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# QUESTIONNAIRE AS A TOOL FOR IDENTIFICATION OF HIGH RISK COMMUNITIES IN URINARY SCHISTOSOMIASIS RESEARCH

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**ABSTRACT**

***A study of Schistosomiasis haematobium infection in all the fifteen primary schools in Agulu town, Anaocha Local Government Area of Anambra State, was conducted using questionnaire. Out of the fifteen schools, 7 had pupils with urinary schistosomiasis infection. Ten villages out of 20 in the town were indicated to contribute individuals that attend the 7 schools. Umuowelle Primary School ranked first with a positivity rate of 54.2 % for response "yes" to "blood in urine" and 40.3 % for "Bilharziasis/schistosomiasis". To rate the diagnostic performance of the questionnaire parasitological urine screening was also conducted in all the schools. The results showed that using questionnaire as a diagnostic tool is highly specific (87.5 %) and sensitive (87.5 %). Questionnaire administration was also shown to be cheaper, with a cost 7 times less than parasitological urine screening as well as being time saving. The diagnostic performance of the questionnaire was good in view of its preliminary screening function.***

**Key words:** Questionnaire, Urinary Schistosomiasis, High risk situations, Rapid method

## INTRODUCTION

Trematode infections of the genus Schistosoma are among the most widespread parasitic diseases of tropical and subtropical areas. The public health impact and the magnitude of the problem are evident from the information on schistosomiasis available from WHO (1993). Lester *et al* (1995) reported that *Schistosoma haematobium* is present in 44 African countries. Recent studies in Tanzania on the community diagnosis of urinary schistosomiasis (Lengeler *et al* 1991a, 1991b) have demonstrated that simple, self - administered questionnaire could be distributed , in a cost - effective manner through an existing and administrative system, and that their diagnostic performance for identifying high risk communities was very good. The studies were based on indirect interview approach because the researchers were not personally involved in the interviewing. This represented an alternative and simplified methodology for health interviews by eliminating the need for a face - to - face (direct) encounter between the investigator and the respondent. The present study will test this approach in Agulu town of Nigeria, West Africa. Moreover, in today's developing country contexts in which field research is conducted, often lack adequate facilities and trained personnel. Scientific rigour also requires that often, studies take too long to meet the immediate needs of disease control programmes. Thus, there is a need for a more rapid method of assessing high - risk situations or diagnosing urgent problems.

## MATERIALS AND METHODS

**The Study Area:** The present study concentrates on *Schistosomiasis haematobium* in Agulu town in Anaocha Local Government Area (LGA), Anambra State, Nigeria where a lake implicated (Emejulu *et al* 1994) in the transmission of this disease is situated. Agulu is located between latitude $6^{o}06^{/}$N and Longitude $7^{o}03^{/}$E. coming from the South, the land is generally a steep dive towards the lake. The lake is fed partly from under ground and partly from a small inlet from across the bridge. It enjoys tropical type of climate. It is located the topography of the area promotes an even distribution of human population of relatively high density.

T**he Questionnaire:** The questionnaire (Table 1) was aimed at identifying the villages with urinary schistosomiasis. The questionnaire was not focused on schistosomiasis but on health and development problems of school children and their communities. This was to avoid a situation of respondents being influenced by the ideas they might already have had about schistosomiasis being a problem in the area or the personnel administering the questionnaire being tempted to select children for interview who they think might have schistosomiasis. The questions relevant to schistosomiasis are part of a list of several diseases and symptoms. A list of detailed instructions for the teachers was also attached to the questionnaire form (Lester, 1995).

**Questionnaire Testing:** The questionnaire was pre-tested using 2 primary schools in Onitsha town in Anambra State, Nigeria.

**Table 1: Questionnaire relevant to health research in primary schools of Agulu town**

**Explanation:** Put a mark √ for "yes" or a 0 for "no" and a dash – if the child does not remember or cannot answer. You have to answer the following questions. Each box is for only one child. If the boxes are not enough on one page, use the back. Return this sheet to the Head teacher. Thank you.

**Name of school:** _____ **Class:** _____

| **Pupils** | 1 | **2** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | → | x |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | | | | | | | | | | | | | | | | | | |
| **Sex (M/F)** | | | | | | | | | | | | | | | | | | |
| ***Question 1: Which of the following symptoms did you experience during the last month?*** | | | | | | | | | | | | | | | | | | |
| **Pupils** | 1 | **2** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | → | x |
| **Coughing** | | | | | | | | | | | | | | | | | | |
| **Itching** | | | | | | | | | | | | | | | | | | |
| **Headache** | | | | | | | | | | | | | | | | | | |
| **Fever** | | | | | | | | | | | | | | | | | | |
| **Abdominal pain** | | | | | | | | | | | | | | | | | | |
| **Blood in urine** | | | | | | | | | | | | | | | | | | |
| **Blood in stool** | | | | | | | | | | | | | | | | | | |
| **Diarrhoea** | | | | | | | | | | | | | | | | | | |
| ***Question 2: Which of the following disease did you experience during the last month?*** | | | | | | | | | | | | | | | | | | |
| **Pupils** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | → | x | |
| **Malaria** | | | | | | | | | | | | | | | | | | |
| **Diarrhoea** | | | | | | | | | | | | | | | | | | |
| **Skin disease** | | | | | | | | | | | | | | | | | | |
| **Eye disease** | | | | | | | | | | | | | | | | | | |
| **Bilharzias / Schistosomiasis** | | | | | | | | | | | | | | | | | | |
| **Respiratory infection** | | | | | | | | | | | | | | | | | | |
| **Worms** | | | | | | | | | | | | | | | | | | |
| **Abdominal problems** | | | | | | | | | | | | | | | | | | |

*X = total number of pupil sampled*

**Table 2: Distribution and positivity rates of urinary schistosomiasis in primary schools in Agulu**

| School | Villages located | No. Interviewed | No positive for Blood in Urine (%) | No positive for Bilharzias (%) |
|---|---|---|---|---|
| **Agunkwo P/S** | Amaorji | 70 | 0 | 0 |
| **Central P/S** | Odidama, Obe | 200 | 0 | 0 |
| **Chukwuka P/S** | Uhueme,Ukunu | 214 | 0 | 0 |
| **Community P/S** | Umunowu | 219 | 74 (33.8) | 45 (20.5) |
| **Ezeanyanwu P/S** | Odidama, | 223 | 0 | 0 |
| **Nwanchi P/S** | Nwanchi | 110 | 0 | 0 |
| **Obe P/S** | Obe | 233 | 5 (2.2) | 1 (0.4) |
| **Obeagu P/S** | Obeagu | 169 | 0 | 0 |
| **Onike P/S** | Okpu | 140 | 0 (0) | 0 (0) |
| **Practicing P/S** | Nkitaku, | 532 | 139 (26.1) | 83 (15.6) |
| **Udoka P/S** | Ukunu, Isiamaigbo | 189 | 9 (0) | 0 (0) |
| **Ugwuaba P/S** | Umunifite | 185 | 64 (34.6) | 39 (21.1) |
| **Umuowelle P/S** | Umuowelle | 201 | 109 (54.2) | 81 (40.3) |
| **Ifiteani P/S** | Ifiteani | 141 | 32 (22.7) | 15 (10.6) |
| **Nneogidi P/S** | Nneogidi | 186 | 52 (28.0) | 34 (18.3) |
| **Total** | | 3029 | | |

*P/S: Primary School*

This was to make sure that it sited the purpose and that the structure was adequate for the respondents who were also primary school pupils.

**Administration of the Questionnaire:** The questionnaires were taken to the Secretary of State Primary Education Board (SPEB) Anaocha Local Government Area, Neni, who had prior knowledge of the research. The Secretary then contacted the head teachers of the concerned schools. These head teachers collected the questionnaires from the SPEB Secretary on 14th Oct. 1999 and in turn instructed their teachers on what to do. Each class teacher was instructed to interview every child in the class and fill in the questionnaire based on the answers given by each pupil. The study was presented to the teachers as investigation of community problems and to the children as an overall health study. In all, fifteen primary schools with a total population of 3029 pupils were involved in the study.

During the survey, the Education Secretary was seen again after 1 week at the Local Government Headquarters to follow up progress and to resolve issues that arose. The head teachers of the various schools were also visited during the survey to monitor the progress. Within two weeks, the completed questionnaires were collected from the Education Secretary processing.

Because of the study design, no final consent could be obtained from the children or their parents; however, the issue was discussed with the head teachers through the Education Secretary.

**Costing:** The cost of transportation, equipment and other expenses were systematically recorded. The cost of teachers' working time in the assessment was not included since this was considered to be part of their duties within the frame work of the school health programme.

**Data Analysis:** Data were analysed using the method of Lester *et al* (1995).

**Parasitological Urine Screening:** All the 3029 children in the fifteen primary schools involved in the study provided urine samples. Samples of urine were collected between 12.00 am – 2 pm. This is the period for greatest egg output (Stimmel and Scott, 1956, Bradley, 1963). Visitation was made to each school on two different days of the week, except the Practicing School which was visited five times because it had over 500 pupils. The urine samples were processed using the sedimentation technique and the centrifugation method (McCullough and Magendantz, 1974). The samples containing ova were recorded. The financial cost, as well as days it took for the screening to be completed were noted and recorded so as to allow comparism with the questionnaire method.

## RESULTS

**Questionnaire Testing:** All the children in 2 selected primary schools in Onitsha (a total of 2,281) children were questioned. The children's questionnaires were filled in properly. The teachers were of the opinion that the children had no problems with the questions and that they were not confused during the interview.

**Response to Questions in the Study Area:** A total of 3,029 children from 15 primary schools located within the 20 villages in Agulu town were interviewed. The children's questionnaires were all returned within 2 weeks. The male: female ratio was 1:0:94 while the mean age of the children was 11.0 years in each of the 15 schools. All the questionnaires were filled in properly.

Table 2 shows that 7 schools namely Umuowelle Primary School, Umunifite Primary School, Umunowu Primary School, Practicing Primary School, Nneogidi Primary School, Ifiteani Primary School and Obeagu Primary School out of 15 had individuals with positive answers for blood in urine and bilharzia / schistosomiasis. These 7 schools were attended by children from 10 villages out of 20 in Agulu town. Umuowelle Primary School ranked first for positive answers for blood in urine and bilharzia while Ugwuaba Primary School ranked second while Obe Primary School ranked 7th (Table 3). The remaining 8 schools after Obe Primary School had no positive answer and were thus ranked last (12th). In Table 4 more males 27.3% and 18. 6% respectively had positive answer for blood in urine and bilharzia / schistosomiasis than females which had 26. 8% and 16.6 % for the respective factors. However, this was not statistically significant (t = 2.17, df = 12) at 5 % level.

**Table 3: Positivity rate ranking of primary schools (P/S) in Agulu with respect to schistosomasis**

| School | Percentage +ve blood in Urine | Percentage +ve Schisto / Bilharzia | Rank* |
|---|---|---|---|
| **Umuowelle P/S** | 54.2 | 40.3 | 1 |
| **Ugwuaba P/S** | 34.6 | 21.1 | 2 |
| **Community P/S** | 33.8 | 20.5 | 3 |
| **Nneogidi P/S** | 28.0 | 18.3 | 4 |
| **Practicing P/S** | 26.1 | 15.6 | 5 |
| **Ifiteani P/S** | 22.7 | 10.6 | 6 |
| **Obe P/S** | 2.2 | 0.4 | 7 |
| **Obeagu P/S** | 0 | 0 | 12 |
| **Onike P/S** | 0 | 0 | 12 |
| **Agunkwo P/S** | 0 | 0 | 12 |
| **Central P/S** | 0 | 0 | 12 |
| **Chukwuka P/S** | 0 | 0 | 12 |
| **Ezeanyanwu P/S** | 0 | 0 | 12 |
| **Nwanchi P/S** | 0 | 0 | 12 |
| **Udoka P/S** | 0 | 0 | 12 |

** Based on the % of positive answers to the question "Did you have bilharz/schisto?*

**Table 4: Positivity in relation to sex**

| School | No. of Male Interviewed | Number positive Blood in Urine / % | Bilhazia / Schisto % |
|---|---|---|---|
| **Umuowelle P/S** | 92 | 51(55.4) | 41 (44.6) |
| **Ugwuaba P/S** | 108 | 33(34.0) | 23(23.7) |
| **Community P/S** | 108 | 36(33.3) | 25?(23.1) |
| **Nneogidi P/S** | 85 | 23(27.1) | 17(20.0) |
| **Practicing P/S** | 263 | 68(25.9) | 43(16.3) |
| **Ifiteani P/S** | 71 | 17(23.9) | 8(11.3) |
| **Obe P/S** | 135 | 4(3.0) | 1(0.7) |
| **Total** | 851 | 232(27.3) | 158(18.6) |
| | **No. of Female interviewed** | **Blood in Urine %** | **Bilhazia /Schistoso %** |
| **Umuowelle P/S** | 109 | 58(53.2) | 39(35.8) |
| **Ugwuaba P/S** | 88 | 31(35.2) | 16(18.2) |
| **Community P/S** | 111 | 38(34.2) | 20(18.0) |
| **Nneogidi P/S** | 101 | 29(28.7) | 17(16.8) |
| **Practicing P/S** | 296 | 56(20.8) | 40(14.7) |
| **Ifiteani P/S** | 70 | 11(15.7) | 7(10.0) |
| **Obe P/S** | 88 | 1(1.1) | 0(0) |
| **Total** | 836 | 224(26.8) | 139(16.6) |

The result of parasitological urine screening is shown in Table 5. Umuowelle Primary school had the highest number of 111 (55.2 %) of infected individuals followed by Ugwuaba Primary School with infection rate of 80 (43.2 %).

In comparism, only one egg count positive Obeagu Primary School out of 7 was classified wrongly as negative by the questionnaire (sensitivity, $^6/_7$ = 85.7 %) and only one egg count negative Obe Primary School out of 8 was classified wrongly as positive (specificity, $^7/_8$ = 87. 5 % ). The positive and negative predictive values were 85.7 % and 87.5 % respectively.

**Table 5: Distribution and prevalence rates of urinary schistosomiasis**

| School | No. Examined | No. Infected | % Infected |
|---|---|---|---|
| **Agunkwo P/S** | 70 | 0 | 0 |
| **Central P/S** | 200 | 0 | 0 |
| **Chukwuka P/S** | 241 | 0 | 0 |
| **Community P/S** | 219 | 76 | 34.7 |
| **Ezeanyanwu P/S** | 223 | 0 | 0 |
| **Nwanchi P/S** | 110 | 0 | 0 |
| **Obe P/S** | 223 | 0 | 0 |
| **Obeagu P/S** | 169 | 7 | 4.1 |
| **Onike P/S** | 140 | 0 | 0 |
| **Practicing P/S** | 532 | 128 | 24.1 |
| **Udoka P/S** | 189 | 0 | 0 |
| **Ugwuaba P/S** | 185 | 80 | 43.2 |
| **Umuowelle P/S** | 201 | 111 | 55.2 |
| **Ifiteani P/S** | 141 | 33 | 23.4 |
| **Nneogidi P/S** | 186 | 55 | 29.6 |
| **Total** | 3029 | 450 | 16.2 |

**Table 6: Operational features and cost-comparisons between questionnaire screening and urine screening**

| Approach | Questionnaire | Urine screening |
|---|---|---|
| **Return rate (Coverage)** | 100% | 100% |
| **No. of school screened** | 15 | 15 |
| **No. of children screened** | 3029 | 3029 |
| **Total cost of approach N** | 2000 | 14,900 |
| **Cost per surveyed school** | 133.33 | 993.33 |
| **Cost per surveyed child** | .66 | 4.92 |
| **No. of times cheaper than Urine filtration** | ×7 | - |
| **Screening time (weeks)** | 2 | 16 |

Costs were calculated for the questionnaire action and for screening by urine (egg count). Table 6 shows that the cost per surveyed school through questionnaire was ₦133.33, while urine screening was ₦993.33. Thus the questionnaire approach was 7 times less expensive than urine screening. The screening time with questionnaire was 2 weeks while urine screening took 16 weeks.

## DISCUSSION

Schistosomiasis/Bilharzia positive schools according to the questionnaire screening were 7 out of 15 schools in Agulu town. These are attended by children from 10 villages viz: Umunowu, Nktitatu, Umubiala, Ifiteani, Obe, Nneogidi, Okpuifite, Amatutu, Umunifite and Umuowelle. This shows that through school positivity result, the endemic villages could be identified. This is in agreement with Jordan and Webbe (1982) who stated that the screening of school children is expected to give result that will represent the whole community since age-infection curves are similar in most setting where schistosomiasis is endemic.

The ranking of the school based on positive answer for blood in urine and bilharzias could provide basis for making decision about the communities that would require intervention and where the control measures should be carried out first. Jamison (1983) was of the opinion that such priority-setting will be affected by many considerations such as finance and time.

Due to the fact that it is not only schistosomiasis that brings about blood in urine, positivity rate for bilharziasis/schistosomiasis was used for most of the analysis. Higher positivity rate for blood in urine and bilharziasis was recorded in males than in females although this was not significant at 5% level (df=12). This could be as a result of more males visiting infected site.

For urine screening, just as with questionnaire study, Umuowelle Primary School recorded the highest prevalence rate followed by Ugwuaba Primary School. The schools identified with positive answers actually had *S. heamatobium* infected children except one school (Obeagu P/S) that had very low prevalence rate. Probably the positive children in this school had not started passing blood in urine as a result of few numbers of eggs in their bladder, thus the school was identified as negative school with questionnaire study. Also one negative school (Obe P/S) which was identified as a positive school by questionnaire may be as a result of female pupils menstruating during the period. The specificity and sensitivity rates as well as the negative and positive predictive values were thus high. Thus the diagnostic performance of the questionnaire was considered good in view of its preliminary screening function. The financial costs suggest that questionnaire method is more cost effective compared with screening using standard urine (10 ml) technique. Once the forms are printed, the necessary staff to executive the survey are already available at the schools through the help of the Education Secretary (ES) at the Local Government Headquarters. This is not the case for the parasitogical screening approach, which not only requires high financial and material outlay, but also involves the services of specialized teams of health workers.

The implication of the finding is that the questionnaire method gives mainly qualitative results and can therefore be used to single out rapidly and inexpensively high-risk and low-risk units. The parasitological screening of a large number of negative units can thus be avoided and available resources can be concentrated on the positive ones.

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# DIGESTIVE ENZYME ASSAYS IN THE GUT OF *Oreochromis niloticus* LINNAEUS 1757, *Parachanna* (*Channa*) *obscura* GUNTHER 1861 AND *Gymnarchus niloticus* CUVIER 1829

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**ABSTRACT**

***Digestive enzyme assays in the different gut regions (oesophagus, stomach, caecum, duodenum, ileum, and rectum) of three commercial African freshwater fish species: Nile tilapia Oreochromis niloticus, African snakehead fish Parachanna obscura, and African long knife fish, Gymnarchus niloticus, revealed an array of glycosidases (amylase, sucrase, maltase, lactase, and cellulase); proteases (chymotrypsin, pepsin, and trypsin) and lipases. The pattern of distribution and relative activity of the enzymes showed that the fishes are capable of digesting carbohydrates, proteins and lipids such that they complemented the different dietary habits of the three fish species. Enzyme activity was not detected in the oesophagus and rectum of the three fish species. The relative distribution and activity of the various enzymes were possibly induced by the nutritional requirements of the fishes.***

**Keywords**: Digestive enzymes, Fish gut, *Oreochromis niloticus*, *Parachanna obscura, Gymnarchus niloticus*

## INTRODUCTION

*Oreochromis niloticus* (Linnaeus 1757) (Family Cichlidae) is the most common species grown in ponds, it is robust, hardy and easy to handle. It is native to Africa, hence found in almost every river and lake. Adult *O. niloticus* are omnivorous but feed predominantly on phytoplankton and can utilize blue-green algae. Juveniles consume a wider range of food items (Jauncey and Ross, 1982). The length of the entire intestine of a tilapia is between five and eight times the length of the fish (Caulton, 1976; Jauncey and Ross, 1982). The intestine is differentiated into an anterior short thin-walled duodenum and a very long posterior section which has a smaller diameter (Bowen, 1982).

The African snakehead fish, *Parachanna* (*Channa*) *obscura* (Gunther 1861) (Family Channidae) is distributed from the Zaire basin through West Africa as far as the Senegal River in the west and the Nile in the east. It is of economic importance as food fish and has great potential for aquaculture in Africa (Fagbenro, 1989; Victor and Akpocha, 1992). *P. obscura* has been described by many authors as a pelagic predator feeding mostly on small fishes and insects (Imevbore and Bakare, 1970; Adebisi, 1981; Elliot, 1986; Victor and Akpocha, 1992; Fagbenro, 1996).

*Gymnarchus niloticus* (Cuvier 1829) (Family Gymnarchidae) is endemic to Africa and live mainly in swamps and is one of the most important commercial fishes in West Africa notably, Lake Chad, Kainji Lake and River Niger (Sagua, 1983). *G. niloticus* are caught throughout the year but become abundant during the wet season when they are speared by fishermen as they swim around their nests. *G. niloticus* is an electro-navigator; it emits continuous electric charges from its tail which it uses in locating objects and its prey. They are most active at night and according to Sagua (1983), young *G. niloticus* feeds on insects, medium sized on mixed diet of insects and fry of other fishes, while the adults are strictly piscivorous feeding mainly on small fish, *Alestes spp*.

The ability of an organism to digest a given material is dependent on the presence of appropriate enzymes. Enzymes responsible for the digestion of lipids, carbohydrates and proteins all occur in the pyloric caeca or intestinal mucosa of fish (Phillip, 1969). In this paper, the occurrence, distribution and relative activities of glycosidases, proteases and lipases in the different gut regions of *O. niloticus*, *P. obscura* and *G. niloticus* are described.

## MATERIALS AND METHODS

Twenty-five *O. niloticus* (SL, 14.40 - 16.50 cm), 25 *P. obscura* specimens (SL, 25.6 - 47.2 cm) and 25 *G. niloticus* specimens (SL, 25.6 - 47.2 cm) were obtained live from catches of artisanal fishermen in Ogbese and Ose rivers in south-western Nigeria. No sexual selection was made. They were transported live to Federal University of Technology Akure fish farm where they were kept unfed for 72 hours inside outdoor concrete tanks in order to bring them to similar physiological state as well as ensure the emptiness of the entire gut. They were anaesthetized with benzocaine (ethyl-p-aminobenzoate) at 100 mg/litre and dissected to remove the entire guts, later separated into the anatomatically distinct regions. The different gut regions were pooled, homogenized and the homogenates were centrifuged

at 1200 rpm for 30 minutes at 4 $^{o}$C. The supernatants were used as crude enzyme extracts without further purification.

Benedict's qualitative reagents were used for the qualitative assay of glycosidases (carbohydrases) following the methods of Olatunde *et al.* (1988). Glycosidases were assayed in a reaction mixture containing 2.0 ml of phosphate buffer (pH 7.0), 0.4 ml of 1 % of substrate and 0.2 ml of the enzyme extract. The test and control samples were incubated for one hour in a water bath at 37 $^{o}$C. Hydrolysis of polysaccharides and non-reducing disaccharides were determined in terms of the appearance of reducing properties using Benedict's reagents. An aliquot of 5.0 ml of the alkaline copper reagent of Benedict was added to 1.0 ml of the reaction mixture and heated for 30 minutes in a water bath at 100 $^{o}$C. The appearance of brick red to cream yellow precipitate was taken as an index of positive reaction. Quantitative assays were conducted using the dinitrosalicyclate (DNS) methods described by Plummer (1978). Each reaction mixture comprised 0.4 ml of 1 % substrate, 0.2 ml phosphate buffer (pH 7.0), 1.6 ml of alkaline 3, 5-dinitrosalicyclic acid reagent (DNSA) and 0.2 ml of the enzyme extract. The reaction mixtures for test and control samples were heated for 30 minutes in a water bath at 100 $^{o}$C. Each of the mixtures was made to 4.0 ml by diluting with 1.6 ml distilled water. The amount of reducing sugars produced on enzymatic reaction was estimated colorimetrically and the absorbance read at 550 nm on a spectrophotometer.

Qualitative determination of proteases followed the method of Balogun and Fisher (1970). Trypsin and chymotrypsin were estimated in a reaction mixture consisting of 1 % alkaline casein (pH 7.6) and 0.5 ml of the enzyme extract. The test and control samples were incubated simultaneously for one hour in a water bath at 37 $^{o}$C. After incubation, 1% acetic acid was added drop by drop. Increase in turbidity indicated the presence of the enzyme. Pepsin was estimated in a reaction mixture consisting of 1% acid casein (pH 2.0) and 0.5 ml of the enzyme extract. The test and control samples were incubated simultaneously for one hour in a water bath at 37 $^{o}$C. After incubation, 1% sodium acetate was added drop by drop. A change in colour indicated the presence of pepsin. Quantitative determination of proteases followed the method of Laskowsky (1955) and Herriott (1955). Trypsin and chymotrypsin were determined in a reaction mixture comprising 10 mg of hide powder azure (HPA), 2.0 ml phosphate buffer (pH 8.0) and 0.5 ml of enzyme extract. The reaction mixture for the determination of pepsin was similar except that the phosphate buffer was at pH 2.0. The test and control samples were incubated for one hour at 37 $^{o}$C. After incubation, 3.0 ml of ice-cold phosphate buffer was added, the mixture filtered immediately and the absorbance read at 595 nm on a spectrophotometer.

The methods described by Ogunbiyi and Okon (1976) were used to determine the qualitative and quantitative activity of lipases. The reaction mixture comprised equal volumes of 1.0 ml of 25 % olive oil emulsion (ph 7.0) and 1.0 ml of enzyme extract. The test and control samples were incubated simultaneously for one hour in a water bath at 37 $^{o}$C. After incubation, 3.0 ml of 95 % ethanol and two drops of phenolphthalein were added. The reaction mixture was titrated against 0.05N sodium hydroxide to a similar pink colour. Increase in titre value indicated the presence of lipases.

## RESULTS AND DISCUSSION

***Oreochromis niloticus:*** A variety of glycosidases (amylase, sucrase, maltase and cellulase), proteases (trypsin, chymotrypsin and pepsin) and lipases were detected in the stomach, duodenum and ileum of *O. niloticus* gut. Their distribution and activity varied along the entire length of the fish gut, and are presented in Table 1. Lactase was not detected in the entire gut of *O. niloticus*. Akintunde (1985) observed a similar general pattern of enzyme distribution in *Sarotherodon galilaeus* (Table 1), which like *O. niloticus*, has a planktivorous dietary habit (Akintunde, 1976). The variety of glycosidases detected (Table 1) indicate the ability of *O. niloticus* to digest a variety of carbohydrate food components. The occurrence of cellulase in the entire gut regions is suspected to be of exogenous microbial origin. The concentration, specific activity and distribution of trypsin, chymotrypsin, amylase and esterase have been measured from the intestine of *O. mossambicus* (Fish, 1960; Nagase, 1964; Moriarty, 1973). Fish (1960) found that a predominantly herbivorous tilapia had amylase activity distributed throughout the gastro intestinal tract. *O. niloticus* is established as an omnivore, feeding on a variety of food items, therefore it is expected that it will possess the array of enzymes required to digest the food. From the foregoing, it is evident that *O. niloticus* is well equipped to digest carbohydrate, protein and lipid components in its diet.

***Parachanna obscura:*** Various glycosidases (amylase, sucrase, maltase and lactase), proteases (trypsin, chymotrypsin and pepsin) and lipases were detected in the different regions of *P. obscura* gut. Their distribution and activity varied along the entire length of the fish gut, and are presented in Table 2. Cellulase was not detected in the entire gut of *P. obscura*. The variety of glycosidases detected (Table 2) indicate the ability of *P. obscura* to digest a variety of carbohydrate food components. The relatively higher activity levels of proteases, particularly in the pyloric caeca and duodenum (Table 2), was not surprising taking cognizance of the large proportion of protein components (fish, insects) in its natural diet (Fagbenro, 1996). A similar general pattern of protein-hydrolyzing enzymes distribution was detected in *Malapterurus electricus* (Table 4), which like *P. obscura*, has a piscivorous dietary habit (Fagbenro *et al.*, 2001). This is the first record of the digestive enzyme activities in *P. obscura,* which is known to be piscivorous, feeding mainly on insects and small fishes.

