic region (Choyce, 1972).

The location of palpable nodules on the head and neck region was highest in the 0-10 years age group (34.8 %) with the frequency decreasing with age. This trend had previously been reported by previous researchers (Amazigo *et al.,* 1993; Ubachukwu, 2004) and the reason for this observed trend is not yet clear. Ubachukwu (2004) suggested that it could be either as a result of more than one vector complex or the height of the children in relation to the height at which *Simulium damnosum* bites. It is possible that children are bitten more in the head and neck regions.

The prevalence of \leopard skin (L/S) was 23.5 % with females again having an insignificantly higher infection rate of 26.0 % than the males (25.0 %). The prevalence of this manifestation increased with age. This is as a result of the cumulative nature of human onchocerciasis. Leopard skin is a characteristic finding in older patients (Okuliez *et al.,* 2007; Nwoke *et al.,* 1989), but surprisingly, it was found to exist in lower age groups, although the rate was quite low. This is an evidence that infection starts quite early in this community.

Conclusion: From the results of the reassessment of the prevalence of onchocerciasis in Etteh community, it is obvious that in spite of the free distribution of Mectizan in the area, onchocerciasis prevalence is still high. This is most likely attributable to inefficiency and inconsistency in the distribution of Mectizan, such that there is no obvious impact of the drug on the community disease prevalence. If only few people take the drug, the likelihood is that they will be reinfected from those that did not take the drug. There is need to investigate the details of Mectizan distribution to discover why disease prevalence is still as high as was recorded in this study, including among the age group 0 – 10 years, who should have had reduced infection rates, if the community had been properly treated with Mectizan for the past 10 years.

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