**Table 1: Assays of digestive enzymes in the gut of *Oreochromis niloticus***

| | Stomach | Duodenum | Ileum |
|---|---|---|---|
| **GLYCOSIDASES**[1] | | | |
| **α-amylase** | 0.951 ± 0.069 a | 0.758 ± 0.084 b | 0.421 ± 0.013 c |
| **Sucrase** | 1.476 ± 0.189 a | 0.784 ± 0.233 b | 0.609 ± 0.018 b |
| **Maltase** | 2.844 ± 0.009 | 2.777 ± 0.067 | 2.810 ± 0.015 |
| **Lactase** | ND | ND | ND |
| **Cellulase** | 2.879 ± 0.006 | 2.845 ± 0.048 | 2.828 ± 0.040 |
| **PROTEASES**[2] | | | |
| **Chymotrypsin** | 0.025 ± 0.006 b | 0.172 ± 0.043 a | 0.150 ± 0.038 a |
| **Trypsin** | 0.166 ± 0.048 b | 0.261 ± 0.089 a | 0.273 ± 0.138 a |
| **Pepsin** | 0.292 ± 0.040 a | 0.118 ± 0.000 b | 0.174 ± 0.040 b |
| **LIPASES**[3] | 34.72 ± 3.15 b | 40.15 ± 3.89 b | 96.02 ± 6.92 a |

*Values (Mean ± standard deviation) in the same row with dissimilar alphabets are different (P= 0.05) ND = not detected [1] mg glucose/min/mg protein at 37°C [2] change in optical density at 595 nm/hr/mg of L-tyrosine/hr at 37°C [3] milliequivalents of fatty acids/mg protein/hr at 37°C*

**Table 2: Assays of digestive enzymes in the gut of *Parachanna obscura***

| | Stomach | Caecum | Duodenum | Ileum |
|---|---|---|---|---|
| **GLYCOSIDASES**[1] | | | | |
| **α-amylase** | 0.065 ± 0.069 b | 0.225 ± 0.163 a | 0.023 ± 0.010 b | 0.040 ± 0.025 b |
| **Sucrase** | 0.120 ± 0.018 b | 0.224 ± 0.173 a | 0.107 ± 0.057 b | 0.211 ± 0.046 a |
| **Maltase** | 1.408 ± 0.137 b | 2.357 ± 0.547 a | 0.968 ± 0.330 c | 1.145 ± 0.506 b |
| **Lactase** | 2.695 ± 0.022 a | 1.748 ± 0.061 b | 1.001 ± 0.043 c | 1.628 ± 0.153 b |
| **Cellulase** | ND | ND | ND | ND |
| **PROTEASES**[2] | | | | |
| **Chymotrypsin** | 0.025 ± 0.007 b | 0.175 ± 0.059 a | 0.157 ± 0.073 a | ND |
| **Trypsin** | 0.040 ± 0.012 b | 0.260 ± 0.014 a | 0.196 ± 0.035 a | 0.084 ± 0.042 b |
| **Pepsin** | 0.385 ± 0.035 a | 0.251 ± 0.057 b | 0.176 ± 0.014 c | 0.139 ± 0.041 c |
| **LIPASES**[3] | 73.19 ± 5.33 b | 64.30 ± 5.09 b | 119.56 ± 9.94 a | 88.93 ± 7.26 b |

*Values (Mean ± standard deviation) in the same row with dissimilar alphabets are different (P= 0.05); ND = not detected, [1] mg glucose/min/mg protein at 37°C, [2] change in optical density at 595 nm/hr/ mg of L-tyrosine/hr at 37°C, [3] milliequivalents of fatty acids/ mg protein/hr at 37°C*

**Table 3: Assays of digestive enzymes in the gut of *Gymnarchus niloticus***

| | Stomach | Caecum | Duodenum | Ileum |
|---|---|---|---|---|
| **GLYCOSIDASES**[1] | | | | |
| **α-amalylase** | 0.39 ± 0.014 b | 0.063 ±0.048 a | 0.040 ± 0.008 b | 0.020 ± 0.000 c |
| **Sucrase** | ND | ND | ND | ND |
| **Maltase** | 0.120 ± 0.071 c | 0.077 ± 0.052 b | 0.057 ± 0.0047 b | 0.037 ± 0.010 c |
| **Lactase** | 0.420 ± 0.094 | 0.370 ± 0.035 | 0.300 ± 0.008 | 0.330 ± 0.014 |
| **Cellulase** | ND | ND | ND | ND |
| **PROTEASES**[2] | | | | |
| **Chymotrypsin** | 0.010 ± 0.005 b | 0.268 ± 0.086 a | 0.251 ± 0.072 a | ND |
| **Trypsin** | 0.017 ± 0.009 b | 0.277 ± 0.076 a | 0.200 ± 0.069 a | ND |
| **Pepsin** | 0.280 ± 0.194 a | 0.083 ± 0.068 b | 0.030 ± 0.022 b | ND |
| **LIPASES** | ND | ND | ND | ND |

*Values (Mean ± standard deviation) in the same row with dissimilar alphabets are different (P= 0.05), ND = not detected, [1] mg glucose/min/mg protein at 37°C, [2] change in optical density at 595 nm/hr/ mg of L-tyrosine/hr at 37°C, [3] milliequivalents of fatty acids/mg protein/hr at 37°C*

**Table 4: Digestive enzymes assayed in the guts of selected tropical African fishes**

| | ***S. m.*** | ***E. n.*** | ***P. p.*** | ***S. g.*** | ***C. g.*** | ***C. i.*** | ***H. b.*** | ***H. n.*** | ***M. e.*** | ***O. n.*** | ***P. o.*** | ***G. n.*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GLYCOSIDASES** | | | | | | | | | | | | |
| **Amalylase** | + | + | - | + | + | + | + | + | + | + | + | + |
| **Cellulase** | - | - | - | - | - | + | + | + | - | + | - | - |
| **Lactase** | - | - | - | - | + | - | - | + | - | - | + | + |
| **Maltase** | - | - | - | + | + | + | + | + | + | + | + | + |
| **Sucrase** | - | - | - | - | + | + | + | + | - | + | + | - |
| **Salicinase** | - | - | - | - | - | + | + | - | - | - | - | - |
| **Trehalase** | - | - | - | - | - | + | + | - | - | - | - | - |
| **PROTEASES** | | | | | | | | | | | | |
| **Chymotrypsin** | - | - | - | + | - | + | + | + | + | + | + | + |
| **Trypsin** | + | + | + | + | + | + | + | + | + | + | + | + |
| **Pepsin** | + | + | + | + | + | + | + | + | + | + | + | + |
| **LIPASES** | - | - | - | + | + | + | + | + | + | + | + | - |
| **References** | Olatunde and Ogunbiyi (1977) | | | Akintunde (1985) | Olatunde *et al.* (1988) | Fagbenro (1990) | Fagbenro *et al.* (1993) | Fagbenro *et al.* (2000) | Fagbenro *et al.* (2001) | This study | | |

*S. m. = Schilbe mystus, E. n. = Eutropius niloticus, P. p. = Physalia pellucida, S. g. = Sarotherodon galilaeus, C. g. = Clarias gariepinus C. i. = Clarias isheriensis, H. b. = Heterobranchus bidorsalis, H. n. = Heterotis niloticus, M. e. = Malapterurus electricus, O. n. = Oreochromis niloticus, P. o. = Parachanna obscura, G. n. = Gymnarchus niloticus*

It is expected that high activity of proteases and lipases will be recorded as they are required to digest the major food items in the diet. From the foregoing, it is evident that *P. obscura* is well equipped to digest carbohydrate component in addition to both protein and lipid components in its diet.

***Gymnarchus niloticus:*** The distribution and activities of glycosidases and proteases along the entire length of the *G. niloticus* gut are presented in Table 3. Sucrase and cellulase were not detected in the entire gut of *G. niloticus* Lipases were also not detected in the entire gut of *G. niloticus*. Proteases activities were not detected in the ileum region in the gut of *G. niloticus*. The lower activity levels of glycosidases in the entire gut regions and the relatively higher activity levels of proteases, were not surprising taking cognizance of its strict piscivorous diet in the wild reported by Sagua (1983). Pepsin would hardly be expected to occur in the two distal gut regions since they are active only in strongly acid media found in the stomach. Fagbenro *et al*. (2001) observed a similar general pattern of proteases distribution in the electric catfish, *Malapterurus electricus* (Table 4), which also has a strictly piscivorous dietary habit (Sagua, 1979; Fagbenro *et al*., 2001). This is the first record of the digestive enzyme activities in *G. niloticus,* which is known to be piscivorous, feeding almost exclusively on fishes. It is expected that high activity of proteases will be recorded as they are required to digest the major food items in the diet. From the foregoing, it is evident that *G. niloticus* is well equipped to digest carbohydrate component in addition to protein component in its diet; and there is no evidence of its ability to digest lipid components of food items.

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# HAEMATOLOGICAL PROFILE OF *Parachanna* (*Channa*) *obscura* GUNTHER 1861, *Malapterurus electricus* GMELIN 1789 AND *Malapterurus minjiriya* SAGUA 1987

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**ABSTRACT**

***Reference values for some haematological indices of Parachanna obscura, Malapterurus electricus and Malapterurus minjiriya were determined. The mean ± SD values for erythrocyte count (Ec), leucocyte count (Lc), haematocrit (Hct), haemoglobin concentration (Hbc), erythrocyte sedimentation rate (ESR), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and plasma protein content (g/dl) determined for P. obscura were 2.00 ± 0.71 x $10^{12}$ /litre, 40.10 ± 1.32 x $10^{9}$ /litre, 26.40 ± 3.89 %, 11.48 ± 1.55 g/dl, 13.12 ± 1.26 mm/h, 131.70 ± 108.20 fl, 57.28 ± 43.25 pg, 43.48 ± 6.97 g/dl, 62.90 ± 9.70 g/dl respectively. Ec, Lc, Hct, Hbc, ESR, MCV, MCH, MCHC and plasma protein content determined for M. electricus were 1.96 ± 0.17 x $10^{12}$ /litre, 31.87 ± 2.30 x $10^{9}$ /litre, 32.03 ± 1.94 %, 7.08 ± 0.22 g/dl, 2.56 ± 0.53 mm/h, 158.59 ± 5.16 fl, 35.24 ± 1.79 pg, 0.225 ± 0.018 g/dl and 52.89 ± 7.23 g/dl, respectively. Ec, Lc, Hct, Hbc, ESR, MCV, MCH, MCHC and plasma protein content determined for M. minjiriya were 2.09 ± 0.21 x $10^{12}$ /litre, 38.48 ± 3.10 x $10^{9}$ /litre, 34.04 ± 2.15 %, 8.28 ± 0.25 g/dl, 2.71 ± 0.58 mm/h, 168.15 ± 8.01 fl, 36.43 ± 2.17 pg, 0.255 ± 0.027 g/dl and 50.85 ± 9.86 g/dl, respectively.***

**Keywords**: Haematological profile, *Parachanna obscura, Malapterurus electricus*, *Malapterurus minjiriya*

## INTRODUCTION

The African snakehead fish, *Parachanna* (*Channa*) *obscura* (Gunther 1861) (Family: Channidae) is distributed from the Zaire basin through West Africa as far as the Senegal River in the West and the Nile in the east (Leveque *et al*.,1991). It is of economic importance as food fish in freshwater capture fisheries and has great potential for aquaculture in Africa. Three species of the endemic African electric catfish genus, *Malapterurus* (Lacepede 1803) (Family Malapteruridae), are recognized from tropical Africa (Leveque *et al*. 1991), namely *M. electricus* (Gmelin 1789), *M. minjiriya* (Sagua 1987) and *M. microstoma* (Lacepede 1803). Both *M. electricus* and *M. minjiriya* occur in commercial catches in West Africa (Reed *et al*., 1967; Sagua, 1987; Raji and Olaosebikan, 1998).

The use of haematological characteristics in evaluating the health status of fish as a tool for its management under captive rearing is well established and the knowledge of the haematological profile of a fish also indicates its dietary sufficiency and physiological response to environmental stress. The haematological profile of few tropical African catfish species are well documented in literature (Kori-Siakpere, 1985; Fagbenro *et al*.,1993; Erondu *et al*.,1993; Etim *et al*.,1999) but those of electric catfishes have not been reported. This study reports for the first time, the 'normal' haematological profile of *P. obscura, M. electricus* and *M. minjiriya* specimens, and compares it with that of other freshwater fish species.

## MATERIALS AND METHODS

Twenty-five adult live *P. obscura* (standard length, 13.8-24.2 cm; somatic weight, 56.7-194.3 g) were obtained from a Government fish farm and kept in glass tanks (120 litre capacity) supplied with filtered and aerated tap water. Twenty-five adult *M. electricus* and 25 adult *M. minjiriya* specimens (18.5 - 27.4 cm standard length, 88.7 - 209.1 g weight) were obtained live from catches of artisanal fishermen in Lokoja, the confluence of River Niger and Benue Rivers in Nigeria. All fishes were considered healthy on the basis of their appearance and the absence of obvious signs of disease. No sexual selection was made. Blood was collected from the caudal vein of each fish using separate heparinized disposable syringes and hypodermic needles. The determination of blood parameters followed the methods of Daramandy and Davenport (1985) and Svobodova *et al*. (1991) as follows:

**Haematrocit (Hct):** was measured after centrifugation at 15000 rpm using an MSE micro centrifuge.

**Haemoglobin Concentration (Hbc):** The indirect acid haematin (Sahli) method was used. This involves the use of a special haemoglobinometer and pipette. Haemoglobin concentration was converted to acid haematin by the action of 0.1N HCl using 0.02 ml pipette. The graduated tube was filled with 20 ml 0.1N HCl and 0.02 ml of blood sample added. The mixture was allowed to stand for 5 minutes and then few drops of distilled water were added until the colour matched the standard. Haemoglobin concentration was later estimated as: Hbc = Value obtained x 17.2gm / 100ml ÷100

**Leucocyte Count (Lc):** The haemocytometer was also used for Lc determination with 0.8 cm objective of the microscope and large squares (area = 1 $mm^2$, depth = 0.1mm) having volume of 0.1$mm^3$ and dilution factor of 20. With four squares used the total count per $mm^3$ was obtain as: 20 x 1 x L cells ÷ 0.4 = 50 x L cells, where L= number of leucocytes counted.

**Erythrocyte Count (Ec):** was determined in heparinized blood diluted by the Haymen solution at a ratio of 1:200. Neubauer improved haemocytometer placed on a compound microscope stage was used to count/estimate the erythrocyte population. The number of cells counted, R, (average of two fields) was multiplied by the dilution factor and the volume factor. Each smallest square has a volume of 1/4000 $mm^3$ (area = 1/4000 $mm^3$, depth = 1/10 mm) and counting done in 80 squares with the sum total volume if 1/50 $mm^3$ the dilution factor was 200. The Ec was obtained as: 200 x 50 x R cells = 10. 000 x R

**Total Plasma Protein:** This was determined by the photometric method based on mauve-coloured complex formed by protein and peptides with a burette agent inside, and was estimated as:
Absolute test x concentration of standard. ÷ Absolute standard, where concentration of standard = 50 g and Absolute standard = 5 g

**Total Plasma Lipid:** The Bio-Lab-Test Celkove Lipid (TL) was used which is based on the reaction of unsaturated lipids and fatty acids, phospholipids and cholesterol with phosphovanillin agent a fear preceding hydrolysis by sulphuric acid.

**Erythrocyte Sedimentation Rate (ESR):** Wintrobe haematocrit tube was filled with the fish blood samples and then placed in perfectly vertical position using a wooden sedimentation rack for one hour at ambient temperature (25$^oC$). The erythrocyte sedimentation rate was determined using haematocrit reader. The erythrocyte column was estimated as % of the total column of the blood and the erythrocyte sedimentation rate within an interval of one hour.

**Mean Corpuscular Volume (MCV):** The mean corpuscular volume is expressed in fentolitres (fl) as: MCV = Hct X 1000 ÷ Ec

**Mean Corpuscular Haemoglobin (MCH):** The mean corpuscular hemoglobin is expressed in Picogrammes (Pg) as: MCH = Hbc÷ Ec

**Mean Corpuscular Haemoglobin Concentration (MCHC):** This was calculated from the haemoglobin concentration value in g $l^{-1}$ and from the haematocrit value using the equation: MCHC = Hbc ÷ Hct X 1000.

Three determinations for each of the haematological indices were made for 25 specimens of each fish species (N = 25). The means and standard deviation (SD) were calculated for all the values obtained.

## RESULTS AND DISCUSSION

**Erythrocyte Count:** Generally, erythrocyte counts (Ec) are used as indicators for anaemia. Mean erythrocyte counts and standard deviation (±SD) obtained for *P. obscura, M. electricus* and *M. minjiriya* were 2.00 ± 0.71, 1.96 ± 0.17 and 2.09 ± 0.21 x $10^{12}$/l, respectively (Table 1), and were comparable to those reported for *H. bidorsalis* (Fagbenro *et al*., 1993) and *C. furcatus* (Etim *et al*., 1999), but were higher than values of 1.33 – 1.77 x $10^{12}$/l reported for other African freshwater fishes (Table 2). Blaxhall and Daisely (1973) noted that fish biologists rely more on haematocrit and haemoglobin concentration estimates as indicators of anaemia.

**Leucocyte Count:** Leucocyte counts (Lc) are useful as indicators of disease condition or response to infection, and significantly elevated or depressed values are obtained in abnormal conditions. Mean Lc and standard deviation (±SD) obtained for *P. obscura, M. electricus* and *M. minjiriya* were 40.10 ± 1.32, 31.87 ± 2.30 and 38.48 ± 3.10 x $10^9$/l, respectively (Table 1). These values were much lower than values reported for *H. bidorsalis* (Fagbenro *et al*., 1993), *C. nigrodigitatus*[2] (Etim *et al*., 1999) and *H. niloticus* (Fagbenro *et al*., 2000); and may be attributed/related to the conditions in the habitat or the general well-being of the fishes. There are wide variations in the leucocyte counts reported for various African freshwater fish species (Table 2).

**Haematocrit:** Mean haematocrit values and standard deviation obtained for *P. obscura*, *M. electricus* and *M. minjiriya* were 26.40 ± 3.89, 32.03 ± 2.30 and 34.04 ± 2.15 %, respectively. Values reported for haematocrit of other fishes are usually between 20% and 35% (Table 2), and scarcely attain values greater than 50 % (Clarks *et al*., 1979). The mean haematocrit values in this study were within this range. Haematocrit is important as an indicator of the percentage of packed red blood cells, and the colour of the plasma layer above the packed cells, and could be used to detect haemolysis (Archer and Jeffcott, 1977). There is hence the possibility of using haematocrit as a tool in aquaculture and fisheries

**Table 1: Haematological (mean ± SD) profile of *P. obscura*, *M. electricus* and *M. minjiriya***

| Haematological parameters | *P. obscura* (n = 25) | *M. electricus* (n = 25) | *M. minjiriya* (n = 25) |
|---|---|---|---|
| **Ec ($10^{12}$/l)** | 2.00 ± 0.71 | 1.96 ± 0.17 | 2.09 ± 0.21 |
| **Lc ($10^{9}$/l)** | 40.10 ± 1.32 | 31.87 ± 2.30 | 38.48 ± 3.10 |
| **Hct (%)** | 26.40 ± 3.89 | 32.03 ± 1.94 | 34.04 ± 2.15 |
| **Hbc (g/dl)** | 11.48 ± 1.55 | 7.08 ± 0.22 | 8.28 ± 0.25 |
| **ESR (mm/h)** | 1.32 ± 0.26 | 2.56 ± 0.53 | 2.71 ± 0.58 |
| **MCV (fl)** | 131.70 ± 10.82 | 158.59 ± 5.16 | 168.15 ± 8.01 |
| **MCH (pg)** | 57.28 ± 43.25 | 35.24 ± 1.79 | 36.43 ± 2.17 |
| **MCHC (g/dl)** | 43.48 ± 6.97 | 0.225 ± 0.018 | 0.255 ± 0.027 |
| **Total Plasma protein (g/dl)** | 62.90 ± 9.70 | 52.89 ± 7.23 | 50.85 ± 9.86 |
| **Total Plasma lipid (g/dl)** | 8.21 ± 1.10 | 6.78 ± 0.89 | 7.40 ± 0.91 |

*Ec = Erythrocyte count, Lc = Leucocyte count, Hct = Haematocrit, Hbc = Haemoglobin concentration, ESR = Erythrocyte Sedimentation rate, MCV = Mean cell volume, MCH = Mean corpuscular haemoglobin, MCHC = Mean corpuscular haemoglobin concentration*

**Table 2: Comparison of the normal haematologic indices (mean ± SD) of some tropical African freshwater fishes**

| Fish Species | Ec ($10^{12}$/1) | Lc ($10^{9}$/1) | Hct (%) | Hbc (g/dl) | Reference |
|---|---|---|---|---|---|
| ***Clarias isheriensis*** | 1.55 ± 0.27 | ND | 31.62 ± 5.17 | 14.56 ± 2.27 | Kori-Siakpere (1985) |
| ***Clarias gariepinus*** | 1.39 ± 0.45 | 30.4 ± 9.6 | 26.07 ± 6.34 | 11.64 ± 2.93 | Erondu *et al.*(1993) |
| ***Heterobranchus longifilis*** | 1.65 ± 0.67 | 28.3 ± 7.9 | 34.67 ± 2.52 | 11.27 ± 2.55 | Erondu *et al.*(1993) |
| ***Heterobranchus bidorsalis*** | 1.99 ± 0.52 | 72.5 ± 6.0 | 24.75 ± 1.23 | 5.43 ± 0.25 | Fagbenro *et al.*(1993) |
| ***Chrisichthys furcatus*** | 1.98 ± 0.15 | 31.0 ± 3.9 | 34.50 ± 5.89 | 8.18 ± 1.70 | Etim *et al.*(1999) |
| ***Chrisichthys nigrodigitatus*[1]** | 1.33 ± 0.25 | 32.8 ± 3.5 | 22.00 ± 2.12 | 8.66 ± 1.91 | Erondu *et al.*(1993)[1] |
| ***Chrisichthys nigrodigitatus*[2]** | 1.77 ± 0.34 | 58.2 ± 8.7 | 31.52 ± 5.27 | 7.44 ± 1.10 | Etim *et al.*(1999)[2] |
| ***Heterotis niloticus*** | 1.50 ± 0.20 | 57.2 ± 4.9 | 28.12 ± 2.98 | 4.46 ± 0.43 | Fagbenro *et al.*(2000) |
| ***Parachanna obscura*** | 2.00 ± 0.71 | 40.1 ± 1.3 | 26.40 ± 3.89 | 11.48 ± 1.55 | This study |
| ***Malapterurus electricus*** | 1.96 ± 0.17 | 31.9 ± 2.3 | 32.03 ± 1.94 | 7.08 ± 2.20 | This study |
| ***Malapterurus minjiriya*** | 2.09 ± 0.21 | 38.5 ± 3.1 | 34.04 ± 2.15 | 8.28 ± 2.48 | This study |

*Ec = Erythrocyte count, Lc = Leucocyte count, Hct = Haematocrit, Hbc = haemoglobin concentration, ND = not determined*

management for checking anaemic condition in fishes.

**Haemoglobin Concentration:** In fish blood, oxygen is carried in physical solution and also in combination with haemoglobin. Haemoglobin is crucial for the survival of the fish as its role is directly related to the oxygen-binding capacity of blood. Mean haemoglobin concentration values and standard deviation obtained for *P. obscura*, *M. electricus* and *M. minjiriya* were 11.48 ± 1.55, 7.08 ± 2.20 and 8.28 ± 2.48 g/dl, respectively. The high values of haemoglobin concentration of *P. obscura* is comparable to those of *C. isheriensis* (Kori-Siapkere, 1985), *C. gariepinus* and *H. longifilis* (Erondu *et al.*,1993) (Table 2); and reflects high oxygen carrying capacity of the blood, which is consistent with the correlation of haemoglobin concentration with fish activity as suggested by Lenfant and Johansen (1972). Mean haemoglobin concentration values of both *M. electricus* and *M. minjiriya* were <10 g/dl (Table 1), close to values of 7.44 – 8.66 g/dl reported for estuarine catfishes, *C. nigrodigitatus* and *C. furcatus* (Erondu *et al.* 1993; Etim *et al.* 1999), but were much lower than the corresponding values of 11.64 – 15.43 g/dl reported for air-breathing clariid catfishes, *C. isheriensis*, *C. gariepinus*, *H. longifilis* and *H. bidorsalis* (Kori-Siakpere,1985; Fagbenro *et al.*,1993; Erondu *et al.*,1993).

**Erythrocyte Sedimentation Rate (ESR):** Erythrocyte sedimentation rate has been used to ascertain the response of fish blood to stress, starvation, pollution, parasitism and nutritional deficiencies (Blaxhall, 1972; Soave and Oikari, 1976; Wedemeyer and Yasutake, 1977). Erythrocyte sedimentation rate for *P. obscura, M. electricus* and *M. minjiriya* were 1.32 ± 0.26, 2.56 ± 0.53, and 2.71 ± 0.58 mm/h, respectively (Table 1). Erythrocyte sedimentation rates for *M. electricus* and *M. minjiriya* were comparable to those reported for *C. nigrodigitatus* and *C. furcatus* (2.32 ± 0.49 and 2.41 ± 0.50 mm/h, respectively) (Etim *et al.*, 1999), but higher than 2.08 mm/h reported for *C. isheriensis* (Kori-Siakpere, 1985).

**Total Plasma Protein:** The mean total plasma protein in the blood of *P. obscura, M. electricus* and *M. minjiriya* were 62.90, 52.89 and 50.85 g/dl, respectively (Table 1). The total plasma protein value for *P. obscura* was comparable to those reported for *C. nigrodigitatus*[2] (61.1 g/dl) and *C. furcatus* (66.8 g/dl) (Etim *et al.*, 1999), while total plasma protein values for *M. electricus* and *M. minjiriya* comparable to 54.2 g/dl reported for *C. isheriensis* (Kori-Siakpere, 1985).

**Mean Corpuscular Haemoglobin Concentration (MCHC):** Mean corpuscular haemoglobin concentration values for *P. obscura, M. electricus* and *M. minjiriya* were 0.435 ± 0.070, 0.225 ± 0.018,

0.255 ± 0.027 g/dl. The MCHC values reported for *M. electricus* and *M. minjiriya* were similar to those reported for some other African freshwater catfishes, such as *C. isheriensis* (Kori-Siakpere, 1985), *C. gariepinus, H. longifilis* and *C. nigrodigitatus* (Erondu *et al.*, 1993).

**Mean Corpuscular Volume (MCV) and Mean Corpuscular Haemoglobin MCH:** There are wide variations in both the mean corpuscular volume and mean corpuscular haemoglobin values reported in literature for various African freshwater fish species.

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# BAOBAB (*Adansonia digitata* L.) SEED PROTEIN UTILIZATION IN YOUNG ALBINO RATS. II. HAEMATOCRIT, PLASMA AND HEPATIC BIOCHEMICAL METABOLITES

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**ABSTRACT**

***The effect of differently processed baobab (Adansonia digitata L.) seed meals on haematocrit and some plasma and liver biochemical parameters in albino rats was investigated. While the animals placed on the raw seed meal recorded comparable growth and liver and plasma biochemical indices to the casein control diet, the cooked and HCl-extracted meals induced significantly ($p<0.05$) slower rates of growth than the control. Also raw and acid-extracted meals induced significant hyperglycemic effect. Serum and liver total lipids were elevated but non-significantly in the animals fed the raw and acid-extracted meals relative to the controls. There was no consistent pattern in the serum and liver cholesterol and the haematocrit trend, but red blood cell (RBC), packed cell volume (PCV) and haemoglobin (Hb) were decreased significantly in rats fed the acid-extracted meal relative to the control. The possible reasons and nutritional implications of these observations were briefly highlighted. It was concluded that the raw seed has a better promise as a source of food supplement and is likely to be satisfactory in supporting growth and maintenance in livestock feeding.***

**Keywords:** *Adansonia digitata*, Baobab, Protein utilization, Haematocrit, Plasma, Hepatic, Biochemical metabolites, Rats

## INTRODUCTION

As population increase in the tropical regions continue to outstrip food production, it is becoming increasingly necessary to explore and possibly exploit scores of little-known wild crops for protein and energy as supplements to traditional crops and staples (Wickens *et al*. 1989, Oelke *et al*., 1997, Ezeagu *et al*., 2002). The exploitation of inexpensive alternative sources of protein and energy for man and/or animal could measurably reduce malnutrition. Unconventional and lesser-known plants could contain useful amounts of nutrients as indicated by some research (Eromosele *et al*., 1994, Murray *et al*., 2001; El-Adawy and Taha, 2001). However, prior to the utilization of such novel sources, either in human food or feed, thorough toxicological evaluation of possible biochemical, haematological or epidemiological response to their ingestion is necessary (Wolf *et al*. 1975). Many plants are endowed with the ability to synthesize a wide variety of chemical substances, which, under practical circumstances, can impair some aspects of animal metabolism when ingested by man or animals (Cheeke and Shull, 1985).

Studies have shown that malnutrition in the form of specific nutrient deficiency results in general stunting and reduced organ size and marked changes in some biochemical parameters. Also ingestion of certain toxic factors or chemicals have manifested in distorted haemato-biochemical metabolites (Geol and Sharma, 1988). Baobab is a common multipurpose tropical fruit tree wildly consumed in savannah region in Northern Nigeria. A previous study (Ezeagu, 2005) indicated the protein marginally limiting in lysine and threonine and that weight gain was retarded in animals fed both the raw, cooked and acid-extracted baobab meals relative to casein. Growth retardation was, however, only significant in rats fed the cooked and acid extracted diets. But whether the body composition was altered was an unanswered question. Therefore, it was thought to be of interest to further investigate possible toxicological effects of ingestion of both raw and processed baobab seed meal with respect to some body systems from medical standpoint.

## MATERIALS AND METHODS

The collection, processing, formulation of diets and feeding protocols were carried out as previously described (Ezeagu, 2005). At the end of the 21 days experimental period, the rats were weighed, anaesthetized with chloroform and dissected. Blood was collected from the heart by cardiac puncture using a syringe and needle and deposited in heparinised tubes. Haematocrit was determined immediately (Jain, 1986). The whole blood was kept in the refrigerator and later centrifuged and separated at 3,000g for 10 minutes to obtain a clear serum. The livers were excised, weighed and homogenized with 5 ml. phosphate buffer (pH 7.5) using a hand homogenizer. Serum and liver proteins, lipids and cholesterol were determined according to the methods outlined by Lynch *et al*. (1969). Food efficiency ratio (FER) and protein efficiency ratio (PER) were calculated by the following formulae: FER = Gain in body weight (g) / Food consumed (g); PER = Gain in body weight (g) / Protein consumed (g). All analyses were done in triplicate.

**Table 1: Nutritional indices of rats fed baobab meals***

| | Casein | Raw | Cooked | HCl-extracted |
|---|---|---|---|---|
| **Weight gain (g/day)** | 0.84 ± 0.08[a] | 0.60 ± 0.17[b] | 0.47 ± 0.03[b] | 0.02 ± 0.01[c] |
| **Food Consumption (g/day)** | 3.41 ± 0.22[a] | 5.51 ± 0.25[a] | 3.13 ± 0.13[a] | 2.79 ± 0.17[b] |
| **FER** | 0.25 ± 0.03[a] | 0.19 ± 0.04[b] | 0.16 ± 0.02[b] | 0.02 ± 0.01[c] |
| **PER** | 2.47 ± 0.08[a] | 1.46 ± 0.35[b] | 1.62 ± 0.21[b] | 0.18 ± 0.04[c] |

*abc (Means not followed by the same superscript on the same row are significantly different (P<0.05), *Mean± SD (Standard Deviation)*

**Table 2: Effect of baobab seed meal on plasma and hepatic biochemical parameters**

| | Plasma (mg/100 ml) | | | | Liver (mg/g) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Diet** | **Sugar** | **Protein** | **Lipid** | **Cholesterol** | **Protein** | **Lipids** | **Cholesterol** | **NPR** | **TD %** |
| **Casein** | 37.58 ±3.95[b] | 4.20 ±0.38[b] | 374.48 ±61.17[a] | 55.23 ±2.7[a] | 41.23 ±10.33[b] | 68.10 ±22.64[a] | 6.10 ±5.13[a] | 3.07 ±2.34[a] | 93.17 ±5.32[a] |
| **Raw** | 66.23 ±20.92[a] | 3.54 ±0.08[a] | 388.94 ±12.90[a] | 60.96 ±4.05[a] | 30.24 ±2.91[a] | 91.70 ±25.27[a] | 4.47 ±6.51[a] | - | - |
| **Cooked** | 42.00 ±11.02[b] | 3.86 ±0.42[a] | 363.81 ±73.3[a] | 48.38 ±5.02[a] | 33.84 ±1.84[a] | 273.69 ±33.11[a] | 4.57 ±9.81[a] | 0.19 ±1.53[b] | 89.57 ±2.0[a] |
| **HCl-extracted** | 66.97 ±18.88[a] | 3.78 ±0.22[a] | 380.29 ±3.73[a] | 62.67 ±5.80[a] | 32.38 ±2.22[a] | 278.5 ±53.39[a] | 4.83 ±6.71[a] | 0.74 ±1.18[b] | 82.03 ±5.32[b] |

*abc (Means not followed by the same superscript on the same column are significantly different (P<0.05) * Mean± SD (Standard Deviation)*

**Table 3: Effect of baobab seed meal on haematocrit***

| | Casein | Raw | Cooked | HCl-extracted |
|---|---|---|---|---|
| **Hb g/100 ml** | 14.95±0.94[a] | 9.98±2.58[a] | 10.68±1.29[a] | 8.00±2.61[b] |
| **RBC x $10^6$ $mm^{-3}$** | 5.97±0.64[a] | 4.64±1.44[a] | 5.40±0.63[a] | 3.25±0.73[b] |
| **WBC x$10^3$ $mm^{-3}$** | 10.33±0.88[a] | 9.85±2.77[a] | 6.00±2.41[a] | 10.40±2.47[a] |
| **PCV %** | 40.0±6.38[a] | 29.5±8.35[a] | 33.5±3.70[a] | 28.25±10.28[b] |

*abc (Means not followed by the same superscript on the same row are significantly different (P<0.05).*Mean± SD (Standard Deviation).Hb: Haemoglobin, RBC: Red blood cell, WBC: White blood cell, PCV: Packed cell volume*

The data were subjected to analysis of variance (ANOVA) and treatment means were compared by the Duncan's (1955) multiple range test.

## RESULTS AND DISCUSSION

Nutritional indices, presented in Table 1, followed the same trend as obtained in the previous report (Ezeagu, 2005). However, rats on the cooked meal recorded relatively better indices in this study. The raw seed meal seems to be more palatable than the cooked and acid-extracted meals, hence the higher feed intake. Palatability may have been affected by acid treatment as indicated by the poor feed intake. This could be due to the effect of possible residual acid or, perhaps, some reaction products. Kawatara *et al*. (1969) has reported similar poor growth in rats fed acid-extracted meals. Nutrient losses during acid-extraction and the cooking process may have contributed to the poor performance of the animals on treated baobab meals (Anthoni Raj and Singaravadivel, 1980).

Blood sugar levels were elevated only significantly ($p < 0.05$) in rats fed raw and acid-extracted meals. Elevated blood sugar may be due to inhibition of glycolysis by the presence of glycoproteins and saponins, which may have adversely effected regulation of insulin from pancreatic B-cells and blood sugar, as suggested by Mandal *et al*. (1982). According to Yadav *et al*. (1973), it seems some plant proteins exhibits hypoglycemic effect and some hyperglycemic in experimental animals. In this regard baobab seeds may not be useful in the management of diabetes.

Serum and liver biochemical parameters are shown in Table 2. Liver protein values show same trend as serum proteins, being related physiologically. Rats on the casein diet recorded significantly ($p<0.05$) higher total plasma and liver proteins than those on the raw, cooked and acid-extracted meals. Among the three baobab test meal groups, plasma and liver protein levels were comparable and non-significantly different, though animals on the acid-extracted meal recorded the lowest levels. Rats on the test diets could be consuming adequate protein but absorption from the alimentary tract may be defective. Loss of protein in the urine and into alimentary tract and increased catabolism of proteins may also be responsible for lower serum and liver proteins of the animals on the baobab meals. However, the low body weight gain and reduced serum total protein as observed for the test diets also reflect the low quality of the baobab protein relative to casein. Plasma total protein is regarded as good indices of the quality of dietary proteins (Lewis *et al*., 1977; Babatunde and Pond, 1988).

Serum total lipids and cholesterol were elevated, but not significantly ($p>0.05$), in rats fed the raw and HCl-extracted meals relative to casein (Table 2). But rats on the cooked meal had lower serum lipid and cholesterol levels. Serum lipids were highest in rats placed on raw diet (388.94 mg/100 ml) and least in those on cooked meal (368.81 mg/100 ml) groups. Balogun *et al*. (1982)

reported significantly higher levels of serum lipids in rats fed plant proteins as compared with rats fed similar diets containing casein as the only protein source. However, other workers observed no consistent differences in serum lipids in rats fed diets containing either plant or animal proteins (Okita and Sugano, 1981; Adeyeye *et al*., 1989; Dong *et al*., 1990).

While liver lipids were elevated, the cholesterol levels were lowered in rats fed the test diets relative to the control but non-significantly ($P > 0.01$). Also the mean serum cholesterol of rats on raw and acid-extracted meals were elevated, while that of those on cooked meal were non-significantly ($P < 0.01$) lowered relative to the controls. These observations seem to be in conflict with the reported hypocholesterolemic effect of plant protein compared with casein diet (Mokady and Liener 1982; Potter, 1995). However, findings by Leelamma *et al.* (1978) have shown that the effect of dietary proteins on lipid levels depends upon the nature of particular protein rather than its source. This may be related to the amino acid composition and digestibility of different proteins and also the experimental animal used (Hassan and Rashwan, 1986; Sugano and Koba, 1993). It is also thought that arginine/lysine (Arg/Lys) ratio in seed proteins, not investigated in this study, may be relevant to the plasma cholesterol lowering effect of plant proteins (Kritchevsky, 1979). Balogun *et al*. (1982) observed that rats fed diets with low Arg/Lys ratios tend to be less hypocholesterolemic than diets having higher ratios. Hence Yadav *et al*. (1973) observed that some plant proteins were hypocholesterolemic while some others were hypercholesterolemic in experimental animals. The processing treatments may have altered the Arg/Lys ratios of the test diets resulting in differing cholesterolemic effects.

Also, since undigested protein is able to bind bile acids, reabsorption of bile acids in the intestine is reduced (Woodward and West, 1984). Recycling of bile acid is thus diminished and consequently synthesis of bile acids from cholesterol is stimulated which results in lower levels of serum cholesterol (Beynen *et al*., 1986). In the light of the fairly high true digestibility (TD) value of the test meals (79.91 - 85.53 %) (Ezeagu, 2005), protein digestibility may not be responsible for the differing cholestrolemic effects of the test meals. Kuyvenhoven *et al.* (1987), after testing four different proteins in rats, reported that there was no conformity between digestibility and serum and liver cholesterol levels. On the other hand, studies in experimental animals have also demonstrated that presence of certain plant fibers in the diet is accompanied by significant lowering of serum and tissue cholesterol levels. Dietary fiber adsorbs bile salts and faecal excretion of bile acids is thus enhanced. Consequently synthesis of bile acids from body cholesterol is stimulated thereby reducing the blood cholesterol concentrations also (Potter, 1995; Oakenful and Fenwick, 1978; Uberoi *et al*., 1992). Fiber content of 14.94g/100g was reported (Ezeagu, 2005) for raw baobab seed meal. Boiling may have increased the fiber components (Vidal-Valverde *et al*., 1992) resulting in the hypocholesterolemic effect of the cooked meal. The higher the lignin component in fibers, the better the hypocholesterolemi effect (Uberoi *et al*., 1992). However, in view of the non-significant results, it is not possible to definitive on the effect of baobab seed meal on serum cholesterol.

Haematological changes are presented in Table 3. Significant ($P < 0.05$) decrease in Hb, RBC and PCV were exhibited only in the HCl-extracted test diet. A significant fall in RBC reflects erythropenia (Geol and Sharma, 1988). Poor feed intake and/or residual acid may be implicated in the poor negative effect of acid-extracted meal. On the other hand acid treatment may have leached out nutritive factors. There was no consistent pattern in white blood cells (WBC) trend, which seems to be of no physiological significance. A significant increase in WBC would indicate toxicity or poisoning.

It is evident therefore that only the HCl-extracted meal exerted a significant negative effect on the body weight and the dynamic equilibrium of blood protein. Except for the higher volume of faecal matter voided by the rats on the test diets, neither the control nor the treated animals showed any sign of behavioral abnormality, side effect or any toxic reaction throughout the experimental period. The negative effect on weight gain could therefore, be due to nutrient loss during processing and/or amino acid imbalance and may not be a result of any toxic insult. Dong *et al*. (1990) reported that lower weight gain in rats fed poor sources of protein could be due mainly to essential amino acid deficiency and/or lower *in vivo* apparent protein digestibility and subsequent supplementation of protein with limiting amino acids restored normal growth response in the animals. It is possibly that normal growth rate would be restored by amino acid supplementation in the experimental animals.

**Conclusions:** On the bases of the present investigation, the raw baobab seed meal exerted little or no negative effect on the dynamic equilibrium of the blood and liver metabolites. Therefore, it may be concluded that baobab seed meal would be safe for edible use and has a better promise as a source of food supplement and likely to be satisfactory in supporting growth and maintenance in livestock feeding. Further studies on the improvement level of animal performance by amino acid supplementation will continue.

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# ECOLOGICAL STUDIES OF THE GASTROPOD FAUNA OF SOME MINOR TRIBUTARIES OF RIVER BENUE IN MAKURDI, NIGERIA

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**ABSTRACT**

***Some tributaries of Benue river in Makurdi were surveyed for gastropod fauna between May and October 2004. The scoop net method was employed and complimented with hand picking technique. Four species of snails were encountered; Lanistes libycus (44.78 %), Melanoides tuberculata (21.86 %), Bulinus truncatus (22.03 %) and Potandoma species (11.33 %). ANOVA revealed no significant difference (P < 0.05) in distribution of snail species and physio-chemical parameters showed no striking disparity in the water bodies sampled. The predominant aquatic flora encountered were Ipomoea aquatica, Nymphaea lotus and Graminae species. The nutritional and medical implications of snail species encountered and observed human water contact pattern were discussed.***

**Keyword:** Gastropod fauna, Ecology, Tributaries of River Benue

## INTRODUCTION

Benue river is one of the two major rivers in Nigeria with many tributaries, at Makurdi; the capital of the state that derive its name from the river, many minor tributaries transverse the town. This network of freshwater system provide ideal habitat for freshwater snails. Some of these snails have no history of serving as intermediate host of any disease, others have been implicated in the transmission of many trematode diseases of man and livestock (Imafidon 1991, Emejulu *et al,* 1992, Okafor 1990, Agi and Okwuosa 2001 and Idris and Ajanusi 2002) Among the major diseases of which gastropod snails serve as intermediate hosts are: schistosomiasis, fascioliasis and paragonimiasis. Schistosomiasis is of the greatest public health importance with about 200 million people infected in 76 endemic countries worldwide and about 600 million are at risk of infection (WHO, 1993).

Studies of the ecology of these snails showing their distribution, diversity, abundance and habitat preference have been reported in many parts of Nigeria (Ndifon 1980, Obureke *et al,* 1987, Okafor 1990, Imafidon 1991, Idris and Ajanusi 2002, Agi and Okwuosa 2001). The tributaries of the Benue river in Makurdi has not been investigated for it's gastropod composition. Such studies are important as they tend to explain local distribution, habitat preference and rate of transmission of disease, which are necessary for snail control programme.

This study is intended to produce data on the distribution and abundance of gastropod molluscs in the tributaries of Benue river in Makurdi with emphasis on environmental and ecological factors affecting them.

## MATERIALS AND METHODS

**Study Area:** The study sites were ten water bodies in Makurdi, a town that lies between latitudes $7^0$30`N and $7^0$45`N and longitude $8^0$30`E and $8^0$35`E covering an area of 16 km$^2$. The main drainage system is Benue river with other smaller tributaries transversing the town (Figure 1). Makurdi has Guinea savannah type of vegetation with annual rainfall of between 150 – 180 m and temperature of $26^0$C-$29^0$C.

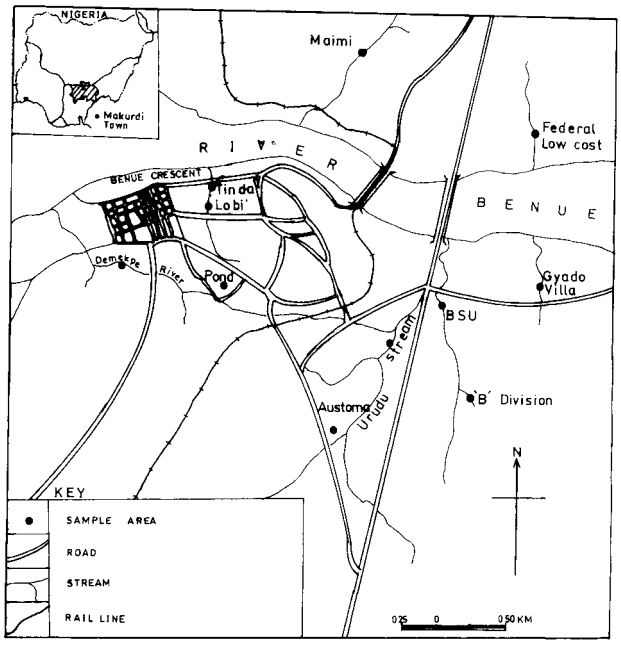


**Figure 1: Map of Makurdi Township showing the tributaries of Benue river and sample sites. Source:** *Benue land and Survey Department 1992*

The wet season spans from April – October while the dry season spans from November – March. Field trips were made to ten tributaries and sampled from May – October, 2004.

**Sampling:** The scooping net techniques and hand picking of snails were employed. Samples were collected with a long-handled snail sieve net (mesh size 3 mm – 4 mm) (Idris and Ajanusi 2002). Snails were often seen near the edges of slightly deep waters or lodging in plant materials. The sieve net was dragged through the water thereby collecting snails clinging to the aquatic plants. Where sieve net could not be used, snails were hand picked with gloved hands and placed in plastic specimen bottles. Aquatic plants to which snails were found clinging were collected and brought to the laboratory for identification. The sample period lasted for ten minutes at each sampled tributary.

Snails collected from each habitat were kept in separate labeled specimen bottles. The snails were preserved in 70 % alcohol for subsequent examination, identification and classification.

The physio-chemical parameters studied were: water temperature, pH, dissolved oxygen and water current (Agi, 1995). The water current was determined by noting the time a piece of cock moved through predetermined points. Water current below 2.0 $ms^{-2}$ was regarded as slow while higher speed was regarded as fast flowing (Agi and Okwuosa 2001).

## RESULTS

Four species of freshwater snails were encountered in the 10 water bodies sampled. The snails were *Bulinus truncatus*, *Melanoides tuberulata*, *Lanistes libycus,* and *Potandoma* species. *Lanistes libyscus* was the most abundant snail species (44.78 %) found in streams, ponds and gutter, followed by *Melaniodes tuberculata* (21.86 %) *Bulinus truncatus* (22.03 %) and *Pontandoma* species (9.33 %) (Figure 2).

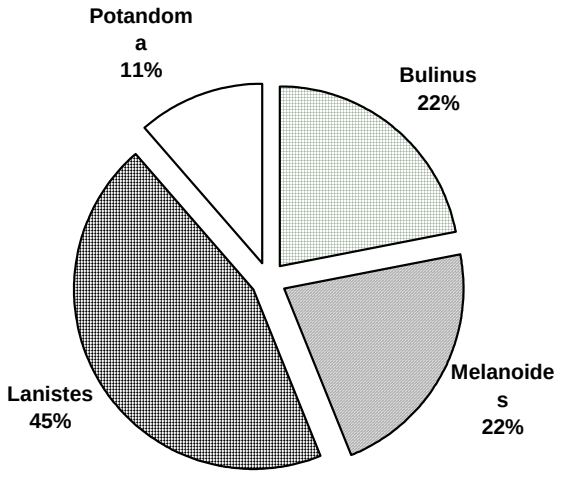


**Figure 2: Cumulative abundance of snail species collected from Benue river tributaries**

Snail occurrence and physio-chemical analysis for each habitat are presented on Table 1. The distribution and abundance of snails in relation to their habitat and characteristics are shown in Tables 2 and 3. Analysis of variance revealed no significant difference in the distribution and abundance of the snails at the different sample sites. There was a general fluctuation in the number of snails collected, it increased from May to August (where it peaked) and decreased thereafter until the end of study in October (Figure 3).

Some of the stream had rich vegetation cover with fallen leaves from surrounding trees providing detrital matter. Other streams were completely exposed to solar radiation, especially those that were more frequently patronized by residents.

*Lanistis libycus* was the only edible snail species encountered. It is generally consumed and sold in the market by the indigenous Tiv people. The other snail species like *Bulinus truncatus* is known to be of medical importance.

The aquatic flora of the habitats were identified as *Ipomoea aquatica, Nymphaea lotus, Mimosa pigra, Marselia* species, *commelina* species, *graminae* species and *Echinochloa pyramidilis. Ipomoea aquatica* was the most abundant.

## DISCUSSION

The distribution and abundance of freshwater snails in tributaries of the Benue river may be attributed to the availability of food, shelter and oviposition sites. Water bodies rich in organic and silt matter are known to support thriving populations of macroinvertebrates because of reduction in water current and as such the substratum tends to make snails indistinguishable from their typical lentic habitat (Whitton, 1975). The favourable effect of vegetation on snail habitat preference was confirmed by the fact that most snails in their various habitats were attached to aquatic plants. Imafidon (1991), Obureke *et al,* (1987) and Amali (1988) had previously reported the influence of aquatic vegetation on distribution of snails of medical importance.

All the habitats had some type of aquatic vegetation sparsely distributed within or at the verge of the habitat. Snails were often seen clustering around vegetation or floating or submerged piece of wood or plant materials. Whitton (1975) and Obureke *et al.,* (1987) attributed the clustering of snails around plants to be due to high oxygen gradient produced by these plants.

One of the four snail species encountered (*Bulinus truncatus*) is a recognized intermediate host for schistosomiasis in Nigeria (Obureke *et al.* 1987; Imafidon, 1991; Emejulu *et al.* 1992; Agi and Okwuosa 2001). The distribution of this species is widely reported in Nigeria and elsewhere. They co-exist with other known schistosome snail vectors like *Bulinus globosus, Biomphalaria pffeifferi* and *Lymnea natalensis* and shed schistosome cercariae (Emejulu *et al.* 1992; Idris and Ajanusi 2002).

**Table 1: Physio-chemical parameters and snail occurrence of the habitats**

| Habitat | Physio-chemical factors | | | Type of snail species | | | | Current |
|---|---|---|---|---|---|---|---|---|
| | pH | T($^0$C) | D0$_2$ | *B.t* | *M.t* | *L.l* | *Pt* | Speed |
| **Austoma** | 8.61 | 27.87 | 2.66 | - | + | + | - | ST |
| **B-Division** | 8.09 | 28.08 | 1.92 | - | + | + | + | ST |
| **BSU Gutter** | 7.49 | 27.45 | 1.74 | + | + | + | + | SF |
| **Demekpe** | 6.98 | 29.04 | 1.98 | + | + | + | + | FF |
| **Fed. Low cost** | 7.85 | 27.42 | 2.61 | + | + | + | + | SF |
| **Gyado villa** | 7.07 | 26.60 | 1.52 | + | + | + | - | ST |
| **Lobi Qtrs** | 7.83 | 26.48 | 1.21 | + | + | + | + | FF |
| **Mammy** | 6.66 | 28.01 | 1.51 | + | + | + | + | SF |
| **Tinda** | 7.51 | 27.11 | 1.81 | + | + | + | + | FF |
| **Urudu** | 7.76 | 27.76 | 2.66 | + | + | + | + | SF |

*B.t = Bulinus truncatus, M.t = Melanoides tuberculata, L.l = Lanistis libycus, Pt = Pontandoma species, FF = fast flowing, SF = Slow flowing, ST = Stagnant, + = Snail present.*

**Table 2: Distribution of snail species in Benue river tributaries**

| Sites | Snail Species and number collected | | | | |
|---|---|---|---|---|---|
| | ***Bulinus*** | ***Melanoides*** | ***Lanistes*** | ***Potandoma*** | **Total** |
| **Austoma** | - | 23 | 68 | - | 91 |
| **B-Division** | - | 22 | 42 | 8 | 72 |
| **BSU Gutter** | 26 | 18 | 60 | 15 | 119 |
| **Demekpe** | 33 | 25 | 45 | 28 | 111 |
| **Fed. Low cost** | 38 | 30 | 37 | 8 | 113 |
| **Gyado** | 17 | 16 | 45 | - | 78 |
| **Lobi Qtrs** | 35 | 23 | 50 | 23 | 131 |
| **Mammy** | 30 | 13 | 42 | 6 | 91 |
| **Tinda** | 38 | 30 | 41 | 20 | 129 |
| **Urudu** | 37 | 56 | 90 | 20 | 195 |
| **Total** | 249 | 247 | 506 | 128 | 1130 |

**Table 3: Distribution of snail species, characteristic of habitat and vegetative composition**

| Site No. | Name of site | Description | Water contact activity | Snail species | Vegetative composition |
|---|---|---|---|---|---|
| 1 | **Austoma** | Swamp area near Austoma filling station. | Rice cultivation domestic use Automobile washing | *Lanistes Melaniodes* | *Ipomoea, Nymphae, graminae.* |
| 2 | **B-Division** | Swamp area, (Fadama) near police B-division | Rice cultivation, fishing, snail collection. | *Lanistes Melanoides* | Same as above plus *marselia, commelina.* |
| 3 | **BSU Gutter** | Drainage gutter in front of BSU main campus | Rice cultivation, fishing, snail collection. | *Lanistes, Bulinus Melanoides Potandoma* | *Ipomoea* |
| 4 | **Demekpe** | stream | Domestic use snail collection, burnt brick making, rice cultivation | *Bulinus, Lanistes, Melanoides, Potandoma* | *Ipomoea Nymphae Graminae commelina* |
| 5 | **Fed. Low-cost** | Stream, runs through Federal low-cost estate, North Bank | Domestic use, irrigation, snail collection. | *Bulinus, Lanistes, Melanoides, Potandoma* | *Graminae Ipomoea Marselia* |
| 6 | **Gyado villa** | Pond | Domestic use, cement brick molding, snail collection, fishing. | *Bulinus, Lanistes, Melanoides, Potandoma* | *Ipomoea Nymphae* |
| 7 | **Lobi Qtrs** | Drainage gutter, runs through Lobi Quarters | Domestic use, sugar cane farming, snail collection | *Bulinus, Lanistes, Melanoides, Potandoma* | *Graminae Nymphae Ipomoea* |
| 8 | **Mammy** | Stream | Domestic use, snail collection Automobile washing, vegetables/Rice cultivation. | *Bulinus, Lanistes, Melanoides, Potandoma* | *Ipomoea* |
| 9 | **Tinda** | Stream, passes behind Tinda Hotel, culvert. | Automobile washing, sugar cane farming. Domestic use watering livestock. | *Bulinus, Lanistes, Melanoides, Potandoma* | *Graminae Nymphae Ipomea Marselia* |
| 10 | **Urudu** | Stream (Fadama) | Domestic use, Rice cultivation, fishing, snail collection | *Bulinus, Lanistes, Melanoides, Potandoma* | *Ipomoea, Nymphae graminae marselia.* |

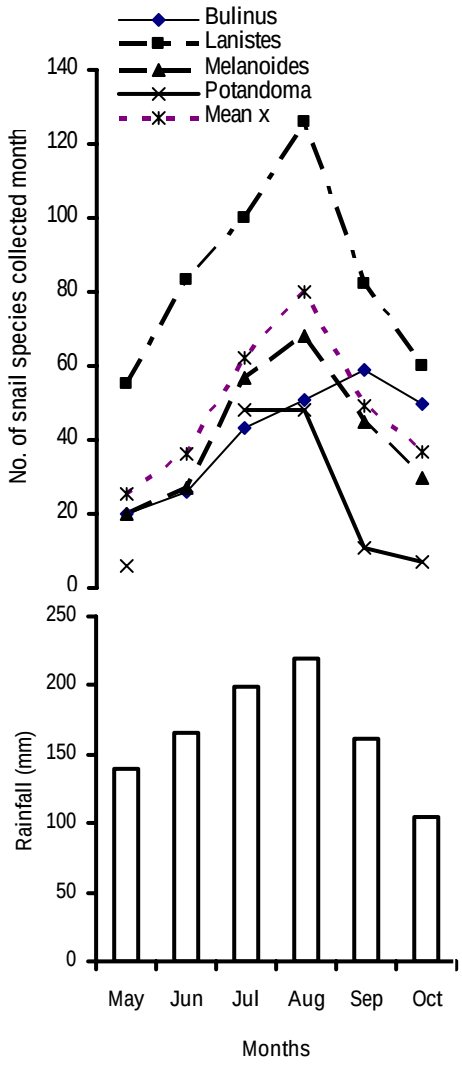


Figure 3: Monthly fluctuation of snail species collected in relation to rainfall in the study area

The wide distribution of *Bulinus truncatus* in these urban water bodies was therefore of epidemiological significance considering the intense water contact activities at the various points. Urinary schistosomiasis have been reported in Makurdi and other parts of Benue State (Amali, 1993; Okwuosa and Banke, 2001).

The dominant snail species encountered in this study was *Lanistes libycus*. They were encountered in all the habitats surveyed. Imafidon (1991) also reported that this species account for 25 % of snail species encountered during the ecological study of freshwaters in Ibadan, Southwestern Nigeria. *Lanistes* species are edible snail and are generally sold in the open markets in Makurdi during rainy seasons. Freshwater sails have become very important alternative source of animal protein as the prize of the more traditional animal protein sources have risen above the reach of many inhabitants. Snail farming is popular in southern Nigeria, however, not much has been heard of in the North. The general eatability of snail meat and the prospect of natural stocking for domestic and economic purposes may be further explored as an income-generator.

The coexistence of *B. truncatus* and *L. libycus* poses a great risk for snail collectors. This is a major pre-occupation for children and women during rainy seasons; this activity and other water contact activities predispose children and women to infection with schistosomiasis. Several epidemiological studies in Nigeria reported that these population group account for the highest prevalence rate (Amali, 1993; Akogun and Obidiah, 1996; Idris *and* Ajanusi*,* 2002; Okwuosa and Banke, 2001). The coexistence of these snail species makes execution of mollusicidal programme as suggested by Webbe (1987) and Akufongwe *et al.* (1995) difficult because of its obvious side effect on the edible snail species.

The snail population dynamic between the months of May to October was highly influenced by the rainfall pattern. This finding was consistent with that reported by Akufongwe *et al.* (1995). They attributed the marked increase of snail population at the onset of rain to the resumption of normal metabolic activities by snails that have successfully gone through period of adverse conditions. Cooper *et al.* (1992) observed that all snails surviving diapause produce large number of egg and cercariae once returned to water.

There were no striking disparities observed in the physio-chemical parameters of the investigated water bodies. Freshwater snails are known to exhibit high degree of tolerance and adaptation within a reasonable range of physio-chemical fluctuation (Imafidon, 1991; Agi and Okwuosa, 2001; Agi, 1995).

The outcome of this study has revealed that the tributaries of the Benue river are good habitat for freshwater snails. The physio-chemical qualities of these water bodies are conducive for optimum distribution and abundance of snail species. The coexistence of both edible and medically important snails calls for urgent awareness on the public health implications of this association.

**ACKNOWLEDGEMENT**

We thank Prof. O. Amali of Department of Biological Sciences, University of Agriculture Makurdi for his immense assistance in Snail Identification and Mr. J. I. Waya of Botany Laboratory Benue State University, Makurdi who helped in identifying the aquatic plants.

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# REPLACEMENT VALUE OF GUINEA CORN FOR MAIZE IN PRACTICAL DIET FED TO QUAIL (*Coturnix coturnix japonica*) CHICKS

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**ABSTRACT**

***A six week feeding trial was conducted to determine the replacement value of Guinea corn for maize in diet fed to 360, day-old quail chicks on deep litter. Four iso-nitrogenous (22 %Crude protein) diets incorporating graded levels (O, 15, 27 and 42 %) of guinea corn as replacement for maize were used in the trial. The ME levels of the diets ranged from 2700 – 2750 kcal/kg. Each treatment was replicated thrice. Feed intake, weight gain and feed/ weight gain ratio did not differ significantly (P>0.05) among the treatments. Feed cost decreased across the treatments and was lowest for the diet in which 42 % maize was replaced by guinea corn. Feed cost/kg weight gain was lower for diet B(15 % guinea corn) than for other diet tested. Results of this study indicated that a dietary crude protein level of 22 % and M E of 2700 to 2750 kcal/kg feed, of 42 % guinea corn based diet was suitable for growth of Japanese quail chicks.***

**Keywords**: Guinea corn, Quail chicks, Productive Performance

## INTRODUCTION

Much care is being exercised by many people on the quantity of animal fat consumed regularly because of the health implications. Japanese quail are small-bodied birds of the galliformiss family and are low in body fat and cholesterol (Garwood and Diehl, 1987, Schwartz and Allen, 1981). Therefore, much effort should be targeted to multiplying these birds for increased consumption of meat with low fat and high protein.

Livestock feed have become very expensive resulting in decrease in livestock production. There is increasing competition between man and livestock for available feedstuffs for food, feed and industrial raw materials. According to Bamgbose, *et al.* (2004), maize accounts for about 45 to 55 % of poultry feed. Therefore any effort to substitute maize in poultry feed will significantly reduce the cost of production. They successfully replaced 40 % maize with maize offal/cashew nut meal based diet and recorded no deleterious effect on carcass yield and nutrient digestibilities of broilers. The most relevant option to arrest the present feed crisis of the livestock industry is by-product utilization (Atteh, 1986). These deductions point clearly to alternative feed stuff for livestock feed productions in order to cut down feed prices and make them more affordable by livestock farmers. Olubamiwa, *et al*. (1999) had also successfully replaced 14 % maize with cocoa husk meal (CHM) with no depressive effect on the growth of quail chicks. Cullison, (1987), reported that sorghum can replace 50 % of corn with no adverse effect on animal performance but weight gain may reduce by 10 % or more with higher levels of replacement. This is contrary to the report of Spiridon, *et al.* (1979) who observed no depressive effect of sorghum on growth and feed efficiency even at 100 % replacement of maize with sorghum in meat chickens. However, carcasses of birds fed most sorghum diets were lighter than control. Guinea corn contains 11 % crude protein, 3300 kcal/kg metabolizable energy and a crude fibre level of 3 % (Aduku, 1992). Reports of Lee et al (1981) and Haruna, *et al.* (1997) had recommended crude protein levels of 24 % and 22 to 25 % respectively for quail chicks. This was contrary to the recommended level of 28 % crude protein (NRC, 1971). The work of Olubamiwa, *et al.* (1999) also recommended metabolizable energy levels of between 2,500 and 2,800-kcal/kg diet for growing quails.

This study investigated the effect of replacing maize with guinea corn in quail chick diet.

## MATERIALS AND METHODS

**Birds:** Three hundred and sixty (360) day old Japanese quail (*Coturnix cotumix japonica*) chicks hatched at National Veterinary Research Institute, Vom Poultry farm were selected on the basis of fitness and uniformity and bodyweight. They were housed in pens in a standard poultry brooding house and spaced 75 sq cm per bird as recommended (NVRI, 1996). Each pen housed 30 unsexed quail chicks. In all there were 12 experimental pens each fitted with 100-watt electric bulbs. Two kerosene stoves (modernized) heated the entire room. Cardboard sheets designed to keep the chicks from straying away from the heat source were put in each pen. These measures were to achieve the desired brooding conditions. All chicks were weighed together in groups before they were placed in the pens. Subsequently, 20 percent of the chicks were weighed from each pen at weekly interval (for six weeks).

**Table 1: Experimental diets (%)**

| Ingredients | | A | B | C | D |
|---|---|---|---|---|---|
| 1. | **Maize** | 42 | 27 | 15 | - |
| 2. | **Guinea corn** | 15 | 27 | 42 | |
| 3. | **FF Soya** | 10 | 10 | 10 | 10 |
| 4. | **Wheat offal** | 20 | 20 | 20 | 20 |
| 5. | **Fish meal** | 1 | 1 | 1 | 1 |
| 6. | **Soya cake** | 23.8 | 23.8 | 23.8 | 23.8 |
| 7. | **Bone meal** | 2.0 | 2.0 | 2.0 | 2.0 |
| 8. | **Limestone** | 0.5 | 0.5 | 0.5 | 0.5 |
| 9. | **Common salt** | 0.25 | 0.25 | 0.25 | 0.25 |
| 10. | **Premix** | 0.25 | 0.25 | 0.25 | 0.25 |
| 11. | **Methionine** | 0.10 | 0.10 | 0.10 | 0.10 |
| 12. | **Lysine** | 0.10 | 0.10 | 0.10 | 0.10 |
| | | 100 | 100 | 100 | 100 |
| **Proximate Composition** | | | | | |
| | CP | 21.86 | 22.16 | 22.40 | 22.70 |
| | ME | 2750 | 2730 | 2714 | 2695 (Kcal/kg) |
| | Ca | 1.07 | 1.51 | 1.51 | 1.09 |
| | P | 0.63 | 0.67 | 0.70 | 0.72 |
| **Feed cost/100 kg** | | 3327.75 | 3252.75 | 3192.75 | 3117.75 |
| **Analysed Composition** | | | | | |
| | CP | 22.20 | 22.15 | 22.30 | 22.50 |
| | Ca | 1.11 | 1.21 | 1.4 | 1.15 |
| | P | 0.61 | 0.64 | 0.67 | 0.69 |

**Table 2: Effect of different guinea corn levels on mean feed consumption, weight gain, and feed efficiency of quail chicks at 6 weeks of age**

| | A | B | C | D | SEM |
|---|---|---|---|---|---|
| **Feed Consumption** | 382.6 | 383.16 | 365.66 | 373.84 | ± 14.19 |
| **Weight gain** | 128.52 | 140.43 | 20.52 | 129.97 | ± 4.62 |
| **Feed/gain ratio** | 3.38 | 3.14 | 3.38 | 4.84 | ± 1.43 |
| **Feed cost (₦/kg)** | 33.28 | 32.53 | 31.93 | 31.18 | .. |
| **Initial weight (g/bird)** | 9.03 | 8.78 | 9.03 | 8.93 | .. |
| **Final weight (g/bird)** | 137.56 | 149.11 | 130.89 | 138.89 | .. |
| **Cost/kg gain (₦)** | 97.87 | 94.23 | 104.94 | 134.81 | ±24.47 |

Three groups each were randomly allocated the experimental feeds (B, C and D) while control group was fed with feed containing no guinea corn (0 level). Feed and water were given *ad. libitum*.

**Guinea Corn:** 100 kg was obtained from the open market in Vom, Plateau State and was verified to be in good condition, free from weevils.

**Experimental Diets:** Four experimental diets were formulated to contain graded levels of guinea corn (0, 15, 27 and 42) at the expense of maize. The diets represented by A, B, C, and D respectively were iso-nitrogenous containing 22 % crude protein. The energy levels of the diets ranged between 2700 to 2750 kcal/kg metabolizable energy. All experimental diets were analysed for proximate chemical compositions (Table 1) (AOAC, 1970).

**Data Collection:** The mean weekly body weight and feed consumption of birds were recorded throughout the experimental period. From the mean body weights and feed intake, feed conversion ratio was calculated. Feed cost /kg diet was calculated using the prevailing market price of feed ingredients around Jos. Data collected were subjected to two way Analysis of variance (ANOVA) (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

Data on feed consumption, weight gain and feed/ weight gain ratio are shown in Tables 2. All the groups on the different treatments started to lay by the 6$^{th}$ week of life which confirms the report of Martins (1987). Even though there were numerical differences between diets in terms of the different parameters measured, they were not significantly different ($P > 0.05$). There were numerical differences in feed intake between treatment diets but the differences were not significant even though the energy levels were slightly decreasing across the diets from diet A. This may be attributed to the observed ability of quail to adjust feed intake over a wide range of dietary energy content (Olubamiwa, *et el.*, 1999). Even though there were seeming differences in weight gain of quail chicks (Table 2), the differences were not significant. The energy

contents of the diets decreased from 2,750 (diet A) to 2,695 (diet D) and apparently did not affect weight gain of quail chicks. Weber and Reid (1967) had reported that quail weight gain on 1760- 2400 kcal/kg ME diets was not significantly altered. Feed conversion efficiency of quail (table 2) did not differ significantly between treatments, though numerically it was highest for diet D and lowest for diet B. It is interesting that quail chicks did not register depressed weight gain, feed consumption or feed conversion even at 42 % guinea corn inclusion in the diet. The lack of depressive effect of the treatment diets on the productive parameters agrees with the report of Spiridon, *et al.* (1979). The tolerance to increasing guinea corn in the diets may be due to the ability of quails to adjust their eating habits. The feed conversion rate for quail was poor when compared to reports for chickens (Sobamiwa and Longe, 1998). This generally poor feed conversion had also been reported by Weber and Reid (1967) and Haruna, *et al.* (1997). This may be due to feed wastage characteristic of quail birds. In terms of feed cost/kg diet, diet D was the cheapest (Table 2). Feed cost/ kg weight gain was numerically lower for diet D than for other diets and compared favourably with those reported by Olubamiwa, *et al.* (1999). It is important to investigate the upper limit of guinea corn for quail chicks.

**ACKNOWLEDGEMENT**

The authors are grateful to the Director National Veterinary Research Institute, Vom for creating an enabling environment and for permission to publish this paper. We are also grateful to God for his grace.

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# PATHOLOGICAL CONDITIONS OF CONDEMNED BOVINE LUNGS FROM ABATTOIRS IN AKWA IBOM STATE, NIGERIA

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**ABSTRACT**

***A study of diseases of the bovine lungs was carried out in Akwa Ibom State, Nigeria between (1999 – 2002). A total of 5,369 cattle were slaughtered within the study period out of which, 459 (8.5 %) lungs were condemned. Tuberculosis accounted for 183(39.921), representing 3.4 % of the total cattle population. This was closely followed by Pneumonia, which was 180(39.2 %), representing 3.4 % of this population. Abscesses, 93(20.1 %) and Taenia sp Cysts 3(0.7%), representing 1.7% and 0.1 % respectively of the total cattle population slaughtered also resulted in lung condemnations. The overall annual prevalence of the diseases amongst condemned bovine lungs shows that most of them were encountered in the last three years of study, 10.1 %, 9.7 % and 8.7% for the years 2000, 2001 and 2002, respectively. There was a clear positive seasonal influence on the prevalence of these diseases. The prevalence rate of tuberculosis and abscesses decreased along the seasonal periods from LDS to EDS. The rainy seasonal periods (ERS and LRS) increased the prevalence of pneumonia more than the dry periods while Taenia cysts were only recorded during the early dry season (EDS). It was, therefore, concluded that tuberculosis and pneumonias, both accounting for over 79 %, were the major reasons for bovine lung condemnations at the abattoirs in Akwa Ibom State.***

**Keywords:** Pathology, Bovine, Lungs, Abattoirs, Akwa Ibom

## INTRODUCTION

Surveillance of animal diseases for the purposes of control and eradication is practiced all over the world. Clinical and post mortem diagnoses are conventional methods being widely used. In developed countries, new methods introduced have been proved very reliable for diseases surveillance, control and eradication. Developing countries are faced with both economic and technological difficulties in putting to use most of the modern methods of surveillance and as such abattoir condemnations based on physical observations is practiced (Alonge and Fasanmi, 1979; Shadbolt *et al*. 1987; Matovelo and Mwamengele 1994; Ofokwu and Okwori, 2000; Okoli *et al.* 2000). Information generated from slaughter houses have equally been used to assess economic losses arising from the condemnations of bovine lungs and other organs (Okolo, 1985; Dipeolu *et al*. 1998; Halle, 1998).

Diseases are the major reasons for organ condemnations at the abattoirs. For example, 41.9 % of whole carcasses condemned between 1975 and 1977 in Nigeria were due to tuberculosis, and 22.2 % due to cysticercosis of *Taenia spp* (Alonge and Fasanmi, 1979). Pneumopathies had also accounted for 20 % of abattoir condemnations in Nigeria (Atsanda and Agbede, 1999), while abscesses had accounted for 0.4 % of liver condemned in abattoirs in Akwa Ibom State (Opara *et al*., 2003).

Infectious diseases of respiratory tracts of farmed animals are caused by a combination of infectious agents and predisposing factors (Eddy *et al*., 1992; Blood and Radostits, 1994). Under rearing conditions most ruminant livestock harbour some disease conditions without clinical manifestation. During abattoir ante-mortem inspections, hundreds of such animals are passed for slaughter (Okolo, 1985; Okoli *et al*., 2002).

In Akwa Ibom State, thousands of cattle are processed as meat for human consumption each year. However no study has been carried out among cattle brought in for slaughter in Akwa Ibom State to determine the prevalence of the diseases affecting the lungs which play vital roles in the maintenance of normal physiological status of these animals.

The present study therefore examined bovine lungs from abattoirs in Akwa Ibom State, Nigeria, to ascertain the prevalence of bovine lung diseases in cattle processed for human consumption.

## MATERIALS AND METHODS

The prevalence of some diseases affecting the lungs of cattle slaughtered in Akwa Ibom State, Nigeria were monitored for four years January-December (1999 – 2002), using meat inspection data collected from Public Health Unit of the Federal Livestock Department (FLD), State Zonal Office, Uyo.

Meat inspection records for the State were generated through the inspection activities of the State Veterinary personnel who cover all the abattoirs in the different local government areas. Monthly, records from the local government areas were pooled together and then resubmitted to the FLD Zonal office as monthly meat inspection report. The meat inspection report, contained disease conditions identified, overall yearly and monthly prevalence rates of the diseases encountered during post mortem inspections.

These data were further analysed for disease trends over the period of study, using descriptive analyses. Averages and percentages were also used to determine the prevalence rates and trends across four seasonal periods namely: early dry (October to December), late dry (January to March), early rains (April to June) and late rains (July to September).

## RESULTS

The disease conditions in condemned lungs of cattle slaughtered at the abattoirs in Akwa Ibom State are shown in Table 1. Out of a total of 5,369 cattle slaughtered, 459 (8.5 %) lungs were condemned. Tuberculosis was responsible for 183 (39.9 %) of the condemned lungs. This accounted for 3.4% of the lungs condemned from the total cattle slaughtered. Pneumonia was encountered in 180 (39.2 %) of the condemned lungs and 3.4 % of the total cattle slaughtered. Abscesses were responsible for 93 (20.1 %) of the condemned lungs which translated to 1.7 % of the total cattle slaughtered. *Taenia* cysts accounted for 3 (0.7 %) of the condemned lungs, representing 0.1 % of the total cattle slaughtered.

**Table 1: Disease conditions in condemned lungs of 5,369 cattle slaughtered at the abattoirs in Akwa Ibom state between January 1999 and December 2002**

| Disease condition | No. (%) of cases | Percentage of total slaughter |
|---|---|---|
| Tuberculosis | 189 (39.9) | 3.4 |
| Pneumonia | 180 (39.2) | 3.3 |
| Abscesses | 93 (20.1) | 1.7 |
| Hydatid cysts | 3 (0.7) | 0.1 |
| Total | 459 (8.5) | 8.5 |

Table 2 presents the overall annual prevalence of disease conditions in condemned bovine lungs, from January 1999 to December 2002. The year 2000, recorded the highest cases of condemnations 98(10.1 %), followed by 131(9.7 %), 140(8.7 %) and 90(6.6 %) recorded in 2001, 2002 and 1999 respectively. Tuberculosis accounted for over 3 % of the reasons for lung condemnation in all the years monitored. It was recorded most in 1999 which was 51(3.8 %) followed by 2001, 2002 and 2002 which recorded 50(3.5 %) and 50(3.1 %), respectively.

Pneumonia accounted for 45(4.6 %) condemned lungs in 2000; 64(4.0 %); 45(3.1 %) and 26(1.9 %) in 2002, 2001 and 1999 respectively. Abscesses were encountered most in 2001 and they accounted for 36(2.5 %) of the condemned lungs. This was followed by 21(2.2 %), 25(1.6 %) and 11(10.8 %) prevalence rates in 2000, 2002 and 1999, respectively. *Taenia* cysts were recorded only in 1999 and 2002. Furthermore, 2(0.1 %) of the lungs had cysts in 1999 while in 2002, cysts were reported in 1(0.1 %) lungs.

The results of the seasonal prevalence of disease conditions in condemned bovine lungs at abattoirs in Akwa-Ibom State are shown in Table 3. Seasons had effect on the prevalence of bovine lung diseases, with ERS recording 142(10.9 %), followed by 99(9.7 %), 150(9.3 %) and 113(7.8 %) also recorded during the LDS, EDS and LSR, respectively. Seasons equally had effect on the prevalence of tuberculosis, with its presence observed in all the four seasonal periods. The peak (5.5%) recorded during the LDS was followed by decreasing patterns of 4.3 %, 3.3 % and 2.7 % occurrences during the ERS, LRS and EDS, respectively. Pneumonias had the highest occurrence 63(5.0 %) during the ERS, followed by 48(3.3 %), 43(2.7 %) and 26(2.6 %) during the LRS, EDS and LDS respectively. Abscesses were encountered mostly during LDS 37(3.6 %) while 23(1.8 %), 16(1.0 %) and 17(1.2 %) were encountered during the ERS, LRS and EDS, respectively. Taenia cysts were not observed during LDS, ERS, and LRS but occurred during the EDS (3, 0.2 %).

The percentage monthly occurrence of disease conditions in condemned bovine lungs from abattoirs in Akwa Ibom State are shown in Figure 1.

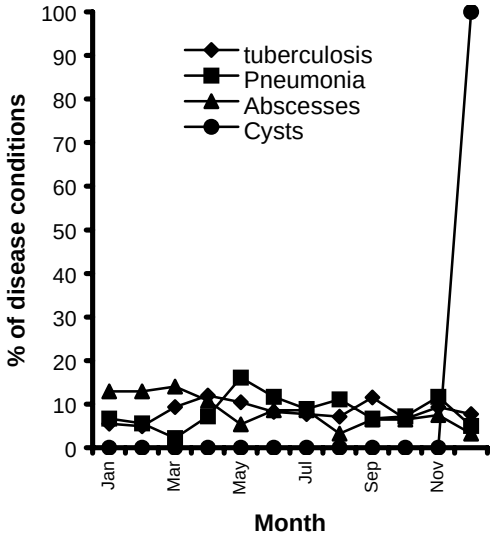


**Figure 1: Percentage monthly occurence of disease conditions in condemned bovine lungs at abbattoirs in Akwa Ibom State (1999-2002)**

A cyclic pattern of tuberculosis monthly distribution was observed for bovine lungs condemned at abattoirs in Akwa Ibom State. A bimodal peak was exhibited in April (12.0 %) and September (11.5 %) for tuberculosis. On the other hand, a cyclic monthly distribution was recorded for bovine lungs infected with pneumonia. Peaks were recorded in the months of May (16.1 %) and November (11.7 %). Abscesses were highest in the months of January, February, March and April (12.9, 12.9%, 14.0 and 10.8%), respectively. Another lesser peak periods were (6.5%) in September, October (6.5%) and November (7.5%).

**Table 2: Disease conditions in condemned lungs of 5,369 cattle slaughtered at the abattoirs in Akwa Ibom state between January 1999 and December 2002**

| Year | No. of animals slaughtered | Tuberculosis cases | Pneumonia cases | Abscesses cases | *Taenia* cysts cases | Total cases |
|---|---|---|---|---|---|---|
| **1999** | 1355 | 51 (3.8) | 26 (1.9) | 11 (0.8) | 2 (0.1) | 90 (6.6) |
| **2000** | 973 | 32 (3.3) | 45 (4.6) | 21 (2.2) | 0 (0) | 98 (10.1) |
| **2001** | 1430 | 50 (3.5) | 45 (3.1) | 36 (2.5) | 0 (0) | 131 (9.7) |
| **2002** | 1611 | 50 (3.1) | 64 (4.0) | 25 (1.6) | 1 (0.1) | 140 (8.7) |
| **Total** | 5,369 | 183 (3.4) | 180 (3.4) | 93 (1.7) | 3 (0.1) | 459 (8.5) |

**Table 3: Seasonal prevalence of disease conditions in condemned bovine lungs at abattoirs in Akwa Ibom state between January 1999 and December 2002**

| Seasonal period | No. (%) of animals slaughtered | Tuberculosis (%) | Pneumonia (%) | Abscesses (%) | *Taenia* cysts (%) | Total |
|---|---|---|---|---|---|---|
| **LDS** | 1017 (18.9) | 56 (5.5) | 26 (2.6) | 37 (3.6) | 0 (0) | 99 (9.7) |
| **ERS** | 1298 (24.2) | 56 (4.3) | 63 (5.0) | 23 (1.8) | 0 (0) | 142 (10.9) |
| **LRS** | 1442 (26.9) | 48 (3.3) | 48 (3.3) | 17 (1.2) | 0 (0) | 113 (7.8) |
| **EDS** | 1612 (30.0) | 43 (2.7) | 43 (2.7) | 16 (1.0) | 3 (0.2) | 150 (9.3) |
| **Total** | 5,369 | 183 (3.4) | 180 (3.4) | 93 (1.7) | 3 (0.1) | 459 (8.5) |

*LDS = Late Rainy Season; ERS = Early Rainy season; LRS = Late Rainy Season; EDS = Early Dry Season*

*Taenia saginata* cysts had only one sporadic occurrence in the month of December (100 %).

## DISCUSSION

Tuberculosis and pneumonias accounted for 79.1 % of the lungs condemned at the abattoirs in Akwa Ibom State during the study period. This finding agrees in part with Ajogi *et al.* (1995) that tuberculosis is the major cause of bovine lung condemnation in abattoirs.

Tuberculosis was considered to be under control in the 1970s and 80s, however the prevalence rate of 3.4 % in 5,369 cattle slaughtered in Akwa Ibom State calls for concern. With the worldwide resurgence of tuberculosis in human beings (Dolin *et al.*, 1994), the prevalence level reported in this study indicates its high endemicity.

Although tuberculosis was encountered in all the years studied, there was a decrease in the prevalence rates along these years. This could be as result of the recent public enlightenment campaign about tuberculosis and better meat inspection activities in the abattoirs (Ukpong, 2002). Results from this study showed that tuberculosis of the lungs was more prevalent during the rainy seasons and decreased with the end of the rains. This is contrary to the reports of Alhaji (1976), Collins *et al.* (1983) and Ajogi *et al.* (1995) who recorded higher prevalence rates of this disease during the dry seasons.

The Fulani herdsmen are nomadic pastoralists. They bring their cattle to the southern parts of the country during rainy season to graze, and re-migrate when the rains begin in the North (Ogundipe *et al.*, 1989). This prevalence of tuberculosis during the rainy seasons correlates with the migratory activity into the south to graze. Possibly these cattle might have acquired the infection up-north before embarking on the south-ward migration for pastures.

The prevalence rate of pneumonia in this study (3.4%) does not agree with the report of Halle (1998) and Odo *et al.* (1999) who reported higher prevalence rates of 6.8% and 18.9% in Enugu and Zaria respectively. It is on record (Okolo, 1985) and Okoli *et al.* 2002) that animals with pneumonia are usually passed for slaughter even though they harbour this condition during rearing and might have shown obvious or specific clinical signs. Some of the cattle examined in our work could have had pneumonia but were unnoticed and passed for slaughter. Pneumonia is of importance in all livestock production due to harsh weather conditions during the dry season and verminous pneumonia during the rainy season which often resulted in bovine mortality (Isoun and Mann, 1977). In this study, pneumonia was recorded during the rainy and dry seasons and thus agrees with Halle (1998) who observed that both seasons exacerbate this condition in livestock. Bronchopneumonia and the accompanying abscessation (1.7 %) in the lungs might have been brought about by secondary bacterial infections with *Pasteurella* and *Mycoplasma* species. Abscess was again observed to predominate during the dry than rainy seasons. This finding agrees with the reports of Ojo and Chineme (1980), Shadbolt *et al.* (1987), Shaffo (1993), Matovelo and Mwamengele (1994) that lack of adequate pastures during the dry season encourages abscess formation in the organs as a result of lowered immunity against infectious agents.

The presence of cysts (0.1 %) in the lungs of slaughtered cattle in Akwa-Ibom State agrees with the reports of Ajogi *et al.* (1995), Atsanda and Agbede (1999) who reported prevalence rates of 0.57 % in Sokoto, 0.67 % and 0.83 % in Ibadan and Maiduguri, respectively. This confirms the lungs as predilection site for *Taenia* cysts. The cysts were encountered only at the early dry season. It is

possible that the isolated cases may have been acquired during the rainy seasons but were retained into the dry season because of favourable physiological conditions in the lungs.

Generally, the overall disease trends tended to increase from 1999 to 2002. This may be due to increasing number of slaughter down the years which also increased the number of condemned lungs. In addition, *Blood et al.* (1979) reported a higher prevalence rate of diseases among female cattle than their male counterparts. Opara *et al*. (2003) had recently reported a higher female cattle slaughter figure in Akwa Ibom State than the male ones. These reasons could be ascribed to the overall annual increase in diseased bovine lung condemned in Akwa Ibom State.

**Conclusion:** Tuberculosis and pneumonia are the major reasons for bovine lung condemnations in the abattoirs, at Akwa Ibom State. This calls for a serious concern as the result of the present study presents information on carcass condemnations. Moreover, illiterate Fulani herdsmen who provide little or attention vis-à-vis disease control and prevention owned animals involved in this study and are the major providers of meat and milk in Nigeria. The information in this study emphasizes the need for improved surveillance and meat inspection programme.

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# EGG QUALITY OF *Gallus domesticus* UNDER DOMESTIC STORAGE IN NIGERIA

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**ABSTRACT**

***Empirical relationships between egg quality parameters and storage length were determined using the total of 174 fresh chicken eggs stored for 14 consecutive days under three different conditions. These conditions mimicked the current methods of handling eggs domestically and in retail business. Differences in percentage weight loss and interior quality characteristics were significantly affected by type of storage, even after only 5 days of storage (P < 0.05). Generally quality depreciation was lowest in eggs placed in an open bowl and stored in a refrigerator (REF eggs), followed by eggs stored in a closed polythene bag and kept under room temperature (PBR eggs), and highest amongst eggs placed in an open bowl and kept under room temperature (OBR eggs). Correlations between egg parameters and length of storage were in most cases very highly significant (P < 0.001), and in all measured parameters, OBR eggs recorded the highest correlation coefficients (r), followed by PBR eggs, and finally REF eggs. Amongst REF eggs, correlation between Haugh unit values and days of storage was not significant (P > 0.05), whereas correlation with percentage weight loss or yolk index was very highly significant (P < 0.001). It was concluded that eggs placed in polythene bags and kept under room temperature suffer less depreciation in quality compared with eggs kept in open bowls. Where facilities are available, it was suggested that eggs should first be packaged in polythene bags before refrigeration.***

**Keywords**: Correlation, Egg quality, Storage length, *Gallus domesticus*, Nigeria

## INTRODUCTION

Post-harvest losses of agricultural products due to deterioration are still a major threat to food security in Nigeria. Factors responsible for this include lack of effective systems for conveying products from myriads of subsistence farmers in the hinterland to the consuming dwellers in urban areas, and the non-performing preservation and conservation facilities occasioned by irregular and defective electric power supply. Deterioration or depreciation in quality commences immediately after harvest in animal products, and its extent is dependent mainly on length and temperature of storage (Fry and Newell, 1957; Hinton, 1968). Most modern preservation facilities employ refrigeration, and the efficiency of this system in maintaining the interior quality of eggs has been the object of numerous investigations (Olomu, 1975; Onwudiike and Sonaiya, 1983; Okoli and Udedibie, 2000; Oguike and Onyekweodiri, 2000). In Nigeria egg storage is in most cases under ambient condition. Whilst the retailer usually displays eggs for sale on open paper or plastic egg trays, the housewife often stores them in the same polythene bag used by the retailer in packaging the eggs. Some housewives have refrigerators, but the irregular electric power supply hinders their operation. The objectives of this study were to measure the quality of eggs stored under conditions similar to the prevailing general practice, and derive regression models relating egg quality indices to length of storage.

## MATERIALS AND METHODS

The fresh chicken eggs used in this study were obtained directly from a commercial farm in Owerri. The total of 174 eggs were divided into three equal groups, and each group of 58 eggs was allotted to one of three storage conditions. The first was storage in an open plastic bowl kept inside a refrigerator (REF eggs); the second was storage in an open plastic bowl under normal room temperature (OBR eggs); and the third, was storage inside black polythene bag under normal room temperature (PBR eggs). In each storage condition, 30 eggs were used for weight loss determination whilst the remaining 28 eggs were reserved for interior quality assessment. Eggs for weight loss determination were subdivided into 3 replicates and each replicate contained 10 eggs. The weight of each replicate was determined daily, and for 14 consecutive days.

Similarly, the eggs for interior quality measurements were separated into two replicates of

**Table 1: Mean scores for various egg quality parameters as affected by temperature and length of storage**

| Parameter | Storage period (d) | Refrigerator (open bowls) | Not Refrigerated (closed bags) | Not Refrigerated (open bowls) | SEM |
|---|---|---|---|---|---|
| **Weight (%)** | 5 | 0.64[a] | 1.13[b] | 1.75[c] | 0.104 |
| | 9 | 0.93[a] | 1.58[b] | 2.33[c] | 0.096 |
| | 14 | 1.35[a] | 2.02[b] | 2.99[c] | 0.098 |
| **Haugh Unit** | 5 | 68.35[a] | 60.86[a] | 49.70[c] | 3.726 |
| | 9 | 68.78[a] | 53.73[b] | 41.91[c] | 3.956 |
| | 14 | 66.50[a] | 44.95[b] | 32.08 [a] | 3.297 |
| **Yolk Index** | 5 | 0.47[a] | 0.40 [b] | 0.37 [b] | 0.030 |
| | 9 | 0.46[a] | 0.34 [b] | 0.31[c] | 0.024 |
| | 14 | 0.45[a] | 0.30 [b] | 0.26[c] | 0.017 |

**Table 2: Regression equation relating egg quality to duration of storage (days)**

| Parameter | Correlation coefficient | Significance |
|---|---|---|
| **Weight loss (%)** | | |
| $Y_1 = 0.0537 + 0.1605X$ | 0.928 | *** |
| $Y_2 = 05953 + 0.1864X$ | 0.986 | *** |
| $Y_3 = 0.09635 + 0.989X$ | 0.989 | *** |
| **Haugh Unit** | | |
| $Y_1 = 72.3167 - 0.7082X$ | 0.442 | NS |
| $Y_2 = 72.2028 - 3.7712X$ | 0.896 | ** |
| $Y_3 = 62.6242 – 3.8580X$ | 0.932 | *** |
| **Yolk Index** | | |
| $Y_1 = 0.4850 - 0.0052X$ | -0.808 | *** |
| $Y_2 = 0.4413 – 0.0209X$ | -0.743 | *** |
| $Y_3 = 0.4250 – 0.0209X$ | -0849 | *** |

14 eggs each. For the 14 days, one egg was removed each day from each replicate, weighed, broken on a Petri dish and the thick albumen height was measured using a spherometer. A Konraws manual weighing balance was used, and weights were obtained to the nearest 0.1 gram. The yolk dimensions were assessed using a Venier caliper. The Haugh unit was calculated as: HU = 100 log (H + 7.57 – $1.7W^{0.37}$), where H = albumen height (mm) and W is egg weight (g). The yolk index was derived by dividing the height of yolk by the width.

**Statistical Analyses:** The means obtained from the replicates in each storage condition were tested for significant differences at the 5th, 9th and 14th days of storage. Analysis of variance and F – LSD were employed to separate treatment means for their significance. Correlation and linear regression analyses relating egg parameters to number of days of storage were carried out. All statistical computations were executed by the SPSS software (SPSS, 1990).

## RESULTS AND DISCUSSION

Differences in percentage weight loss were significantly different ($P < 0.05$) across the three storage conditions on the 5th, 9th and 14th days of storage (Table 1). Consequently the refrigerated eggs suffered the least weight loss, followed by eggs placed in polythene bags. Eggs placed in open bowls and kept under room temperature recorded the greatest weight loss. These results demonstrate the practical advantage of egg storage in closed polythene bags over storage in open bowls or egg trays. Essien *et al.* (1996) made similar observations. Differences in Haugh units and yolk indices amongst the various treatment groups generally followed the trend established by differences in weight loss. It is known that a polythene packaging material provides a barrier to evaporation and other gaseous losses. Therefore, packaging eggs in polythene bags may be somewhat similar to oil coating of eggs in its preserving effect since the latter is known to preserve the interior quality of eggs by minimizing gaseous losses (Knight *et al.*, 1972; Ihekereonye and Ngoddy, 1985; Ikeme and Enelamah, 1985; Okeudo *et al.*, 2003). Nonetheless, storing eggs in the polythene bag in which they were purchased should present less handling problems than oil coating of eggs. Details of correlations between egg quality indices and periods of storage are presented in Table 2. Correlation coefficients (r) were very high, and generally similar to figures reported by Essien *et al.* (1996). Correlation coefficients were highest for eggs placed in bowls and kept under room temperature, and lowest in refrigerated eggs. The implication is that egg quality deterioration was more responsive to days of storage in the former, than in the later, and demonstrates once again the greater tendency for eggs to decay under ambient conditions. Amongst the refrigerated eggs, the relationship between Haugh unit and days of storage was not significant ($P > 0.05$), whereas the relationship between percentage weight loss or yolk index and days of storage was very highly significant ($P < 0.001$). This indicated that refrigeration cannot completely preserve the quality of eggs during the storage period. Certainly this underpins the necessity of packaging eggs in gas proof materials (such as polythene) before

refrigeration. Bell (1996) noted that domestically, eggs are kept in the refrigerator, usually in cartons in which they were retailed. The very high correlation coefficients recorded in this study underscore the usefulness of these regression equations in predicting egg quality changes, even on daily basis.

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# ANTI-MICROBIAL RESISTANCE PROFILE OF *Escherichia coli* ISOLATES FROM COMMERCIAL POULTRY FEEDS AND FEED RAW MATERIALS

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**ABSTRACT**

***Information on the level to which commercial feeds and feed raw materials are involved in the dissemination of anti-microbial resistant pathogenic and commensal bacteria in Nigeria is necessary for feed and stock management. Forty four Escherichia coli isolates from 4 commercial feed brands coded SF, GF, TF and ACF and from 90 various feed raw materials such, fish meal (FM), maize (MA), maize offal (MO), wheat offal (WO), spent grain (SG), blood meal (BM) and soybean meal (SM) etc were screened for anti-microbial resistance profile against 10 antibiotics using the disc diffusion method. Overall, the isolates recorded 80.8 % resistance to cefuroxime, 76.9 % to nalidixic acid, 75 % to ampicillin, and 59.6 % to cotrimoxazole while very low 7.7 % was recorded for tetracycline and 5.8 % for gentamycin, ciprofloxacin and chloramphenicol. Across commercial feed brands, isolates from SF were resistant to nitrofurantoin (100 %), nalidixic acid (50 %) and ampicillin (70 %), while those from TF, GF and ACF were resistant to 7, 6 and 5 antibiotics respectively. Resistance against ampicillin, nalidixic acid and cefuroxime, in isolates from SG, palm kernel cake (PK), MO and WO were high. Organisms isolated from SG and PK recorded high resistance against cefuroxime and cotrimoxazole. Isolates from bone/limestone (B/L) registered 100 % resistance against ampicillin, cotrimoxazole and cefuroxime, while those from maize MA recorded 100 % resistance to cefuroxime and norfloxacin, and over 70 % to nalidixic acid. Soybean meal isolates values for nitrofurantoin, tetracycline, nalidixic acid and ampicillin were high but below 80 %. Thirty fives resistance patterns were observed; with the CF-NB-CO-NA-AM pattern being the most predominant (occurring 10 times). The present data shows that commercial feeds and feed raw materials are important vehicles for the introduction of multi-drug resistance encoding E coli into poultry.***

**Keywords:** Anti-microbial resistance, *E. coli*, commercial feeds, feed raw materials, antibiotics

## INTRODUCTION

Evolution and spread of anti-microbial resistant bacterial strains have become a global problem and could possibly be described as a silent epidemic of the millennium (Bush, 1997; OIE, 1999; EMEA, 1999; Franklin *et al*, 2001; Okoli *et al,* 2002 and Stratton, 2003). Anti-microbial resistance, especially of pathogenic bacteria, has been partly attributed to the misuse of anti-microbial agents in medicine and agriculture (van den Bogaard, 1997; Apley *et al,* 1998; Okeke *et al*, 1999 and Okoli *et al*, 2002). The critical importance of this evolution and dissemination of drug resistant bacteria is reflected by the existence of many national and international networks on the surveillance of anti-microbial resistance in bacteria. Thus, there is a need to constantly monitor susceptibility trends in bacterial agents of economic and public health importance.

*E coli* is an intestinal inhabitant of all animals and is therefore widely distributed (Gross, 1994). They are responsible for numerous animal diseases of economic and public health importance (Jordan, 1990). *E. coli* strains are known to exhibit considerable variations in sensitivity to anti-microbial agents such that isolates from one area of a country or those from different diseases within the same area may vary in sensitivity (Blood and Radostits, 1989). Several materials such as litter, fecal matter, dust in poultry houses, rodent droppings, water and feeds among others have been implicated as possible sources of *E. coli* in poultry (Jordan, 1990).

Of all these possible routes, commercial feeds and feed ingredients are generally regarded as major routes of *E. coli* outside the flock manager's control (Wilson, 1990; Garland, 1996). Since commercial feeds and feed ingredients are usually sourced from wide geographical locations, they remain the major vehicles for the introduction of *E. coli* strains harboring novel resistant factors to local farm environment. Published information on the level to which commercial feeds and feed raw materials are involved in the dissemination of anti-microbial resistant pathogenic and commensal bacteria in Nigeria is however scanty (Uwaezuoke *et al*, 2000). The need to further assess the resistance status of pathogenic and commensal microbes in farm inputs is therefore very imperative and urgent.

The present study determines the prevalence of anti-microbial resistance in *E. coli*

isolates from commercial poultry feeds and feed ingredients in Imo State, Nigeria.

## MATERIALS AND METHODS

**Study Area:** The study was carried out in Imo State, Nigeria. Imo State is situated in the central part of the southeastern region of Nigeria. The State is divided into 27 Local Government Areas (LGA) for administrative purposes. These LGAs are further grouped into 3 senatorial zones namely, Owerri, Orlu and Okigwe. Poultry production in the study area could be broadly divided into extensive, semi-intensive and intensive systems. The greatest populations of chicken in the study area were made of local breeds reared by rural farmer under the extensive system. Other poultry producers included the owners of small to medium scale poultry farms that are sited in both rural and urban areas (Sonaiya, 2000). Rearing of started exotic broilers and cockerels has also become an important aspect of this production system in Imo State (Meremikwu, 2001).

Commercial intensive productions include table eggs, broiler, parent stock, turkey and chicken. These operations have been shown to range from very small scale (50 - 100 birds), to medium scale (101 to 1000 birds) and large scale (above 1000 birds). Small and medium farms are usually back yard affairs predominantly found in urban and peri-urban centers. Large scale, operations are located in peri-urban and rural environments. In most of the back yard poultries, hygienic and bio-security measures were usually poor with all the family members being involved in the daily management activities; usually there was no organized effort at vermin, ferrets and human traffic control. Hatcheries located in the area were involved in in-house and toll hatching.

Commercial poultry farmers in the area usually purchase their feeds from dealers on any of the popular commercial feed brands such as Top, Sanders, Guinea, Livestock and Vital Feeds among others. Most large-scale operators produce their own feeds from feed raw materials like fish meal, maize, maize offal, wheat offal, spent grain, blood meal and soybean meal etc purchased from dealers. Water is obtained from public taps where available or from streams or harvested rainwater. Self-medication was very rampant among the farmers with some of them also using human drugs for the treatment of poultry diseases (Okoli *et al*, 2002).

**Sample Collection:** Four popular commercial feeds and 2 feed raw materials depots selling common brands of feeds that farmers usually buy and assorted feed raw materials were purposively selected for the study. The four commercial feed brands sampled were coded SF, GF, TF and ACF. Feed raw materials sampled included, fish meal, maize, maize offal, wheat offal, spent grain, blood meal and soybean meal. Each commercial feeds and feed raw material depot was visited twice over a period of 6 weeks for sampling.

Samples were collected to cover the different types of poultry feed such as layer mash, chick mash, broiler starter mash, broiler finisher mash, grower mash and breeder mash. Three bags of feed were randomly sampled for each type of poultry mash, after which they were pooled to make a representative sample of that type of mash for a particular feed brand. Sampling was done by carefully opening each selected bag of feed and collecting approximately 5 grams of the feed with sterile universal bottles. Thereafter, the brand name, type of mash and town produced were recorded. The same procedure was adopted in sampling the feed raw materials. Sixty-two commercial poultry feeds and 110 feed raw materials were sampled.

**Cultivation and Isolation of Organisms:** Five grams of each feed sample was properly homogenized in 45 ml of sterile water and a 10-fold serial dilution of the homogenized samples was done (Ogbulie and Okpokwasili, 1999). A 0.1 ml aliquot of the appropriate dilution was inoculated onto MacConkey agar (MCA) plates. In all cases, the inoculation techniques described by Cruickshank *et al* (1983), were adopted. The plates were incubated overnight at 37 $^{O}$C.

Growths on the MCA plates suggestive of *E. coli* colonies, 2 – 4 mm in diameter, opaque and convex edge and rose pink colonies on account of lactose fermentation (Gillies and Dodds, 1976) were further isolated onto eosin methylene blue (EMB) plates and incubated overnight at 37 $^{O}$C. Green metallic sheen colonies indicative of *E. coli* were then subjected to biochemical tests for *E. coli* identification (Edwards and Ewing 1972).

**Susceptibility Testing:** The isolated *E. coli* were screened for anti-microbial resistance profile using the disc diffusion method (Bauer *et al,* 1966) as recommended by the National Committee for Clinical Laboratory Standards Guidelines (NCCLS, 1999). The disc diffusion method is widely recognized to work well with rapidly growing facultatively anaerobic and aerobic organisms such as Enterobacteriaceae (NCCLS, 1999).

Commercial antibiotics drugs used in the study included AM, ampicillin (25 µg); CO, cotrimoxazole (50 µg); NI, nitrofurantoin (100 µg); GN, gentamycin (10 µg); NA, nalidixic acid (30 µg); TE, tetracycline (30 µg); CH, chloramphenicol (10 µg); CF, cefuroxime (20 µg); NB, norfloxacin (10 µg); CP, ciprofloxacin (5 µg).

**Data Collection and Interpretations:** Susceptibility data were recorded quantitatively by measuring the diameters to the nearest millimeter using a meter rule. Using the interpretative chat of Kirby-Bauer Sensitivity Test Method (Cheesbrough, 2000), the zones were interpreted as resistant or sensitive. For the purpose of the present study, isolates with intermediate sensitivity were categorized as sensitive. Furthermore, proportions of isolates resistant to individual drugs and having each anti-microbial resistance patterns were computed according to feed brands and raw material types.

## RESULTS

**Feed Sampling, Isolation and Cultivation of Organisms:** Forty four (70.97 %) *E. coli* organisms were isolated from the 62 commercial feeds sampled and 90 (81.82 %) *E. coli* were isolated from raw materials. Table 1 showed that most of the sampled commercial feeds and feed raw materials originated from outside the state. Fish meal, maize and ACF for example originated from places located more than 500 kilometers from the sampling sites.

**Table 1: Sampling sites, town of production and estimated distance to sampling sites of poultry feeds and feed raw materials**

| Sample type | Sampling site | Town of Production | Estimated distance from sampling site (Km) |
|---|---|---|---|
| **(A) Commercial feeds** | | | |
| **ACF** | Owerri | Lagos | 500+ |
| **SF** | Owerri | Aba | 40 |
| **TF** | Owerri | Sapele | 150 |
| **GF** | Owerri | Ewu | 250+ |
| **(B) Feed raw materials** | | | |
| **Fish meal (FM)** | Owerri | Maiduguri | 1200+ |
| **Maize (MA)** | Owerri | Jos | 800+ |
| **Palm kernel cake (PK)** | Owerri | Enugu | 150 |
| **Spent grain (SG)** | Owerri | Aba | 40 |
| **Wheat offal (WO)** | Owerri | Port Harcourt | 80 |
| **Maize offal (MO)** | Owerri | Aba | 40 |
| **Limestone (LS)** | Owerri | Calabar | 180 |
| **Bone meal (BO)** | Owerri | Mbaise | 20 |
| **Blood meal (BM)** | Owerri | Mbaise | 20 |
| **Soybean meal** | Owerri | Enugu | 150 |

The overall anti-microbial resistance frequencies of *E. coli* isolates from commercial feeds and feed raw materials are presented in Figure 1.

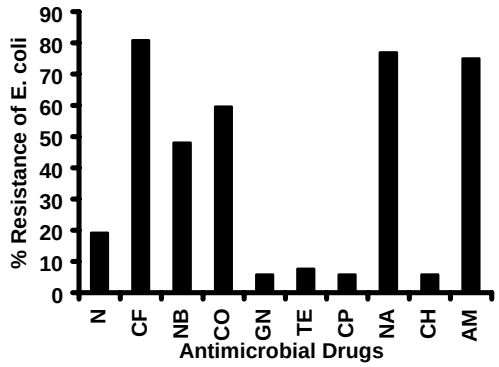


**Figure 1: Overall anti-microbial resistance frequencies of E coli isolates from commercial feed brands and feed ingredients sold in Imo state. N, nitrofurantoin; Cf, cefuroxime; Nb, norfloxacin; Co, cotrimoxazole; Gn, gentamycin; Te, tetracycline; Cp, ciprofloxacin; Na, nalidixic acid; Ch, chloramphenicol; Am, ampicillin.**

The isolates were 80.8 % resistant to cefuroxime, 76.9 % to nalidixic acid, 75.0 % to ampicillin, and 59.6 % to cotrimoxazole. Very low resistances (5.8 %) were recorded for gentamycin, ciprofloxacin and chloramphenicol, while 7.7 % was returned for tetracycline**.**

**Anti-microbial Resistance Profile of *E. coli Isolates* from Commercial Feeds:** Across commercial feed brands (Figure 2), isolates from SF were resistant to only nitrofurantoin (100.0 %), nalidixic acid (50.0 %) and ampicillin (70.0 %). Organisms isolated from TF and GF on the other hand were resistant to 7 and 6 antibiotics respectively, while those from ACF were resistant to 5 with values for these remaining below 100.0 %. None of the isolates recorded resistance against ciprofloxacin and chloramphenicol, while those from GF and TF recorded very low rates to gentamycin and tetracycline.

Table 2, showed that *E. coli* isolates from SF had significantly higher resistance against nitrofurantoin and ampicillin ($P < 0.05$), while with the exception of nalidixic acid, the other antibiotics had low resistances. Resistance figure for nalidixic acid among ACF isolates was also significantly low while GF values recorded for cefuroxime, norfloxacin, cotrimoxazole and gentamycin were significantly higher than that of the others ($P < 0.05$).

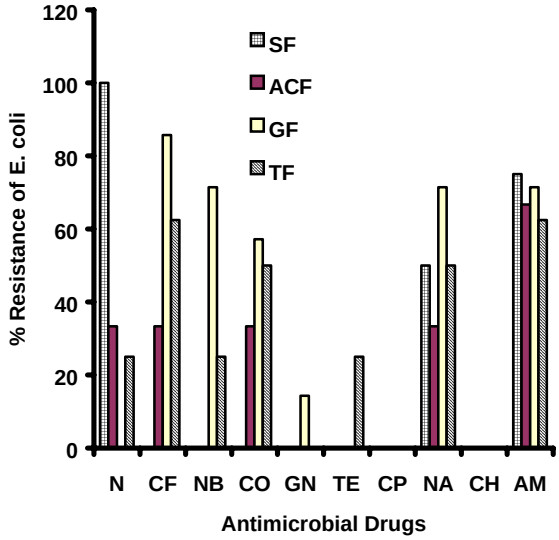


**Figure 2: Comparison of anti-microbial resistance frequencies of E coli isolates from commercial feed brands sold in Imo state. N, nitrofurantoin; Cf, cefuroxime; Nb, norfloxacin; Co, cotrimoxazole; Gn, gentamycin; Te, tetracycline; Cp, ciprofloxacin; Na, nalidixic acid; Ch, chloramphenicol; Am, ampicillin. SF = Sanders feed; ACF = Animal care feed; GF = Guinea feed; TF = Top feed.**

**Table 2: Anti-microbial resistance frequencies of *E coli* isolates from commercial feed brands sold in Imo State**

| Feed Type | NI | CF | NB | CO | GN | TE | CP | NA | CH | AM | n |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SF | 8(100.0)$^{a}$ | 0(0.0)$^{b}$ | 0(0.0)$^{b}$ | 0(0.0)$^{b}$ | 0(0.0)$^{b}$ | 0(0.0)$^{b}$ | 0(0.0) | 4(50.0)$^{b}$ | 0(0.0) | 6(75.0)$^{a}$ | 8 |
| ACF | 2(33.3)$^{a}$ | 2(33.3)$^{ab}$ | 0(0.0)$^{b}$ | 2(33.3)$^{ab}$ | 0(0.0)$^{b}$ | 0(0.0)$^{b}$ | 0(0.0) | 2(33.3)$^{b}$ | 0(0.0) | 4(66.7)$^{b}$ | 6 |
| GF | 0(0.0)$^{a}$ | 12(85.7)$^{a}$ | 10(71.4)$^{a}$ | 8(57.2)$^{a}$ | 2(14.3)$^{a}$ | 0(0.0)$^{b}$ | 0(0.0) | 10(71.4)$^{a}$ | 0(0.0) | 10(71.4)$^{ab}$ | 14 |
| TF | 4(25.0)$^{a}$ | 10(62.5)$^{a}$ | 4(25.0)$^{ab}$ | 8(50.0)$^{a}$ | 0(0.0)$^{b}$ | 4(25.0)$^{a}$ | 0(0.0) | 8(50.0)$^{b}$ | 0(0.0) | 10(62.5)$^{b}$ | 16 |
| Total | 14(31.8) | 24(54.6) | 14(31.8) | 18(40.9) | 2(4.6) | 4(9.1) | 0(0.0) | 24(54.6) | 0(0.0) | 30(68.2) | 44 |
| SEM | 21.3 | 18.5 | 16.8 | 12.7 | 3.6 | 6.3 | 0.0 | 7.8 | 0.0 | 2.7 | |

*ab means with different superscripts in the same column are significantly different (P<0.05). N, nitrofurantoin; Cf, cefuroxime; Nb, norfloxacin; Co, cotrimoxazole; Gn, gentamycin; Te, tetracycline; Cp, ciprofloxacin; Na, nalidixic acid; Ch, chloramphenicol; Am, ampicillin.*

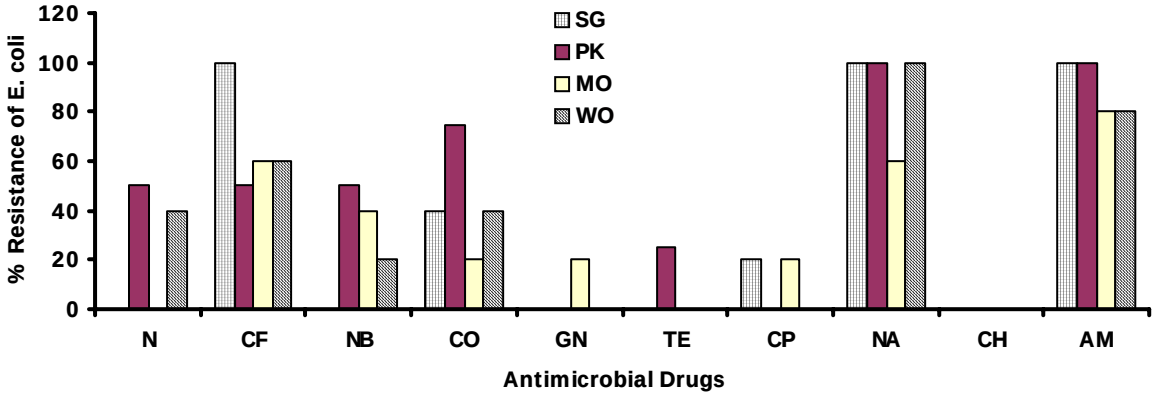


**Figure 3: Anti-microbial resistance frequencies of E coli isolates from different feed ingredients sold in Imo state. N, nitrofurantoin; Cf, cefuroxime; Nb, norfloxacin; Co, cotrimoxazole; Gn, gentamycin; Te, tetracycline; Cp, ciprofloxacin; Na, nalidixic acid; Ch, chloramphenicol; Am, ampicillin. SG = Spent grain; PK = Palm kernel cake; MO = Maize offal; WO = Wheat offal.**

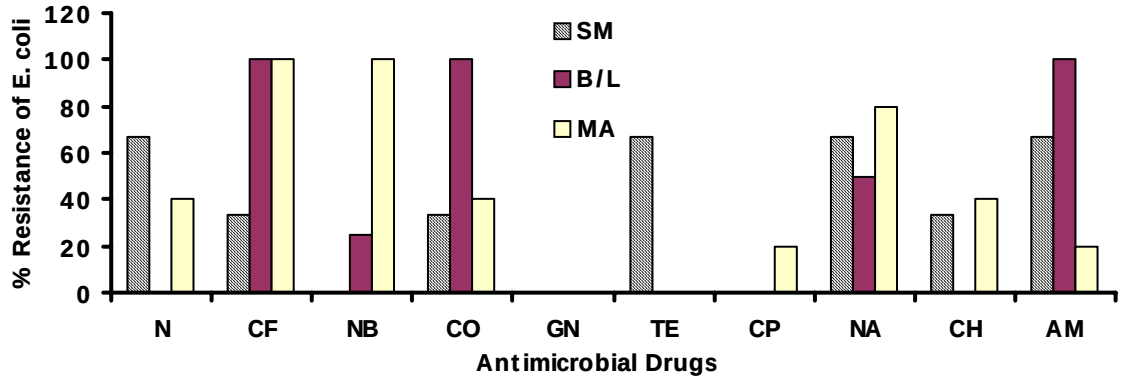


**Figure 4: Anti-microbial resistance frequencies of E. coli isolates from soybean meal (SM), bone/limestone (B/L) and maize (MA) sold in Imo state. N, nitrofurantoin; Cf, cefuroxime; Nb, norfloxacin; Co, cotrimoxazole; Gn, gentamycin; Te, tetracycline; Cp, ciprofloxacin; Na, nalidixic acid; Ch, chloramphenicol; Am, ampicillin. SM = Soybean meal; B/L = Bone meal/ Limestone; MA = Maize.**

**Anti-microbial Resistance Profile *E. coli* of Isolates from Feed Raw Materials:** Anti-microbial resistance of *E coli* isolated from various feed raw materials is presented in Figure 3. Values recorded against ampicillin, nalidixic acid and cefuroxime, in isolates from spent grain (SG), palm kernel cake (PK), maize offal (MO) and wheat offal (WO) were relatively high.

Organisms isolated from SG and PK recorded high resistance against cefuroxime and cotrimoxazole respectively. No resistance was observed against chloramphenicol in any of the sample types, while resistance to gentamycin and tetracycline were observed exclusively in MO and PK isolates respectively.

**Table 3: Anti-microbial resistance frequencies of *E. coli* isolates from different feed raw materials sold in Imo State**

| FEED TYPE | N | CF | NB | CO | GN | TE | CP | NA | CH | AM | n |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Spent grain | 0(0.0)$^{c}$ | 10(100.0)$^{a}$ | 0(0.0)$^{c}$ | 4(40.0)$^{bc}$ | 0(0.0)$^{b}$ | 0(0.0)$^{c}$ | 2(20.0)$^{a}$ | 10(100.0)$^{a}$ | 0(0.0)$^{b}$ | 10(100.0)$^{a}$ | 10 |
| Palm kernel cake | 4(50.0)$^{b}$ | 4(50.0)$^{bc}$ | 4(50.0)$^{b}$ | 6(75.0)$^{a}$ | 0(0.0)$^{b}$ | 2(25.0)$^{b}$ | 0(0.0)$^{b}$ | 10(100.0)$^{a}$ | 0(0.0)$^{b}$ | 10(100.0)$^{a}$ | 8 |
| Maize offal | 0(0.0)$^{c}$ | 6(60.0)$^{b}$ | 4(40.0)$^{b}$ | 2(20.0)$^{c}$ | 2(20.0)$^{a}$ | 0(0.0)$^{b}$ | 2(20.0)$^{a}$ | 6(60.0)$^{c}$ | 0(0.0)$^{b}$ | 8(80.0)$^{ab}$ | 10 |
| Wheat offal | 4(40.0)$^{b}$ | 6(60.0)$^{b}$ | 2(20.0)$^{c}$ | 4(40.0)$^{bc}$ | 0(0.0)$^{b}$ | 0(0.0)$^{c}$ | 0(0.0)$^{b}$ | 10(100.0)$^{a}$ | 0(0.0)$^{b}$ | 8(80.0)$^{ab}$ | 10 |
| Fish meal (No) | 2(14.3)$^{c}$ | 14(100.0)$^{a}$ | 12(85.7)$^{ab}$ | 14(100.0)$^{a}$ | 0(0.0)$^{b}$ | 0(0.0)$^{c}$ | 0(0.0)$^{b}$ | 14(100.0)$^{a}$ | 0(0.0)$^{b}$ | 12(85.7)$^{ab}$ | 14 |
| Fish meal (On) | 4(40.0)$^{b}$ | 8(80.0)$^{ab}$ | 6(60.0)$^{b}$ | 4(40.0)$^{bc}$ | 0(0.0)$^{b}$ | 2(20.0)$^{bc}$ | 0(0.0)$^{b}$ | 8(80.0)$^{b}$ | 0(0.0)$^{b}$ | 6(60.0)$^{b}$ | 10 |
| Soybean meal | 4(66.7)$^{a}$ | 2(33.3)$^{c}$ | 0(0.0)$^{c}$ | 2(33.3)$^{bc}$ | 0(0.0)$^{b}$ | 4(66.7)$^{a}$ | 0(0.0)$^{b}$ | 4(66.7)$^{bc}$ | 2(33.3)$^{a}$ | 4(66.7)$^{b}$ | 6 |
| Bone/limestone | 0(0.0)$^{c}$ | 8(100.0)$^{a}$ | 2(25.0)$^{c}$ | 8(100.0)$^{a}$ | 0(0.0)$^{b}$ | 0(0.0)$^{c}$ | 0(0.0)$^{b}$ | 4(50.0)$^{c}$ | 0(0.0)$^{b}$ | 8(100.0)$^{a}$ | 8 |
| Maize | 4(40.0)$^{b}$ | 10(100.0)$^{a}$ | 10(100.0)$^{a}$ | 4(40.0)$^{bc}$ | 0(0.0)$^{b}$ | 0(0.0)$^{c}$ | 2(20.0)$^{a}$ | 8(80.0)$^{b}$ | 4(40.0)$^{a}$ | 2(20.0)$^{c}$ | 10 |
| **Total** | **22(25.6)** | **68(79.1)** | **40(46.5)** | **48(55.8)** | **2(2.3)** | **8(9.3)** | **6(7.0)** | **74(86.1)** | **6(7.0)** | **68(79.1)** | **86** |
| **SEM** | **8.3** | **8.6** | **11.8** | **9.9** | **2.2** | **7.5** | **3.3** | **6.5** | **5.4** | **8.6** | |

*abc means with different superscripts in the same column are significantly different (P<0.05). N, nitrofurantoin; Cf, cefuroxime; Nb, norfloxacin; Co, cotrimoxazole; Gn, gentamycin; Te, tetracycline; Cp, ciprofloxacin; Na, nalidixic acid; Ch, chloramphenicol; Am, ampicillin.*

**Table 4: Anti-microbial resistance patterns of *E coli* isolates from different commercial feeds and feed raw materials sold in Imo state**

| Resistance pattern | Freq. of occurrence | Resistance pattern | Freq. of occurrence |
|---|---|---|---|
| **I Zero Resistance** | 4 | 2 NA | 1 |
| 3 NI | 1 | 4 NA-AM | 3 |
| 5 CF-AM | 1 | 6 CF-NB | 1 |
| 7 CF-NA | 1 | 8 NI-NA | 2 |
| 9 NI-AM | 3 | **10 CF- CO** | 1 |
| 11 CF-CO-AM | 6 | 12 CF-NA-AM | 5 |
| 13 CF-CO-NA | 1 | 14 CF-NB-NA | 1 |
| **15 CF-NB-AM** | 1 | 16 NB-NA-AM | 1 |
| **17 CF-CO- NA-AM** | 2 | **18 CF-CP-NA-AM** | 1 |
| 19 CO-TE-NA-AM | 2 | 20 CF-NB-NA-CH | 1 |
| 21 NI-CF-NB-NA | 1 | 22 NB-CO-GN-NA-AM | 1 |
| 23 CF-NB-CP-NA-AM | 1 | 24 NI-CF-CO-NA-AM | 1 |
| 25 CF-NB-CO-NA-AM | 10 | 26 NI-CF-NB-CO-NA | 1 |
| 27 CF-CO-TE-NA-AM | 1 | 28 NI-CF-TE-NA-AM | 1 |
| 29 NI-CF-NB-CO-NA-AM | 4 | 30 CF-NB-CO-GN-NA-AM | 1 |
| 31 NI-CO-TE-NA-CH-AM | 1 | 32 CF-NB-CO-TE-NA-AM | 1 |
| 33 NI-CF-NB-CO-GN-CH-AM | 1 | 34 NI-CF-NB-CO-CP-NA-CH | 1 |
| 35 NI-CF-NB-CO-TE-NA-AM | 1 | | |

*N, nitrofurantoin; CF, cefuroxime; NB, norfloxacin; CO, cotrimoxazole; GN, gentamycin; TE, tetracycline; CP, ciprofloxacin; NA, nalidixic acid; CH, chloramphenicol; AM, ampicillin.*

Figure 4 showed the anti-microbial resistance frequencies of *E. coli* isolates from soybean meal (SM), bone/limestone (B/L) and maize (MA). Isolates from bone meal and limestone were 100 % resistant against ampicillin, cotrimoxazole and cefuroxime, while those from maize recorded 100 % resistance to cefuroxime and norfloxacin, and over 70 % to nalidixic acid. Soybean meal isolates values for nitrofurantoin, tetracycline, nalidixic acid and ampicillin were high but below 80 %. None of the isolates from B/L, MA and SM recorded resistance against gentamycin.

Table 3 showed that isolates from spent grain and palm kernel cake had significantly high resistance to cefuroxime, nalidixic acid, and ampicillin ($P < 0.05$), while wheat offal and fish meal also had significantly high resistance to nalidixic acid and cefuroxime ($P < 0.05$). Isolates from bone/limestone recorded significantly ($P < 0.05$) higher resistance to cefuroxime, cotrimoxazole and ampicillin, while those from maize on the other hand, equally returned significantly higher resistance to cefuroxime and norfloxacin. Ciprofloxacin values in isolates from spent grain and maize offal, gentamycin value in those from maize offal, tetracycline and chloramphenicol values from soybean meal isolates, were all significantly ($P < 0.05$) higher than figures returned for others.

**Anti-microbial Resistance Patterns:** Anti-microbial resistance patterns of *E. coli* isolates from different commercial feeds and feed materials are presented in Table 4. Thirty fives resistance patterns were observed, with CF-NB-CO-NA-AM pattern being the most predominant and occurring 10 times. The pattern was observed in isolates from fish meal, blood meal, GF and TF. Other resistance patterns, CF-CO-AM and CF- NA-AM occurred 6 and 5 times respectively. CF-CO-AM was observed in GF, and TF, spent grain, limestone and blood meal, CF- NA-AM was observed in isolates from spent grain, maize offal, wheat offal and fish meal. Organisms recording zero resistance occurred 4 times and were predominant in maize offal, TF and soybean meal. The NI-CF-TE-NB-CO-NA-AM pattern equally occurred 4 times and were observed in palm kernel cake, wheat offal and fish meal. Sixteen of the resistance patterns contained between 0 and 3 antibiotics per pattern, while the rest 19 contained between 4 and 7 antibiotics.

## DISCUSSION

Overall, *E. coli* isolates from commercial feeds and feed raw materials had very high resistance to cefuroxime, nalidixic acid, ampicillin, and cotrimoxazole, while the rate against norfloxacin was moderate at 48.1 %. Low resistant rates (5.8 %) were recorded for gentamycin, ciprofloxacin and chloramphenicol. 7.7 % for tetracycline and 19.2 % against nitrofurantoin were also recorded. The present result does not agree with the over 90 % resistant rate reported by Uwaezuoke *et al* (2000) for gentamycin in *E. coli* isolates from a cocktail of feeds obtained from Owerri. Commercial feeds and feed ingredients are generally regarded as major routes of coliform and bacterial infections in poultry (Wilson, 1990; Garland, 1996).

Isolates from GF, a commercial feed brands, harbored *E. coli* organisms with relatively higher resistance against cefuroxime, norfloxacin, cotrimoxazole, nalidixic acid and ampicillin, while those from SF harbored *E. coli* resistant against nitrofurantoin, nalidixic acid and ampicillin. It would therefore seem from the present study that GF might be a major vehicle for the dissemination of resistant bacteria in the study area. None of the commercial feed brands was implicated in the dissemination of ciprofloxacin and chloramphenicol resistant *E. coli.*

Feed raw materials were found to harbor preponderantly more resistant bacteria than the commercial feeds. Fish meal and maize were specifically important vehicles for the dissemination of quinolone resistant *E. coli* isolates. The fish meal from Maiduguri returned between 60 and 100 % resistance to norfloxacin and nalidixic acid. These isolates also recorded very high values against ampicillin, cotrimoxazole and cefuroxime but 0% resistance to ciprofloxacin, tetracycline and gentamycin. Of interest also is the 100 % resistance recorded in isolates from maize to norfloxacin and cefuroxime. Since these drugs are not readily employed in veterinary therapy, the present data suggests that the major source of these organisms might be through human contamination during the processing stages of the feed raw materials. The high overall resistance rates in the *E. coli* isolates from the present study may thus be attributed to the fact that *E. coli* occupies multiple niches in the environment including human and animal hosts and can in addition exchange genetic materials with many other bacteria (Blood and Radostits, 1989).

Thirty-five resistance patterns were observed; with the CF-NB-CO-NA-AM pattern being the most predominant and occurring 10 times. The pattern was well distributed in isolates from fish meal sourced from Maiduguri, blood meal from Mbise, GF from Ewu and TF from Sapele. Sixteen of the resistance patterns contained between 0 and 3 antibiotics per pattern, while the rest 19 contained between 4 and 7 antibiotics. The present study shows that the most important factor in the dissemination of resistance factors through commercial feeds and feed ingredients is the fact that they are sourced from a very wide area. Thus, organisms from Maiduguri in northern Nigeria or those from Lagos in the west may end up in a small village farm in Imo State and become the focus for the establishment of new resistance mechanisms in the area. While different treatments including heating, acidification (Nape and Murphy, 1971; Cox *et al,* 1986) and other forms of treatment (Nielsen, 1992; Haggblom 1993; Dorey, 2001) have been found relatively effective in reducing bacterial load in feeds, such methods should be easily adopted in a developing economy such as Nigeria in order to reduce E. coli buildup in commercial feed.

## ACKNOWLEDGEMENT

This work was financed from the Federal University of Technology Senate grant No. 4701578(11-757-4260). We are grateful to Dr. K. F. Chah of the Department of Veterinary Pathology and Microbiology, University of Nigeria, Nsukka for laboratory analysis of the feedstuff.

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# PARASITES AND ASSOCIATED CHANGES IN PACKED CELL VOLUME OF HORSES (*Equus caballus*) IN THE SEMI-ARID ZONE, NORTH-EASTERN NIGERIA

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**ABSTRACT**

***A comparative study on the internal and external parasites and the associated changes in the packed cell volume of horses from a rural community (Bama) and an urban Centre (Maiduguri) in the semi-arid zone of North-eastern Nigeria was evaluated through routine clinical and laboratory examinations. Blood and external parasites were not encountered in any of the 18 horses. Four (22.2 %) of the horses were noticed to be shedding the ova of intestinal parasites in their faeces during the study period. Gastrodiscus aegyptiacus (16.7 %) and strongyle (5.6 %) eggs were recovered from the horses. Infection was more common in rural (50 %) than urban (14.3 %) horses. In both locations, infected horses had higher Packed Cell Volume (PCV) (31.3 ± 5.3) than uninfected ones (30.4 ± 3.6). Irrespective of infection status, horses at Maiduguri had higher PCV than their counterparts at Bama. The results suggest that horses in the semi-arid zone of North-eastern Nigeria had moderately low prevalence of infection with gastro-intestinal parasites and that those at the urban location were relatively better cared for than their rural counterparts.***

**Keywords:** Parasites, Horses, Packed cell volume, Semi-arid, Nigeria

## INTRODUCTION

Horses have been closely associated with man from ancient time. They are used as means of transportation for riders, for drawing carriages, delivery vans and pulling agricultural implements, for recreational purposes like polo and racing and for research and development purposes. They may also be slaughtered for meat. In North-eastern Nigeria, the Mounted Troop Police train them to withstand loud noises, bangs and flag waving and thus use them for crowd control, land surveillance and border patrol. Furthermore, in this region, especially the Muslim dominated towns, horses are used for ceremonial purposes such as durbar, religious and traditional festivals.

Horses suffer from a variety of parasitic infections especially helminthiasis that could result in anaemia, diarrhoea of sudden onset, hypoalbuminaemia, unthriftiness, reduced reproductive and work performance and in some cases death (Soulsby, 1982). The prevalence of these infections and the associated changes in the clinical and haematological parameters of the animals have been extensively studied and reported from many countries (Graber, 1970; Keenan, 1979; Lekeux *et al.*, 1991; Reilly, 1993). However, apart from the reports of Okon (1976) and Nwosu *et al.* (1990) on the prevalence of equine helminths at Ibadan and Maiduguri respectively, information is scarce on the parasitic infections and the associated changes in the clinical and haematological parameters of horses in Nigeria.

The Mounted Troop of the Borno State Command, Nigeria Police Force maintains some horses in both Maiduguri and Bama districts. This paper reports on the parasitic infections and associated changes in the packed cell volume of the horses maintained in the semi-arid zone of North-eastern Nigeria.

## MATERIALS AND METHODS

**Horses:** The horses used in this study were owned and maintained by the Mounted Troop, Nigeria Police Force, Borno State Command. The horses were stabled at two locations, Maiduguri and Bama, in the semi-arid zone of North-eastern Nigeria. Maiduguri is the capital and largest urban centre in Borno State while Bama is a rural community located about 65 kilometres east of Maiduguri. The horses were usually grazed in open fields with occasional supplementation with crop residues during the few months of the rainy season but were permanently stabled and fed with hand-cut grass and crop residues during the dry season.

**Sampling:** The horses were routinely examined individually for both internal and external parasites and signs of their presence (Hassan and Hassan, 2003). All external parasites seen were collected and preserved in labelled bottles containing 10 % formalin. Skin scrapings were collected from mange-like lesions into clean Petri dishes. Blood samples were collected from the jugular vein, using a hypodermic syringe fitted with an 18-gauge needle, into sample bottles with ethylene diamine tetra-acetic acid (EDTA) as anti-coagulant.

**Table 1: Prevalence of intestinal parasites among horses examined in North-eastern Nigeria**

| | Location of horses | | All locations |
|---|---|---|---|
| | Bama | Maiduguri | |
| **Number examined** | 4 | 14 | 18 |
| **Number (%) infected** | 2 (50) | 2 (14.3) | 4 (22.2) |
| ***G. aegyptiacus* ova** | 1 (25) | 2 (14.3) | 3 (16.7) |
| **Strongyle ova** | 1 (25) | 0 | 1 (5.6) |

**Table 2: Packed cell volume (Mean ± S. D.) of infected and uninfected horses examined in North-eastern Nigeria**

| Location of horses | Infected | Uninfected | All animals |
|---|---|---|---|
| **Bama** | 29 ± 1.4 | 28.5 ± 0.7 | 28.8 ± 1.0 |
| **Maiduguri** | 33.5 ± 7.8 | 30.7 ± 3.8 | 31.1 ± 4.3 |
| **All locations** | 31.3 ± 5.3 | 30.4 ± 3.6 | 30.6 ± 3.9 |

Faecal samples were taken directly from the rectum into appropriately labelled sample bottles.

**Examination of Samples:** Skin scrapings were placed in a test tube containing 10 % potassium hydroxide solution and gradually brought to boil (100°C) for 3 minutes in a water bath to remove excess tissue material. The test tube was allowed to cool and the content centrifuged for 2 minutes at 2,000 revolutions per minute. The supernatant solution was decanted and the sediment placed on a slide and examined microscopically (MAFF, 1977). Wet Blood mounts and Giemsa stained thin and thick blood smears were routinely prepared and examined microscopically for parasites (Schalm *et al*., 1975). Packed cell volume was determined using the microhaematocrit method (Schalm *et al.,* 1975). Faecal samples were examined using the direct smear; sedimentation method and flotation technique employing saturated sodium chloride solution as the floating medium (MAFF, 1977). All the parasites recovered were identified using standard parasitological criteria (Soulsby, 1982).

## RESULTS

Blood and external parasites were not encountered in the horses examined during the study. However, out of the 18 horses examined, 4 (22.2 %) were shedding the ova of intestinal parasites in their faeces (Table 1). Two helminth egg types, *Gastrodiscus aegyptiacus* (16.7 %) and strongyle species (5.6 %) were recovered during the study.

Horses located at Bama were more commonly infected (50 %) than those at Maiduguri (14.3 %). The animals located at Maiduguri had higher PCV (31.1 ± 4.3) than those at Bama (30.6 ± 3.9) irrespective of their infection status (Table 2). In general, infected horses (Bama and Maiduguri) had relatively higher PCV than their uninfected counterparts.

## DISCUSSION

The results of this study showed that horses owned by the Borno State Police Command were generally not parasitised by blood and ecto-parasites during the period of the study. This observation may be due to an efficient management programme including the availability of adequate veterinary attention and regular and effective grooming of the animals. However, although the horses were stable animals, they usually grazed freely during the rainy season, thus accounting for the *Gastrodiscus* and strongyle egg types recovered during the study.

In earlier studies, Ajayi and Ajayi (1983) recorded respective prevalence of 26.2 % and 52.5 % for *Gastrodiscus* and strongyle species from 61 horses examined at the Jos Plateau while Okon, (1976) reported that 91.3 % of 138 horses grazed on natural pastures in Ibadan had strongyle eggs in their faeces. The results of the present study were generally lower probably due to climatic differences between the study areas. Jos Plateau and Ibadan are generally more humid and thus more favourable for the development and survival of preparasitic stages of equine helminths in the environment compared to the semi-arid nature of the present study area. Similarly, the results of the present study were lower than the 2.04 % and 23.81 % respectively reported by Nwosu *et al.* (1990) for *Gastrodiscus* and strongyle eggs in an earlier study in the same study area probably because the present animals were better cared for when compared to the market horses examined in the earlier study.

The horses located at Maiduguri were generally less commonly parasitised than those at Bama probably due to the fact that the former animals were better cared for than the later. Bama is a rural area and also only a Divisional Headquarters whereas Maiduguri is the State capital and Headquarters of the Borno State Police Command. It is therefore possible that animals located at the Command Headquarters would receive better care and veterinary attention than those located elsewhere in the State. Nwosu *et al.* (1990) in an earlier study reported that horses in urban centres were significantly less commonly infected with parasites (24.49 %) than their counterparts in rural communities (73.47 %).

The above observations may also account for the generally higher PCV levels observed in Maiduguri horses compared to their counterparts in Bama. Ironically, the infected horses maintained

higher PCV levels than their uninfected counterparts at both Maiduguri and Bama. The reason for this observation is not immediately apparent although Soulsby (1982) noted that as a result of acquired immunity to re-infection, some adult horses carry heavy worm burdens without manifesting any clinical or pathogenic effects.

In conclusion, therefore, the results of this study have shown that horses at Bama and Maiduguri in the semi-arid zone of North-eastern Nigeria harbour similar parasite species but at relatively low prevalence. Also, horses located at the urban centre were relatively less infected than those in the rural community. Furthermore, the infected horses had comparatively higher PCV levels than their uninfected counterparts.

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# STRATIFICATION AND LIVESTOCK POPULATION CENSUS FOR ENUGU URBAN, NIGERIA: A PILOT SURVEY

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**ABSTRACT**

***Stratification and livestock population census for Enugu Urban, Nigeria, between February and April 2005 is described. Based on ground reconnaissance, six stratification zones identified for Enugu Urban (180 km$^2$) were, unplanned Village set-up (9.69 km$^2$), High-density built-up areas (20.25 km$^2$), Medium-density built-up areas (7.90 km$^2$), Low-density built-up areas (9.50 km$^2$), Commercial areas (26.44 km$^2$) and Undeveloped lands/Farms (106.93 km$^2$). About 46.63 km$^2$ or 25.90 % of the stratified Enugu Urban was principal suburbs. Estimated livestock population was achieved with 91.70 % of 2927 households in 21 sample blocks of about 8.34 Km$^2$ or 17.88 % of the principal suburbs. Livestock population and average population density for stratified Enugu Urban were 32309 (179) for goats, 17027 (95) for sheep, 3765 (21) for pigs, 16152 (90) for dogs, 4338 (24) for cats, 108354 (602) for chickens, 28985 (161) for turkeys and 17160 (95) for ducks. The results of this study may be useful in the formulation of Veterinary, Livestock, Public and Environmental Health Policies, as well as for Livestock Diseases Surveillances, Research Communications and Bioinformatics. The model for this survey could also be adapted for other urban cities in Nigeria and the developing countries of the world where there are no reliable livestock population statistics.***

**Keywords:** Urban stratification, livestock population, diseases surveillances, Bioinformatics.

## INTRODUCTION

The civil service, railways and coal mining activities were among the attractions for early immigrant workers to Enugu. Many settlements, which now constitute the principal suburbs, had rapidly sprung up within and at the outskirts of the Coal City. Today, Enugu Urban is a heterogeneous community characterized by social stratifications.

Livestock (goat, sheep, pig, dog, cat, chicken, turkey, and duck) keeping in Enugu was a natural consequence of human settlement. There is now noticeable increase in the number of livestock on free range within the City. Many domestic animals, which strayed about the city, had constituted public menace. Moreover, the situation whereby domestic animals were allowed to scavenge on street garbage, refuse dumps, sewage effluents, slaughter premises, markets, shallow streams, open parks, farmlands, and school premises etc., constituted potential hazards to public and environmental health. *Toxocara canis*, one of the commonest parasites of dogs in many parts of the world (Woodruff, 1975; Stewart *et al*., 1979), is the most important cause of Visceral Larval Migrans (VLM) in man (Beaver, 1956). Chiejina and Ekwe (1986) had reported on the environmental contamination associated with *Toxocara* eggs in dog feaces in Enugu and Nsukka. Dada and Belino (1979), Onadeko and Ladipo (1989) also described the public health significance of Ascariasis, Trichuriasis and helminthes' ova in dog feaces from Nigerian urban towns. Rabies is also transmitted to man through the bite of a rabid dog. 'Street rabies virus' (SRV) had been demonstrated in the saliva of dogs (Vaughn *et al.,* 1965). Other human infections like trichinosis and hydatid diseases may be contracted from infested pork and beef, respectively.

The aim of this pilot study was to establish stratification zones in Enugu Urban for an effective conduct of livestock population census, test the instruments of urban livestock population census, assess the reliability and usability of the demarcation maps and ascertain the time that may be required to conduct livestock population census for Enugu Urban. Since there is a dearth of information on livestock population figures in Enugu and other urban cities of Nigeria, data from this pilot survey and related studies may be useful in the formulation of Veterinary, Livestock, Public and Environmental Health Policies, as well as for Livestock Diseases Surveillances, Research Communications and Bioinformatics.

## MATERIALS AND METHODS

**Ground Survey:** Street map of Enugu Urban obtained from the Department of Lands, Surveys and Urban Planning, Enugu was used for this survey. Based on ground reconnaissance, six stratification zones were established. The extent of each stratum was demarcated on the stratification map of Enugu while the areas (Km$^2$) were determined by the use of a squared graph paper. Twenty-one sample blocks were randomly selected from the principal suburbs of Enugu (excluding commercial and farmlands which had no permanent livestock). The extent of the 21 sample blocks were established physically on the ground both by pacing (a pace $\approx$ 1 metre) and with the aid of a pedometer strapped to the hip belt. Guides to the extent of the strata and sample blocks were produced (Figure 1).

**Table 1: Stratification zones and sample blocks in Enugu Urban***

| Stratification Zones | | | | Sample Blocks | | | |
|---|---|---|---|---|---|---|---|
| **Strata** | **Text Abbreviation** | **Area ($Km^2$)** | **% of Urban Enugu** | **No.** | **Area ($Km^2$)** | **Bounding streets** | **Principal Suburbs (where sample blocks were located)** |
| **Unplanned Village Set-up** | **'Village'** | 9.69 | 5.38 | 1 | 0.76 | Entire Agu-Abor | Agu Abor |
| | | | | 2 | 0.56 | Half of Ugbo Odogwu | Ugbo Odogwu |
| | | | | 3 | 0.64 | Entire Ugwu Aaron | Ugwu Aaron |
| | | | | 4 | 0.70 | Entire Ugwu Alfred | Ugwu Alfred |
| **High density areas** | **'Township'** | 20.25 | 11.25 | 5 | 0.24 | Nkpor – Atani – Ikem Streets | Abakpa |
| | | | | 6 | 0.18 | Inyi – Obioma – Umunwakum Streets. | Achalla Layout |
| | | | | 7 | 0.40 | Agbani Road – Umueze Street | Awkunanaw |
| | | | | 8 | 0.14 | Colliery Quarters | Coal Camp |
| | | | | 9 | 0.36 | Chima Avenue – Kano Street | New Haven |
| | | | | 10 | 0.46 | Agbani Road – Gold Smith Ave. | Ogbete |
| | | | | 11 | 0.26 | Edinburgh Road – Kenyatta St. | Ogui New Layout |
| | | | | 12 | 0.22 | Zik's Ave – Christ Church – Agbani Rd. | Uwani |
| **Medium density areas** | **'Low-cost'** | 7.19 | 4.00 | 13 | 0.38 | Ichida Street – Osina Street | Federal Housing |
| | | | | 14 | 0.28 | Ogui Rd – 1st – 4th Avenue | Artisan Quarters |
| | | | | 15 | 0.86 | Imoke Street – Ekulu St – Nwodo Ave. | Trans-Ekulu Housing |
| | | | | 16 | 0.60 | NCO Blocks | Army Barracks |
| **Low density areas** | **'GRA'** | 9.50 | 5.27 | 17 | 0.16 | Abakaliki Rd – Army Barracks | Army Officers' Qtr. |
| | | | | 18 | 0.30 | Rangers' Ave – Ezzikwo Street | Modern Residential |
| | | | | 19 | 0.38 | Abakaliki Lane – Charles Street | "GRA" |
| | | | | 20 | 0.26 | Riverside Estate – Air Force Base | Thinkers' Corner |
| | | | | 21 | 0.20 | ESUTH – WTC - UNEC | Campus Residential |
| **Commercial areas** | **'Industrial '** | 26.44 | 14.70 | Livestock census was not carried out in 'Industrial' &'Open' (Uninhabited Urban Enugu) where no permanent livestock existed | | | |
| **Undeveloped lands/Farms** | **'Open'** | 106.93 | 59.40 | | | | |
| **Stratified Urban Enugu** | | 180.00 | 100.00 | | | | |

*****Total area of sample blocks in 'Village' = 2.66 $Km^2$ (27.45 % of 'Village'),Total area of sample blocks in 'Township' = 2.26 $Km^2$ (11.16 % of 'Township'); Total area of sample blocks in 'Low-cost' = 2.12 $Km^2$ (29.48 % of 'Low-cost'); Total area of sample blocks in 'GRA' = 1.30 $Km^2$ (13.68 % of 'GRA'); Total area of sample blocks = 8.34 $Km^2$ (17.88 % of inhabited Enugu); Area of inhabited Enugu = 46.63 $Km^2$ (25.90 % of stratified Enugu); Area of uninhabited Enugu = 133.37 $Km^2$ (74.10 % of stratified Enugu)*

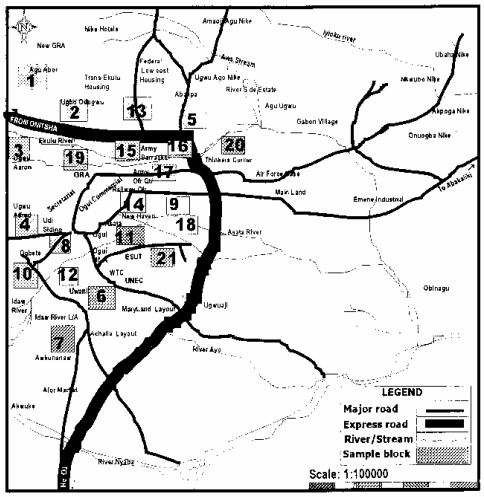


**Figure 1: Map of Enugu urban showing the principal suburb and 21 sampled blocks**

**Livestock Enumeration:** Three pairs of livestock assistants and a livestock superintendent served as enumerators and field supervisor respectively, while the researcher coordinated all activities. Field workers, provided with logbooks, were guided through the extent of the sample blocks. There were seven sample blocks per pair of enumerators. Enumeration in each sample block required only two days (i.e., Saturday and Sunday) of a week, so that the entire fieldwork lasted for 14 working days spread in-between 7 weeks from February to April 2005. Data on every sample size (household) and species (livestock) enumerated were entered differently in the logbooks.

**Collation and Analysis of Data:** All data entries in the logbooks were collated and analyzed to obtain the estimated populations and population densities of each species of livestock in Enugu. Absolute numbers of animals in a stratum were obtained after multiplying the totals for the sample blocks in that stratum by 'a factor', which was the percentage area of that stratum represented by the sample blocks. The average livestock population density for Enugu (including commercial and farm lands) was obtained by dividing the 'total' for that livestock species by the area of stratified Enugu Urban.

## RESULTS AND DISCUSSION

The stratification of Enugu is illustrated in Figure 1. Six stratification zones (Strata) described for Enugu were unplanned Village set-up ('Village'), High-density areas ('Township'), Medium density areas ('Low-cost'), Low-density areas ('GRA'), Commercial areas ('Industrial') and Undeveloped lands/Farmlands

**Table 2: Livestock species enumerated from 21 sample blocks in stratified Enugu**

| Strata | Sample Blocks | Principal Suburbs | Households | | | | Livestock | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NR* | NL | LA | TH | Goat | Sheep | Pig | Dog | Cat | Chicken | Turkey | Duck |
| Village | 1 | Agu Abor | 5 | 4 | 113 | 122 | 93 | 35 | 15 | 40 | 8 | 211 | 30 | 50 |
| | 2 | Ugbo Odogwu | 3 | 3 | 121 | 127 | 58 | 24 | 25 | 35 | 5 | 521 | 51 | 42 |
| | 3 | Ugwu Aaron | 4 | 5 | 104 | 113 | 76 | 49 | 19 | 37 | 16 | 152 | 23 | 21 |
| | 4 | Ugwu Alfred | 9 | 3 | 108 | 120 | 68 | 61 | 29 | 29 | 9 | 273 | 18 | 28 |
| Township | 5 | Abakpa | 5 | 1 | 182 | 188 | 36 | 18 | 40 | 54 | 5 | 610 | 51 | 128 |
| | 6 | Achalla Layout | 4 | 3 | 156 | 163 | 53 | 42 | 18 | 45 | 7 | 421 | 20 | 92 |
| | 7 | Awkunanaw | 12 | 1 | 170 | 183 | 116 | 73 | 37 | 28 | 8 | 720 | 210 | 281 |
| | 8 | Colliery | 3 | 2 | 70 | 75 | 75 | 38 | - | 19 | 5 | 241 | 53 | 51 |
| | 9 | New Haven | 7 | 4 | 149 | 160 | 43 | 14 | - | 23 | 17 | 308 | 61 | 30 |
| | 10 | Ogbete | 2 | - | 165 | 167 | 143 | 70 | 16 | 76 | 21 | 652 | 43 | 69 |
| | 11 | Ogui New Layout | 2 | 15 | 80 | 97 | 204 | 96 | - | 35 | 10 | 446 | 52 | 45 |
| | 12 | Uwani | 11 | 2 | 210 | 223 | 127 | 74 | 10 | 23 | 15 | 390 | 95 | 109 |
| Low-cost | 13 | Fed. Housing | 8 | 20 | 121 | 149 | 71 | 33 | - | 41 | 8 | 271 | 110 | 15 |
| | 14 | Artisan Qtr | 9 | 14 | 110 | 133 | 144 | 81 | - | 59 | 7 | 188 | 232 | 25 |
| | 15 | Trans Ekulu Hous. | 2 | 12 | 124 | 138 | 77 | 35 | - | 65 | 18 | 171 | 181 | 39 |
| | 16 | Army Barracks | 10 | 11 | 80 | 101 | 120 | 57 | - | 14 | 13 | 280 | 25 | 43 |
| GRA | 17 | Army Offs' Qtr | 3 | 2 | 78 | 83 | 28 | 13 | - | 16 | 9 | 75 | 56 | 13 |
| | 18 | Mod. Residential | 3 | 1 | 125 | 129 | 58 | 29 | - | 46 | 16 | 63 | 27 | 9 |
| | 19 | "GRA" | 9 | 5 | 167 | 181 | 71 | 33 | - | 88 | 21 | 81 | 46 | 18 |
| | 20 | Thinkers' Cn. | 5 | - | 130 | 135 | 45 | 28 | - | 71 | 11 | 121 | 37 | 12 |
| | 21 | Campus Residential | 15 | 3 | 122 | 140 | 30 | 12 | - | 44 | 13 | 208 | 50 | - |
| TOTAL | | | 131 | 111 | 2685 | 2927 | 1736 | 915 | 209 | 888 | 242 | 6403 | 1471 | 1120 |

**NR = No response from Household (4.5 %); NL = No livestock owned by household (3.8 %); LA = Livestock owned by household (91.70 %); TH = Total number of households visited (2927)*

**Table 3: Estimated livestock population and population density of stratified Enugu**

| Species | Estimated Livestock Population | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Sample Blocks | | | | Stratified Urban Enugu | | | | | |
| | 'Village' | 'Township' | 'Low-cost' | 'GRA' | Village (27.45)* | Township (11.16) | Low-cost (29.48) | GRA (13.68) | Total | Population Density |
| Goats | 295 | 797 | 412 | 232 | 8097 | 8894 | 12145 | 3173 | 32309 | 179 |
| Sheep | 169 | 425 | 206 | 115 | 4639 | 4743 | 6072 | 1573 | 17027 | 95 |
| Pigs | 88 | 121 | - | - | 2415 | 1350 | - | - | 3765 | 21 |
| Dogs | 141 | 303 | 179 | 265 | 3870 | 3381 | 5276 | 3625 | 16152 | 90 |
| Cats | 38 | 88 | 46 | 70 | 1043 | 982 | 1356 | 957 | 4338 | 24 |
| Chickens | 1157 | 3788 | 910 | 548 | 317 | 42274 | 26826 | 7496 | 108354 | 602 |
| Turkeys | 122 | 585 | 548 | 216 | 3348 | 6528 | 16155 | 2954 | 28985 | 161 |
| Ducks | 141 | 805 | 122 | 52 | 3870 | 8983 | 3596 | 711 | 17160 | 95 |

* ***Absolute numbers of livestock in a stratum were obtained after multiplying the totals for all the sample blocks in each stratum by 'a factor (in brackets)', i.e., the percentage area of that stratum represented by the sample blocks. The average population density was obtained by dividing the 'Total' column by 180 Km$^2$, which was the area of stratified Enugu.***

('Open'). Iyioku, Nyaba, Asata, Ayo, Ekulu and Idaw rivers and Awa stream drain the Coal City, which is traversed by the Onitsha-Enugu-Port Harcourt Expressway.

Principal Suburbs and twenty-one (21) sample blocks are represented in Figure 1 while Table 1 shows the extent of the six (6) stratification zones (strata) and the twenty-one (21) sample blocks surveyed in Enugu Urban (180 km$^2$). Unplanned village set-ups (9.69 km$^2$ or 5.38% of stratified Enugu Urban) are nearly as old as the city and are located mostly on the outskirts of the city. 'Village' included Agu Abor, Agu Ugwu, Gabon, Obinagu, Onu Ogba Nike, Ugbo Odogwu, Ugwu Aaron, Ugwuaji and Ugwu Alfred. High-density townships (20.25 km$^2$ or 11.25 % of stratified Enugu) included Abakpa, Achalla layout, Asata, Awkunanaw, Idaw-river layout, Mainland, Mary land, New Haven, Ogbete (Coal camp), Ogui, Ogui New layout, Udi Siding (PWD and P and T Quarters), Ugwu Ago Nike, and Uwani. Medium-density areas (7.19 km$^2$ or 4.0 % of stratified Enugu) included the Federal low-cost houses, Trans Ekulu layout, Army barracks, and Railway quarters. Low-density 'GRA' category (9.50 km$^2$ or 5.27 % of stratified Enugu) included the Abakaliki Road GRA, Independence Layout, Government House, Modern and Campus

residential areas, Senior Army Officers quarters, and Thinkers corner.

Commercial areas (26.44 $km^2$ or 14.70 % of stratified Enugu) included the Air Force base, Emene industrial, Markets, Nike Lake Hotels, Ogui commercial, Secretariat, and WTC/Queens/ESUT/IMT areas. Undeveloped areas (106.93 $km^2$ or 59.40 % of stratified Enugu) were made up of farmlands and undeveloped plots at Akwuke, Amaoji, New GRA, Nkwubo Nike, Obinagu, Onu Ogba Nike, Ubaha Nike, and Ugwuaji, where permanent livestock were not observed. About 46.63 $km^2$ (25.90 %) of Enugu was regarded as inhabited and from which the 21 sample blocks (8.34 $km^2$ and about 17.88 % of inhabited Enugu) were located. Permanent livestock were observed here.

Data on household and livestock enumeration are presented in Table 2. 2927 households were visited during the exercise. Occupants of 131 (4.5 %) were either absent or did not respond. Occupants of 111 (3.8 %) had no livestock while those in 2685 (91.70 %) had one type of livestock species or the other.

Table 3 showed the estimated livestock population census figures for stratified Enugu (including 'Industrial' and 'Open' areas). The average population densities of the different livestock species (number per $km^2$) were estimated to be in the order of chickens (602) > goats (179) > turkeys (161) > sheep and ducks (95) > dogs (90) > cats (24) > pigs (21).

Large herds of nomadic cattle and many commercial poultry farms encountered during the survey, no doubt contributed to urban environmental contamination and pollutions but were not included in this pilot study, which was limited to small animals and ruminants that were usually kept in the 'back yard', allowed on free range and which frequently strayed within the urban city.

This study effectively tested the instruments of urban livestock population census, assessed the reliability and usability of the demarcation maps and ascertained the time that may be required to conduct livestock population census for Enugu Urban. Since the percentage of non-cooperation was $\leq$ 5%, the result may not contain any great 'unknown' within its figures. The study was also productive of results without waste of labour. The model for this pilot survey could also be adapted for use in other cities of the country and in the developing countries of the world where livestock population statistics are either unavailable or unreliable.

**ACKNOWLEDGEMENT**

I thank Mr. Peter Okafor (a Cartographer with the Ministry of Lands, Survey and Urban Planning, Awka), all the livestock assistants and their superintendent who assisted in the accomplishment this arduous task. I am grateful to Dr (Mrs.) N. N. Ezumah of Gender and Developmental Research Group (GADREG) - an Enugu based Non-Governmental Organization (NGO) - for financing this pilot study.

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# HOST-VECTOR-PARASITE RELATIONSHIP AMONG INHABITANTS OF THE ANAMBRA RIVER BASIN IRRIGATION PROJECT AREA

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**ABSTRACT**

***A questionnaire survey was employed to identify the sources of contact with parasites and disease vectors among people living in the Anambra River Basin Irrigation Project Area. The survey indicated that more than half of the inhabitants of this area go to farm. While in the farm disease vectors such as mosquitoes, biting midges, snails and tsetse flies are usually encountered. In addition, the lack of proper sewage disposal common among the communities exacerbates the situation. Water from various sources such as rivers, ponds, streams, as well as rainwater are used for many purposes. Common disease symptoms such as diarrhoea, abdominal pain, blood in sputum, body nodules, blood in stool, coughing, itching, headache, fever, haematuria were commonly recorded. Positive relationships were observed between the presence of some vectors and the corresponding disease symptoms.***

**Keywords:** Parasites, Vectors, Contact, Sources, Host, Relationship

## INTRODUCTION

The overall effect of developmental projects on parasitic disease spread is related to the alteration in natural habitat, population movements, water flow, vegetation cover, micro environmental condition and change in value systems. The overall consequences of these situations are causes of concern in communities with low level of education, poor environmental quality, and limited access to preventive and curative healthcare (Davis, 1983; McGarvey *et al.,* 1992). For rural dwellers, exposure to vectors and diseases become part of the normal life experiences. Preventive measures are not well known and curative therapy largely involves self-medication and concomitant drug abuse.

Direct information from rural dwellers on signs and symptoms of presence of vectors and diseases offers a vital source of information required for disease monitoring and intervention programmes (Tanner and Savingny, 1987).

Diseases noted at the village health centres and the perception of health problems by the community members can be used to rank the major health problems and results from such studies always matched with data from parasitological surveys (Degremont *et al.*, 1987; Tanner and Savingny, 1987). Lengeler *et al*, (1991), also pointed out that using the opinions of key informants such as school children, teachers, and community leaders, information obtained can be compared with the result from health status surveys.

The Anambra River Basin rice irrigation project provides large expanse of open rice farms with canals of flowing water. Influx of people to the communities in the project area became high with the establishment of the river basin rice project. Rice farmers spend up to 12hrs daily in rice farms in each season.

With the irrigation system, water becomes available to communities that previously had no source of regular water supply. The open rice field and available water also brought the Fulani cattle rearers to dwell among the surrounding communities. The process of rice production provides job for every age group including young children.

This study was carried out to detect possible avenues of contact with parasites and disease vectors among the people inhabiting Anambra River Basin irrigated project site.

## MATERIALS AND METHODS

**Pre-test:** The multiple purpose questionnaires were used according to the method of Tanner and Savingny (1987) and Lengeler *et al* (1991). The questionnaire was pre-tested at Opi-Agu and Eha-Ndiagu, all in Nsukka Local Government Area. These communities have similar environmental settings with the study area. Rivers and streams are the major sources of water supply.

**The Study Areas:** Towns covered by the study include Umumbo, Omor, Adani, Omasi, Umulokpa and Ifite Ogwari. They have been described previously (Onyishi and Okafor, 2004). A total of 300 persons made up of 150 males and 150 females took part in the study. The questionnaire was designed to assess their perception of the most prevalent disease vectors and disease symptoms in their communities (Table 1). Additional information required in the questionnaire include sources of drinking water, uses of water, methods of water treatment, rates of contact of vectors of parasites, method of sewage disposal and use of faecal matter as manure.

## RESULTS

**Frequency of Visit to the Farms by the People in the Various Communities:** The people in all communities sampled go to the farms. Figure 1 showed that in Omor town, 81 % of the people sampled visited their farms frequently.

**Table 1: Questionnaire format for the assessment of host-vector-parasite relationship among the inhabitants of the Anambra river basin irrigation project area**

Name:_____Sex: Male( ) Female ( )
Village:_____Town:_____
Local Government Area:_____
1. How often do you go to the farm? Frequently ( ) Sometimes ( )
2. Rank according to order of importance in your area the following diseases signs and symptoms.
   - Coughing
   - Itching
   - Headache
   - Fever
   - Blood in urine
   - Blood in stool
   - Diarrhoea
   - Abdominal pain
   - Blood in sputum
   - Nodules on the body (Akpu)
3. Rank in their order of importance the uses of water in your community.
   - Recreational uses
   - Domestic uses
   - Occupational uses
   - All of the above
4. Tick the most common sources of drinking water in your community
   - Taps (pump)
   - Stream
   - Ponds
   - Irrigation canals
   - Rivers
   - Rain water
5. Indicate the drinking water treatment methods employed in your family.
   Filtering ( ) Boiling ( ) Addition of alum ( ) None ( )
6. How often do you come in contact with these organisms?
   Mosquitoes
   Frequently ( ), Sometimes ( ) Rarely ( ) Never ( )
   Biting midges
   Frequently ( ), Sometimes ( ) Rarely ( ) Never ( )
   Cockroaches
   Frequently ( ), Sometimes ( ) Rarely ( ) Never ( )
   Rats
   Frequently ( ), Sometimes ( ) Rarely ( ) Never ( )
7. Indicate the most convenient and most common type(s) of toilet system in your community.
   Pit toilet ( ) Farm ( ) Bush ( ) River ( ) Irrigation canals ( ) Water cistern ( )
8. How often do you use human faeces as manure in rice farm?
   Frequently ( ), Sometimes ( ) Rarely ( ) Never ( )
9. Rank in order of importance, the organism most encountered while at the farm.
   - Mosquitoes
   - Biting midges
   - Snails
   - Rats
   - Others specify

Other records were Umumbo (78 %), Ifite Ogwari (74 %), Omasi (70 %), Umulokpa (60 %) and Adani (50 %).

**Order of Importance of Disease Signs and Symptoms among the Communities:** The order of importance of disease signs and symptoms in the communities are shown in Table 2: Diarrhoea (17.6 %) and body nodules (15 %) were the most frequent symptoms reported in all the communities. Other symptoms were blood in stool (14.6 %), fever (13.6 %) itching (12.6 %), blood in urine (0.66 %) and blood in sputum (2.3 %) Blood in urine and sputum were the least recognized of all the disease symptoms in all the communities. There was a positive relationship between the presence of biting midges and body itching in the communities (r = 0.594) (Figure 2). Furthermore, the presence of biting midges and body nodules showed very high positive relationship (r = 0.682). (Figure 3).

**Water Usages in the Communities:** Of all the water use methods in the communities, domestic water use topped the list in all the communities (Figure 4). This was followed by the use of water for occupational and recreational purposes. Occupational use of water was principally for par-boiling rice grains during processing, cassava fermentation and garri processing.

Swimming for leisure and relaxation was observed among people returning from farm. Rivers in Adani, Ifite Ogwari, and large streams in Umulokpa offered recreational grounds for swimming. Farmers in Umumbo, Omor and Omasi used large part of the major irrigation canals for swimming and hunting of edible frogs *(Rana rana).*

**Major Sources of Drinking Water in Various Communities:** Irrigation canals and ponds (burrows pits) were the major sources of drinking water in Umumbo (Table 3), while streams were the major sources of drinking water in Omor and Umulokpa. Rivers were principally used by inhabitants of Adani (96 %), Umulokpa (88 %), Ifite Ogwari (88 %) and Omasi (78 %). Umumbo community lacked streams and rivers. The use of rainwater for drinking was admitted by all communities and none of the communities had pipe borne water.

**Water Treatment Methods among the Communities:** The highest value of "No water treatment method" was indicated in all the communities while addition of alum was the next most popular water treatment adopted by all the communities (Figure 5). This is followed by boiling and then filtration of water.

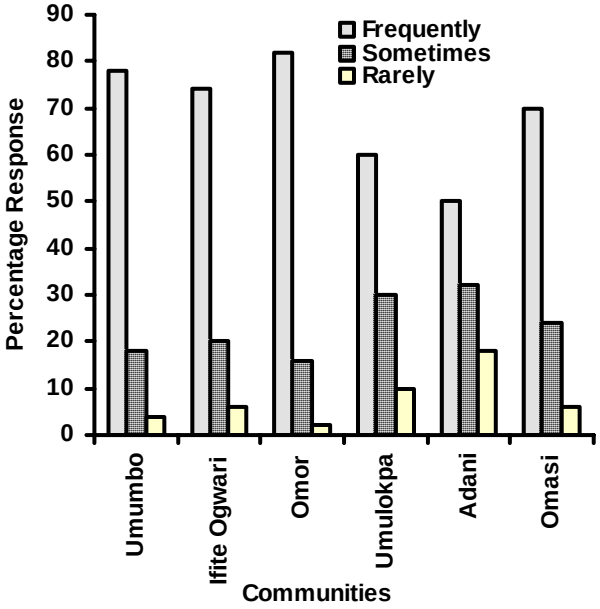


**Figure 1: Rate of visits to farm by people in the different communities**

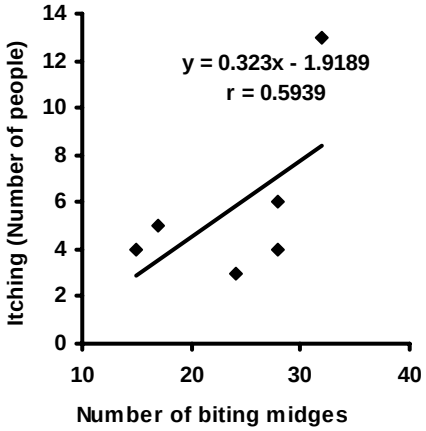


**Figure 2: Interaction between biting midges and presence of body itching**

**Table 2: Disease symptoms based on responses from community members**

| Towns | No. of persons sampled | Coughing | | Itching | | Headache | | Fever | | Blood in urine | | Diarrhoea | | Abdominal pain | | Blood in sputum | | Nodules | | Blood in Stool | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response |
| Adani | 50 | 3 | 6 | 2 | 4 | 3 | 6 | 8 | 16 | 1 | 2 | 14 | 28 | 6 | 12 | 0 | 0 | 2 | 4 | 11 | 22 |
| Ifite Ogwari | 50 | 2 | 4 | 3 | 6 | 13 | 26 | 2 | 4 | 1 | 2 | 12 | 24 | 1 | 2 | 0 | 0 | 6 | 12 | 10 | 20 |
| Omasi | 50 | 1 | 2 | 5 | 10 | 5 | 10 | 5 | 10 | 0 | 0 | 13 | 26 | 3 | 6 | 3 | 6 | 6 | 12 | 9 | 18 |
| Omor | 50 | 1 | 2 | 4 | 8 | 9 | 18 | 8 | 16 | 0 | 0 | 12 | 24 | 3 | 6 | 2 | 4 | 1 | 2 | 10 | 20 |
| Umumbo | 50 | 4 | 8 | 12 | 24 | 5 | 10 | 4 | 08 | 0 | 0 | 1 | 2 | 5 | 10 | 1 | 2 | 15 | 30 | 2 | 4 |
| Umulokpa | 50 | 4 | 8 | 12 | 24 | 5 | 10 | 4 | 08 | 0 | 0 | 1 | 2 | 5 | 10 | 1 | 2 | 15 | 30 | 2 | 4 |
| Total and % Response for each disease Symptom | 300 | 15 | 5 | 38 | 12.6 | 40 | 13.3 | 41 | 13.6 | 2 | 0.66 | 53 | 17.6 | 23 | 7.6 | 7 | 2.3 | 45 | 15 | 44 | 14.6 |

**Methods of Sewage Disposal in the Communities:** Table 4 showed the various methods of sewage disposal in the communities sampled. The use of pit latrine (80 %) was admitted by people in Adani and (72 %) in Umulokpa. Few people admitted the use of pit latrine in Ifite Ogwari (30 %), Omasi (16 %) and Umumbo (10 %). The use of bush as a method of sewage disposal was most popular in Umumbo (76 %) and Omasi (58 %) while it is rare in Adani (14 %) and Umulokpa (20 %). Farms, rivers and irrigation canals were used not routinely but in emergencies. Cisterns are present in very few homes in Umulokpa (6 %) and Umumbo (4 %).

**The use of Human Faeces as Manure in Rice Farms:** The use of human faeces as manure in rice farms was not acceptable in Umulokpa. From Figure 6 it was observed that 96 % of the respondents admitted never using human faeces in rice farms. This is similar to the situation in Adani (94 %), and Omasi (72 %). However, this practice was admitted by 24 % of respondents in Umumbo (30 %) in Omor and 20 % in Ifite Ogwari.

**Prevalence of Vectors in the Farms among the Communities:** The numbers of vectors encountered in farms are shown in Figure 7. The responses are

similar in all the communities with biting midges topping the list of all the vectors followed by

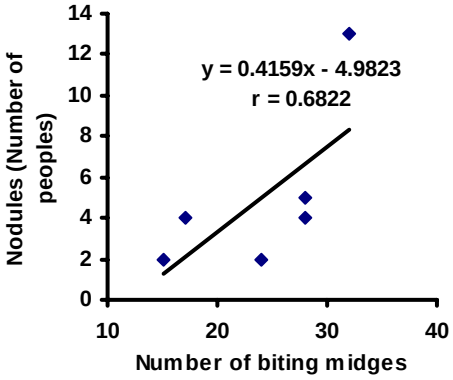


**Figure 3: Interaction between the presence of biting midges and the presence of body nodules**

mosquitoes. The records for the biting midges were Umumbo (70 %), Adani (70 %), Umulokpa (67 %), Omor (60 %) and Ifite Ogwari (40 %). Rats were also encountered in the farms while snails were least encountered in all the communities. Other vectors included tsetse fly, housefly, and cockroaches.

**Human Contact with Vectors:** The highest contact rates with mosquitoes 96 % and biting midges 80 % were observed in Umumbo community (Figure 8). This was followed by rats 64 % obtained in Omor community and 56 % for cockroach observed in Adani.

**Table 3: Sources of drinking water in the communities**

| Towns | | Tap water | | Stream | | Pond | | Irrigation | | River | | Rain water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. Sampled | No. of response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response |
| **Umumbo** | 50 | - | 0 | - | 0 | 40 | 80 | 45 | 90 | - | 0 | 20 | 40 |
| **Adani** | 50 | - | 0 | 25 | 50 | - | 0 | - | 0 | 48 | 96 | 25 | 50 |
| **Omor** | 50 | - | 0 | 50 | 100 | 25 | 50 | 24 | 48 | - | 0 | 9 | 18 |
| **Umulokpa** | 50 | - | 0 | 49 | 98 | - | 0 | - | 0 | 44 | 88 | 9 | 18 |
| **Ifite Ogwar** | 50 | - | 0 | 19 | 38 | 8 | 16 | 30 | 60 | 44 | 88 | 14 | 28 |
| **Òmasi** | 50 | - | 0 | 26 | 52 | 21 | 42 | - | 0 | 39 | 78 | 24 | 48 |
| **Total and Mean Percentage Response** | 300 | - | 0 | 169 | 56.3 | 94 | 31.3 | 99 | 33 | 175 | 58.3 | 101 | 33.6 |

## DISCUSSION

The environmental health quality of any community can be assessed from the sources of contact with parasites and disease vectors within the area. A safe environment is one where the habitats as well as the habits of the people do not have any negative health implication. The Anambra river Basin Rice Irrigation Project Area is made up of communities without the

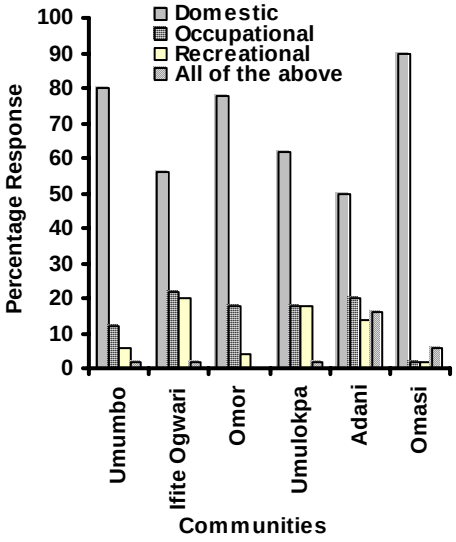


**Figure 4: The order of importance of water use in the communities**

basic amenities that could reduce vector-parasite-man contacts. For instance, in a community like Umumbo the major sources of drinking water include ponds and irrigation canals. In most homes there are absence of pit latrines for proper sewage disposal and the nearby bushes are used for this purpose. There was strict legislation against defeacating in farms (especially rice farms) and rivers in all communities. Absence of pit latrines in most communities was as a result of the closeness of the water tables to the surface. Attempts to dig pit latrines resulted in water flooding the pit and making it uncomfortable for use. It can also be observed that sewage was used as manure in some communities. These conditions are favourable for parasites such as *Ascaris, Enterobius, Trichuris* infections (Bundy and Cooper, 1989). Addition of alum was however, not frequently

practiced as means of water treatment method because it wastes soap (as a result of hardness) and because "alum purified water" had taste.

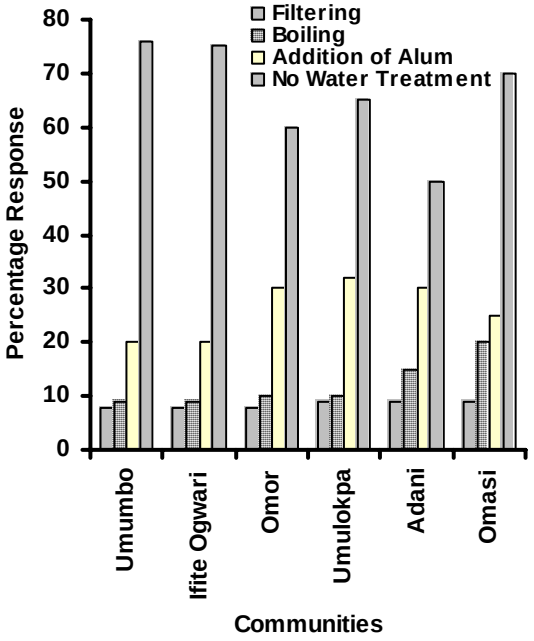


**Figure 5: Water treatment methods among the communities**

The farming habit of people in the research area makes them to maintain dual homestead. During the rice cultivation periods, farmers are always in the fields and at other times, they move to distant farm homes where other crops like yam and maize are cultivated. These farm homes are nitches for mosquito as well as forest *Onchocerca* vector.

**Table 4: Methods of sewage disposal in the communities**

| Towns | | Pit latrine | | Farm | | Bush | | River | | Irrigation Canals | | Cisterns | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. Sampled | No. of response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response | No. of Response | % Response |
| **Umumbo** | 50 | 5 | 10 | 3 | 6 | 38 | 76 | 0 | 0 | 5 | 10 | 2 | 4 |
| **Adani** | | 40 | 80 | 2 | 4 | 7 | 14 | 0 | 0 | 0 | 0 | 1 | 2 |
| **Omor** | 50 | 22 | 44 | 2 | 4 | 20 | 40 | 0 | 0 | 5 | 10 | 1 | 2 |
| **Ifite Ogwari** | 50 | 15 | 30 | 3 | 6 | 21 | 42 | 2 | 4 | 8 | 16 | 1 | 2 |
| **Òmasi** | 50 | 8 | 16 | 5 | 10 | 29 | 58 | 3 | 6 | 5 | 10 | 0 | 0 |
| **Umulokpa** | 50 | 36 | 72 | 1 | 2 | 10 | 20 | 0 | 0 | 0 | 0 | 3 | 6 |
| **Total and Mean Percentage Response** | 300 | 126 | 42 | 13 | 4.3 | 125 | 41.6 | 5 | 1.6 | 23 | 7.6 | 8 | 2.6 |

Frequent visit was necessary in order to chase away weaver birds from the rice farms. The chasing away of birds was often undertaken by children except in cases where the rice field was located far away from the farmer's home. The most prevalent vectors of parasites encountered in the farms are biting midges followed by mosquitoes. Body itching and nodules are commonly reported

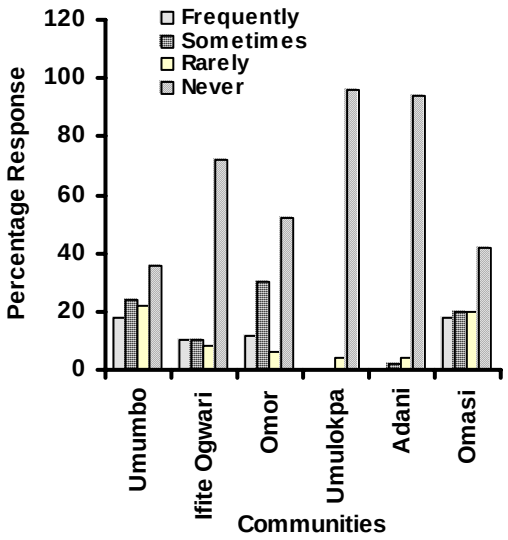


**Figure 6: The use of human faeces as manure in rice farms among communities**

indicating a positive relationship between the symptoms of Onchocerciasis and the vector of the disease among the people. Basically there was no conscious effort made to reduce parasite-vector-people contact in the irrigation project area during its establishment contrary to what is usually advised (Tanner and Savingny, 1987).

From what is known, changes in the environment often cause changes in human behaviour and vector habitat. When a rural community is involved in this kind of development, ignorance, conservatism and poverty amplifies the risk of multiple infections (Booth and Bundy, 1995).

As a result of micro political situations common in rural African communities, basic infrastructural facilities are often not available in rural communities to combat parasitic infections common among individuals of such communities.

The result is increase in morbidity and mortality rates, reduction in agricultural productivity,

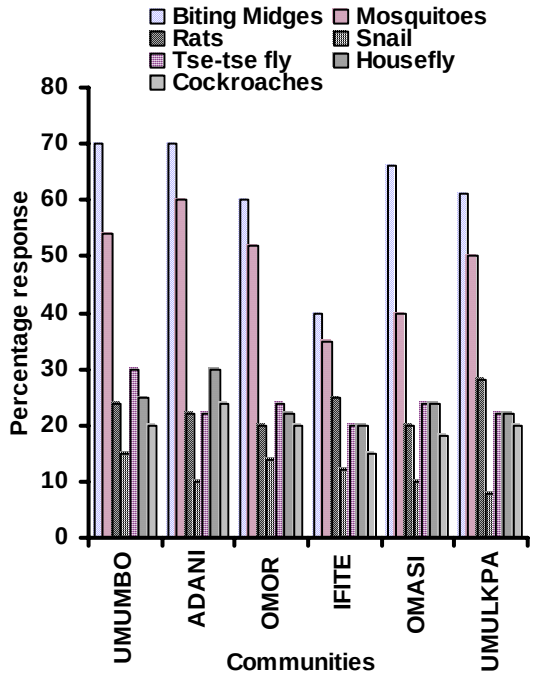


**Fig 7: Prevalence of vectors in the farms among the communities**

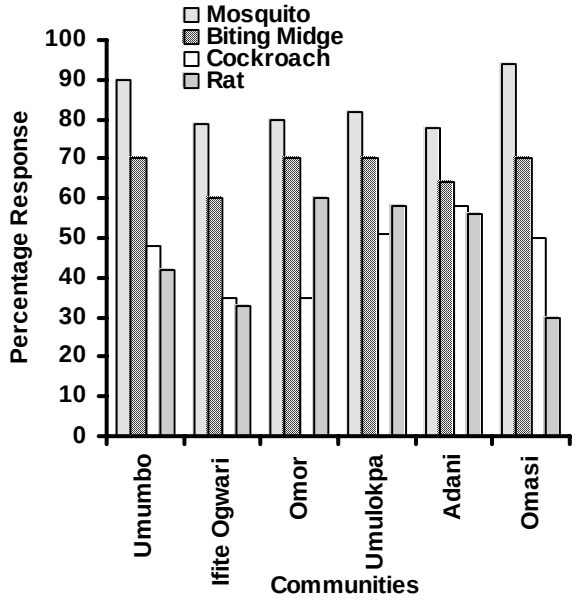


**Figure 8: Rates of contact with of vectors of parasites**

malnourishment, and other conditions associated with poverty (Belcher and Wurapa, 1995).

It is therefore necessary that adequate disease intervention strategies be instituted in the areas around the Anambra River Basin irrigation Project Area to avert the popular "decay" in health status associated with rural areas in countries where there is lack of care and attention for rural dweller.

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# ABATTOIR-BASED STUDY OF THE SUSCEPTIBILITY OF TWO NATURALLY INFECTED BREEDS OF GOAT TO *Haemonchus contortus* IN NSUKKA AREA OF ENUGU STATE, NIGERIA

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**ABSTRACT**

***The study was carried out to assess the susceptibility of two indigenous breeds of goat – the Red Sokoto (RS) and the West African Dwarf (WAD) goats to Haemonchus contortus infection by using the abomasal worm burden and the worm's uterine egg count as the indices. One hundred (100) abomasa each from the RS and WAD slaughter goats were purchased from Nsukka Urban abattoir and Ibagwa rural abattoir for examination between October 2002 and Janaury 2003. The WAD goats had a significantly higher worm burden (7286) than the Red Sokoto goats (4675) (P<0.01). The female-male ratio of the worms showed the RS goats with a higher female population ratio of 1:0:90 as against the 1:1:03 for WAD goats. 240 adult female worms, which were randomly selected from each breed for the uterine egg count showed that the average uterine egg count was significantly higher in WAD goats (748.37) than in RS goats (620.50) (P<0.01). Both the worm and egg burdens exhibited a significant steady drop in both breeds from October 2002 to January 2003 (P<0.001). It is suggestive from this study that RS goats may be less susceptible to naturally acquired Haemonchus contortus infection than WAD goats.***

**Key words**: *Haemonchus contortus,* Abattoir, Goats, Susceptibility, Egg-burden, Nsukka

## INTRODUCTION

Meat, which is the primary source of animal protein in staple diets, has always been in short supply in Nigeria where individual consumption of about 3.24g per day falls far below the FAO recommended value of 34g per day (Shaib *et al*, 1997). Part of this requirement is met by the goat meat from its Nigeria population estimated at 35 million (RIM, 1992). Of the indigenous breeds of goats in Nigeria, the West African Dwarf (WAD) goats (chondroplastic breed) are found in the hot humid forest and derived savannah zones of southern Nigeria. The Red Sokoto (RS) goats (Maradi breed) constitute the dominant indigenous breed in the northern part. WAD goats are mostly managed by the tethering technique in the south (Ademosun, 1987 and Ayo *et al*., 1998a). 2 to 7 animals in a herd are usually kept to meet domestic consumption demand and sundry cash needs in addition to producing manure for crop production (Adu *et al*, 1979; Chidebelu and Ngo Ndjon, 1998). Red Sokoto goats are usually extensively managed in northern Nigeria (Ayo and Minka, 2003). The pastoralists rear them as trade animals, which are mostly sold in southern Nigeria. Among the factors militating against the realization of the full potentials of small ruminant production in Nigeria is helminthoses especially the gastrointestinal nematodes of which *Haemonchus contortus* is the most prevalent (Fakae, 1990). A loss of $40 million is recorded annually in livestock industry from parasitic gastroenteritis (Akerejola *et al*., 1979).

Efforts are now being made to selectively upgrade and rear *Haemonchus* resistant goat breeds (Shavulimo *et al*., 1988; Fakae *et al*., 2003). The frequency of drug administration, under dosing, prohibitive cost of chemotherapy and, presently, the influx of fake and adulterated drugs in Nigeria had given rise to the development of resistance to the currently used anthelminthics by the worm (Ikeme, 1997). An alternative approach is urgently needed, therefore, to check the rising frequency of resistant genes in the nematode population (Ikeme, 1997). The differences in susceptibility to *Haemonchus contortus* infection were found to be greater between breeds than within breeds from studies in East Africa (Preston and Allonby, 1978). This study therefore aims to find out the susceptibility of the two most common indigenous breeds of goats, the Red Sokoto and the West African Dwarf goats in Nigeria to *Haemonchus contortus* infection.

## MATERIALS AND METHODS

**Study Area:** Nsukka urban town and Ibagwa-Aka, a suburban town, lie at longitude $7^{o}$ $23^{1}$ and $7^{o}$ $25^{1}$ East, and latitude $6^{o}$ $51^{1}$ and $7^{o}$ $9^{1}$ North, respectively. The two towns are about 10 km apart as the crow flies and about 20 km by road transport (Figure 1). They situate at an altitude of 400m above sea level. An annual rainfall range of 200-400 mm is recorded between March and December. Rainfall is very minimal in the dry season months of October to February.

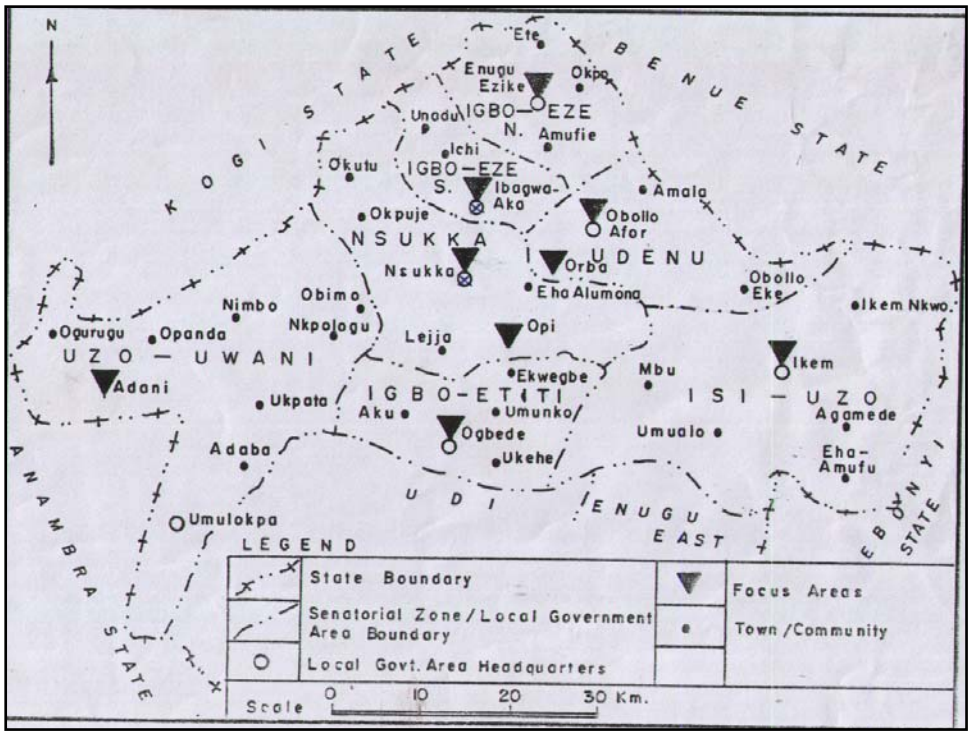


**Figure 1: Map of Nsukka cutural zone in Enugu State (The study area)**

**Sample Collection and Analysis:** Between 5 - 7 infected abomasa of Red Sokoto (RS) goats were purchased weekly from Nsukka abattoir on alternate daily visits while 2-4 infected West African Dwarf (WAD) goat abomasa were purchased from Ibagwa slaughter house on each (Nkwo) market day. A monthly total of 25 abomasa were purchased for each breed. A total of 100 abomasa for each breed were collected during the 4-month study period. Before flaying and dressing the animal, each abomasum was ligated at about 2 cm beyond the fundic and the pyloric ends of the gastrointestinal tract and excised. This was to prevent the influx or reflux of the worms (if any) from the abomasum into the adjacent chambers during handling. The abomasum was longitudinally slit open. Only infected abomasa with adult worms were paid for. In the laboratory, 100-mesh sized sieves were used to repeatedly wash and recover the worms until only the faecal debris were left. The adult male and female worms were separated and counted using their distinctive morphological characteristics with a stereo-microscope (MAFF, 1977). Fifteen (15) gravid female worms were randomly selected from each weekly collection for the uterine egg count for each breed of goat. A total of 60 was processed each month for each breed. Egg recovery was done by using a metal spatula to crush the gravid females on a glass Petri-dish with about 5 ml of water. 5 gravid females were processed at a time. A piece of fine muslin was used to sieve off the tissue debris in a water jet. The solution containing the eggs were transferred into centrifuge tubes, which were filled up with normal saline solution. The contents were centrifuged at 2000 rpm for 5 minutes. The upper third of the solution, which contains the floating eggs, was decanted into test tubes. The egg count was done using the modified McMaster technique with a compound microscope at x 100 magnification. The average egg load of the individual worm was calculated by simple average. The Chi-square, student t-test and One Way ANOVA statistical analyses were used in result analysis.

## RESULTS

The results as presented in Tables 1 and 2 show a significant steady decrease in worm burden and egg load respectively from October 2002 to January 2003 ($P<0.01$). However, the cumulative worm burden of 7286 from the WAD goats was significantly higher than the 4675 obtained from the RS goats ($P<0.01$). There was a slightly higher female/male worm ratio among the RS goats as shown in Table 1. The average uterine egg load of the individual female worm was significantly higher in the WAD goats than in the RS from October to December as shown in Table 2 ($P<0.01$).

## DISCUSSION

The steady decrease in the worm burden from the early months of the dry season onwards observed in both breeds was consistent with the findings of other workers (Okon and Enyenihi, 1975).

**Table 1: The Mean Abomasal Worm Burden and male-female ratio of *Haemonchus contortus* in Red Sokoto (RS) and West African Dwarf (WAD) goats**

| Month | Breed | | | | |
|---|---|---|---|---|---|
| | Red Sokoto (RS) Goats | | West African Dwarf (Wad) Goats | | Total |
| | Mean worm burden per goat | Female/Male Ratio | Mean worm burden per goat | Female/male ratio | |
| **October** | 50.98 ± 8.99 | 677/596(0.88) | 92.53 ± 26.69 | 1056/1206(1.14) | 3535 |
| **November** | 48.61 ± 10.46 | 612/562(0.92) | 88.60 ± 16.39 | 1153/995(0.86) | 3,322 |
| **December** | 48.21± 9.18 | 616/540(0.88) | 69.69 ± 11.60 | 810/904(1.12) | 2870 |
| **January** | 43.77± 6.79 | 560/512(0.91) | 47.51 ± 7.60 | 568/594(1.05) | 2234 |
| **Total** | | 2465/2210 (0.90) | | 3587/3699(1.03) | |
| | | 4675 | | 7286 | 11961 |

**Table 2: Monthly mean uterine egg load in female *Haemonchus contortus* recovered from Red (RS) or West African Dwarf (WAD) goats**

| Month | Breed | |
|---|---|---|
| | Red Sokoto (RS) goats | West African Dwarf (WAD) |
| **October** | 671.00 ± 4542 | 969.90 ± 52.65 |
| **November** | 662.83 ± 44.92 | 870.33 ± 99.51 |
| **December** | 600.57 ± 9.53 | 688.88 ± 101.68 |
| **January** | 548.17 ± 54.57 | 464.37 ± 103.94 |

This may be due to the onset of adverse climatic condition for preparasitic stages and their transmission. The higher worm burden in the WAD goats may probably be attributed to the micro-climate of the hot humid rainforest zone of the south. This is their adapted natural eco-habitat, which favour the development of the pre-parasitic stages of the worm. In contrast, the less humid zone of the Savannah where the RS goats are reared has a delimiting effect on the pre-parasitic stage development. But the watering or drinking points found in the savannah grasslands are known to be foci of herd infections. Therefore this position alone may not fully explain the significant differences observed in the individual worm's uterine egg load between the two breeds. It may also seem that the tethering technique could compromise the health status of the WAD goats. This is because the technique is known to subject goats to physical discomfort, behavioural deprivation, emotional instability, etc (Danilevsky, 1991). These factors, which are very minimal in the RS goats reared on the free-grazing or extensive management system, predispose the goats to infections (Ademosun, 1987; Ayo and Minka, 2003). But it can equally be contended that the extensive trekking and fodder-feeding to which the RS goats are subjected could elicit such stress factors with similar consequences. It was advanced that animals on a higher plane of nutrition are normally more resistant to *Haemonchus* infection (Shavulimo *et al.*, 1988; Preston and Allonby, 1978). In this case, both breeds had their nutritional benefits compromised through their different management systems, especially in the dry season when this study was carried out. It may further be argued that the traditional method of feeding the WAD goats with grasses which are cut closer to the roots may expose them to the pre-parasitic stages of the nematode. This is because goats are naturally high browsers and so are less exposed to the infective stages of the parasites found closer to the foliage bases. But the RS goats equally resort to low grazing especially during the dry months in savanna when shorter foliage abound. Hence they likewise become exposed to the pre-parasitic or infective stages of the worm. So, this too may have less influence on the significant disparity observed in the uterine egg load of the individual worm between the two breeds. A stronger contention may therefore lie in the breed-dependent host resistance against the *Haemonchus* infection. The higher uterine egg load of the WAD goat may be associated with its rearing system. The tethering technique gives the goat little exposure to contaminated environment where trickle infections of *Haemonchus* would have boosted the development of natural resistance against it by the goat over a period (Chiejina *et al.*, 1988). The RS goats reared on the extensive management system are constantly being exposed to such trickle infection. This most probably explains why the WAD goats were more susceptible to the infection as evident in both the higher worm burden and egg load. This pattern had also been observed against other gastrointestinal nematodes (Chiejina *et al.*., 1988). However, the higher residual female/male worm ratio of the RS goats may be responsible for the usual fast transmission rate and quicker population of the environment usually observed at the on-set of the rainy season in the savanna (Fakae, 1990).

**Conclusion**: The wide variations observed in the uterine egg counts among the WAD goats may indicate a small population of *Haemonchus*–resistant goats within the breed. A controlled further study at the genetic level may confirm this. However, with accommodation for individual variability within both breeds, the Red Sokoto (RS) goats most probably may offer a more promising degree of resistance against naturally acquired (*Haemonchus contortus*

infection than the West African Dwarf (WAD) goats. This is of significant advantage to a farmer in a less selective goat breeding programme.

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# HELMINTH ENDO-PARASITES OF MOCHOKIDS IN A TROPICAL RAINFOREST RIVER SYSTEM

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**ABSTRACT**

***A study of the helminth endo-parasites of Brachysynodontis batensoda, Hemisynodontis membranaceous, Synodontis gobroni, S. clarias, S. sorex, S. budgetti, S. xiphias, S. nigrita, S. filamentosus, S. eupterus, S. schall, and S. ocellifer, randomly sampled from commercial fishers, was made in the lower reaches of Anambra river from March 2001 to February 2002. The helminth endo-parasites recovered were Sandonia sudanensis (Trematoda), Wenyonia synodontis, W. youdeoweii, W. kainji (Cestoda) and Procamallanus laeviconchus (Nematoda). B. batensoda, S. clarias, S. eupterus, S. gobroni and S. ocellifer are new geographical records for W. synodontis, which appeared to be the most important endo-parasite of mochokids in terms of fishery management in the Anambra river. It infected more hosts than the other Wenyonia species put together or the other parasite species. The prevalence of all the endo-parasites was low (≤ 20 %). There were cases of mixed infection involving S. sudanensis and P. laeviconchus as well as Wenyonia species and P. laeviconchus but never between Wenyonia congeners. The habitat most preferred by S. sudanensis and Wenyonia species was the small intestine, whereas P. laeviconchus was found only in the stomach. Prevalence, mean intensity and abundance of all the endo-parasites were generally higher in the dry than in the rainy season. No visible damage or injury resulting from the endo-parasites was evident on parasitized fish.***

**Keywords:** Parasites, Mochokids, Anambra river

## INTRODUCTION

The mochokids, with approximately 110 species, occur throughout the Afro-tropical region. In Nigeria, the family has about 30 species distributed in five genera, namely, *Chiloglanis, Mochokus, Brachysynodontis, Hemisynodontis* and *Synodontis* (Olaosebikan and Raji, 1998). *Synodontis* has the highest number of species (19), whereas *Hemisynodontis* and *Brachysynodontis* have one each. The last two genera are, therefore, monotypic and common in the lower Niger drainage basin of which the Anambra river basin constitutes an important part. In the Anambra river, there are probably 16 synodontid species; 10 of these and the hemisynodontid and brachysynodontid species are examined in this study.

The mochokids, particularly species of *Brachysynodontis, Hemisynodontis* and *Synodontis*, are of commercial importance. They constitute from 11 to 16 % by number and 10 to 18 % by weight of the total catch of fish in the Kainji lake (Lelek, 1973; Lewis, 1974; Willoughby, 1979) and in river basins where they occur, including the Anambra basin (Reid and Sydenham, 1979; Teugels *et al.*, 1992; HMGE, pers. obs.). This is particularly so during the rainy season when they are very abundant, reflecting their high fecundity. Despite the long and strong spines of mochokids, they are a delicacy and a source of scarce animal protein and nutrients for the riverine inhabitants of the Anambra basin.

While there are reports on various aspects of the biology and ecology of the commercially important species (Breder and Rosen, 1966; Willoughby, 1979; Hickley and Bailey, 1987; Agnese *et al.*, 1990; Oberdorff *et al.*, 1990; Ofori-Danson, 1992), little exists on their parasites and diseases (Khalil, 1969; Khalil and Thurston, 1973; Azugo, 1978). Azugo's (1978) study in the Anambra river system is highly limited by sample size, generally less than six specimens, and is over 20 years old.

This paper investigates the helminth endo-parasites of *Brachysynodontis batensoda* (Rupell, 1832), *Hemisynodontis membranaceous* (Geoffroy Saint-Hilaire, 1893), *Synodontis gobroni* Daget, 1954, *S. clarias* Linne, 1758, *S. eupterus* Boulenger, 1901, *S. ocellifer* Boulenger, 1900, *S. schall* (Bloch and Schneider, 1801), *S. sorex* Gunther, 1864, *S. budgetti* Boulenger, 1911, *S. xiphias* Gunther, 1864, *S. nigrita* Valenciennes, 1840 and *S. filamentosus* Boulenger, 1901 in the Anambra river paying particular attention to their composition, habitat, seasonality and effect on their host(s).

## MATERIALS AND METHODS

Fresh specimens of the mochokids were randomly sampled from commercial fishers around Otuocha, Anam and Nsugbe in the lower reaches of the Anambra river from March 2001 to February 2002. The geographical location, climate, vegetation and other features of this area in the Anambra river basin have been described (Ezenwaji, 1998).

The standard length (snout to end of caudal peduncle) (SL, to the nearest centimetre) and body weight (W, to the nearest gram) of each specimen were measured and their sexes determined. The internal organs were thoroughly examined for helminth parasites after dissection. Parasites recovered were first shaken in normal saline to remove mucus and other host debris. The trematodes were shaken vigorously in cold 4 % formaldehyde until they died, while the cestodes were relaxed in distilled water and fixed in formal (5 %) - alcohol (90 %) - acetic acid (15 %) (F. A. A.). Live nematodes were killed in extended form by pouring steaming 70 % alcohol on them in Petri dishes; they were then preserved in 70 % alcohol to which 2 % glycerine had been added to prevent brittleness.

The terminology of infection statistics (Bush *et al.,* 1997) was employed in the analysis of data. ANOVA was done using a two-way classification. Means were separated with the aid of the new Duncan's multiple range test (Duncan, 1955).

## RESULTS

The helminth endo-parasites recovered from the fish hosts were the paramphistomatid digenean, *Sandonia sudanensis* (Trematoda), the monozoic caryophyllaeid tapeworms, *Wenyonia synodontis, W. youdeowii, W. kainji* (Cestoda) and the camallanid roundworm, *Procamallanus laeviconchus* (Nematoda) (Table 1).

The overall prevalence was low; only 52 (8.7 %) of the 601 mochokids examined were infected and 2687 helminth specimens were recovered (Table 1). This table also showed that the prevalence of *S. sudanensis* in *H. membranaceous* was higher than in *Synodontis* species (≤ 10.0 %), which it parasitized ($P<0.05$). The prevalence of *W. synodontis* ranged from 1.9 % in *S. gobroni* to 13.3 % in *S. ocellifer, S. schall* and *B. batensoda*. More mochokids were infected by *W. synodontis* than the other tapeworms – *W. youdeowii* and *W. kainji* – which, generally, had lower prevalence. The mean intensity and abundance of *W. synodontis* in *S. ocellifer* and of *W. youdeowii* in *S. eupterus* were exceptionally very high. The prevalence of *P. laeviconchus* ranged from 3.8 % in *S. nigrita* to 20 % in *S. xiphias*. No *S. filamentosus (*n = 40) examined was infected. All the endo-parasites were present in *S. clarias* at low prevalence (2.9 – 7.2 %).

The habitats of *S. sudanensis* and *Wenyonia* species were the small and large intestines and stomach but the preferred habitat appeared to be the small intestines of the infected mochokids (Table 2). *P. laeviconchus* infected only the stomach.

There were two cases of mixed infection involving *S. sudanensis* and *P. laeviconchus,* and nine involving *Wenyonia* species and *P. laeviconchus* but no case involving *Wenyonia* congeners was found. In all cases of mixed infection, the parasites occupied their preferred habitats.

Generally, the prevalence, mean intensity and abundance of *S. sudanensis, Wenyonia* species and *P. laeviconchus* in the mochokids were higher in the dry than the rainy season ($P < 0.05$) (Table 3). Some of the endo-parasites were not even present in the rainy season.

Apart from the *P. laeviconchus* specimens that were reddish, apparently from engorgement of blood, no noticeable harm was evident on the stomach mucosa to which they were attached by their buccal capsules. Fish, such as *S. ocellifer* (mean intensity = 262.5) and *S. eupterus* (mean intensity = 333.3), with heavy *Wenyonia* species worm burden appeared weak, moved sluggishly and died easily in the process of marketing them. Yet, no visible injury resulting from their infection was observed.

## DISCUSSION

Several species of mochokids, particularly members of the genera *Brachysynodontis, Hemisynodontis* and *Synodontis,* are known to harbour monogenean, digenean, cestode, acanthocephalan, nematode (and other) parasites (Khalil, 1971; Khalil and Thurston, 1973; Azugo, 1978). Among these, *Wenyonia* species appear to show a marked preference for mochokids in which several of them have been recorded (Ukoli, 1965; Khalil, 1971; Azugo, 1978); *B. batensoda, S. clarias, S. eupterus, S. gobroni* and *S. ocellifer* in this study are new geographical records for *W. synodontis*. Similarly, *S. budgetti, S. clarias, S. eupterus* and *S. sorex* are new geographical records for *W. kainji*. As a truly transafrican species, which appears to be host-specific, *P. laeviconchus* occurs widely in synodontids and other tropical catfish, especially *Clarias* species (Khalil and Thurston, 1973; Ezenwaji and Ilozumba, 1992; Paperna, 1996; Oniye *et al.,* 2004).

The low prevalence of parasites in fish from lotic flood water systems has been widely reported. Our results on the prevalence of endo-parasites in mochokids from the Anambra river are consistent with the reports of Ezenwaji and Ilozumba (1992), Anosike *et al.* (1992), Ezenwaji (2002), Nwani (2004) and Oniye *et al.* (2004). This is to be expected because the relatively fast flow of water in lotic habitats would inevitably reduce host-parasite contact frequency resulting in low prevalence.

While the low prevalence may be causally related to flow regime, Williams and Jones (1994) report the interplay and effect of other abiotic factors (such as, rainfall, pH and dissolved oxygen) and biotic factors (such as, food and crowding) on the level of parasitism in aquatic systems. This interplay may be responsible for the higher prevalence, mean intensity and abundance of the parasites in the mochokids in the dry than the rainy season. During the rains, particularly at high flood, the increased volume of water and higher flow regime result in wide dispersal of the infective stage of the parasite and the fish host. Consequently, there is a drastic reduction in host-parasite contact frequency. On the other hand, the contraction of water in the main river channel and floodplain lentic water bodies in the dry season would bring the infective stage of the parasite in close proximity to the fish host, both of which become crowded into a smaller area, resulting in much higher contact between them.

**Table 1: Parasite species spectrum and their prevalence in the mochokids from the Anambra river**

| Parasite taxa | Parasite species | Host fish | No. of fish examined | No. of fish infected | Total no. of parasites recovered | #Prevalence (%) | **Mean intensity | ¶Abundance |
|---|---|---|---|---|---|---|---|---|
| **Trematoda** | *Sandonia sudanensis* | *Hemisynodontis membranaceous* | 20 | 4 | 16 | 20.0 | 4.0 | 0.8 |
| | | *Synodontis clarias* | 69 | 2 | 4 | 2.9 | 2.0 | 0.1 |
| | | *S. filamentosus* | 40 | 0 | 0 | 0 | 0 | 0 |
| | | *S. schall* | 30 | 3 | 20 | 10.0 | 6.7 | 0.7 |
| **Cestoda** | *Wenyonia synodontis* | *Brachysynodontis batensoda* | 30 | 4 | 17 | 13.3 | 4.3 | 0.6 |
| | | *Hemisynodontis membranaceous* | 20 | 2 | 30 | 10.0 | 15.0 | 1.5 |
| | | *Synodontis clarias* | 69 | 4 | 20 | 5.8 | 5.0 | 0.3 |
| | | *S. eupterus* | 50 | 6 | 200 | 12.0 | 33.3 | 4.0 |
| | | *S. gobroni* | 160 | 3 | 32 | 1.9 | 10.7 | 0.2 |
| | | *S. ocellifer* | 30 | 4 | 1050 | 13.3 | 262.5 | 35 |
| | | *S. schall* | 30 | 10 | 30 | 33.3 | 3.0 | 1.0 |
| | *W. youdeowii* | *S. clarias* | 69 | 5 | 20 | 7.2 | 4.0 | 0.3 |
| | | *S. eupterus* | 50 | 3 | 1000 | 6.0 | 333.3 | 20.0 |
| | *W. kainji* | *S. budgetti* | 30 | 3 | 15 | 10.0 | 5.0 | 0.5 |
| | | *S. clarias* | 69 | 4 | 10 | 5.8 | 2.5 | 0.1 |
| | | *S. eupterus* | 50 | 3 | 82 | 6.0 | 27.3 | 1.6 |
| | | *S. sorex* | 32 | 4 | 20 | 12.5 | 5.0 | 0.6 |
| **Nematoda** | *Procamallanus laeviconchus* | *S. clarias* | 69 | 3 | 46 | 4.3 | 15.3 | 0.7 |
| | | *S. eupterus* | 50 | 3 | 18 | 6.0 | 6.0 | 0.4 |
| | | *S. nigrita* | 80 | 3 | 20 | 3.8 | 6.7 | 0.3 |
| | | *S. schall* | 30 | 4 | 10 | 13.3 | 2.5 | 0.3 |
| | | *S. xiphias* | 30 | 6 | 27 | 20.0 | 4.5 | 0.9 |
| | | | 601 | 52 | 2687 | 8.7 | -- | -- |

*#Prevalence: Number of host infected divided by the number examined expressed as a percentage. **Mean intensity: Mean number of parasites per infected host. ¶Abundance: Mean number of parasites per host examined.*

**Table 2: The prevalence of the helminth parasites in relation to habitats in the mochokids from the Anambra river**

| Parasite species | Host fish | Habitat | No. of fish examined | No. of fish infected | Total no. of parasites recovered | Prevalence (%) | Mean intensity | Abundance |
|---|---|---|---|---|---|---|---|---|
| ***Sandonia sudanensis*** | *Hemisynodontis membranaceous* | Large intestine | 20 | 4 | 16 | 20.0 | 4.0 | 0.8 |
| | *Synodontis clarias* | Small intestine | 69 | 2 | 4 | 2.9 | 2.0 | 0.1 |
| | *S. filamentosus* | | 40 | 0 | 0 | 0 | 0 | 0 |
| | *S. schall* | Small intestine | 30 | 3 | 20 | 10.0 | 6.7 | 0.7 |
| ***Wenyonia synodontis*** | *Brachysynodontis batensoda* | Small intestine | 30 | 4 | 17 | 13.3 | 4.3 | 0.6 |
| | *H. membranaceous* | Small intestine | 20 | 2 | 30 | 10.0 | 15.0 | 1.5 |
| | *S. clarias* | Small intestine | 69 | 4 | 20 | 5.8 | 5.0 | 0.3 |
| | *S. eupterus* | Stomach | 50 | 1 | 7 | 2.0 | 7.0 | 0.1 |
| | | Large intestine | 50 | 5 | 193 | 10.0 | 38.6 | 3.9 |
| | *S. gobroni* | Small intestine | 160 | 2 | 28 | 1.3 | 14.0 | 0.2 |
| | | Large intestine | 160 | 1 | 4 | 0.6 | 4.0 | + |
| | *S. ocellifer* | Small intestine | 30 | 4 | 1050 | 13.3 | 262.5 | 35.0 |
| | *S. schall* | Small intestine | 30 | 10 | 30 | 33.3 | 3.0 | 1.0 |
| ***W. youdeowii*** | *S. clarias* | Small intestine | 69 | 5 | 20 | 7.2 | 4.0 | 0.3 |
| | *S. eupterus* | Large intestine | 50 | 3 | 1000 | 6.0 | 333.3 | 20.0 |
| ***W. kainji*** | *S. budgetti* | Large intestine | 30 | 3 | 15 | 10.0 | 5.0 | 0.5 |
| | *S. clarias* | Large intestine | 69 | 4 | 10 | 5.8 | 2.5 | 0.1 |
| | *S. eupterus* | Small intestine | 50 | 3 | 82 | 6.0 | 27.3 | 1.6 |
| | *S. sorex* | Small intestine | 32 | 4 | 20 | 12.5 | 5.0 | 0.6 |
| ***Procamallanus laeviconchus*** | *S. clarias* | Stomach | 69 | 3 | 46 | 4.3 | 15.3 | 0.7 |
| | *S. eupterus* | Stomach | 50 | 3 | 18 | 6.0 | 6.0 | 0.4 |
| | *S. nigrita* | Stomach | 80 | 3 | 20 | 3.8 | 6.7 | 0.3 |
| | *S. schall* | Stomach | 30 | 4 | 10 | 13.3 | 2.5 | 0.3 |
| | *S. xiphias* | Stomach | 30 | 6 | 27 | 20.0 | 4.5 | 0.9 |

**Table 3: The prevalence of the helminth parasites in relation to the dry (n=270) and rainy (n=291) seasons in the mochokids from the Anambra river**

| Parasite species | Host fish | Season | No. of fish examined | No. of fish infected | Total no. of parasites recovered | Prevalence (%) | Mean intensity | Abundance |
|---|---|---|---|---|---|---|---|---|
| ***Sandonia sudanensis*** | *Hemisynodontis membranaceous* | Dry | 8 | 3 | 11 | 37.5 | 3.7 | 1.4 |
| | | Rainy | 12 | 1 | 5 | 8.3 | 5.0 | 0.4 |
| | *Synodontis clarias* | Dry* | 29 | 2 | 4 | 6.9 | 2.0 | 0.1 |
| | *S. schall* | Dry* | 20 | 3 | 20 | 15.0 | 6.7 | 1.0 |
| ***Wenyonia synodontis*** | *Brachysynodontis batensoda* | Dry* | 20 | 4 | 17 | 20 | 4.3 | 0.9 |
| | *Hemisynodontis membranaceous* | Dry* | 8 | 2 | 30 | 25.0 | 15.0 | 3.8 |
| | *Synodontis clarias* | Dry | 29 | 2 | 15 | 6.9 | 7.5 | 0.5 |
| | | Rainy | 40 | 2 | 5 | 5.0 | 2.5 | 0.1 |
| | *S. eupterus* | Dry | 30 | 4 | 170 | 13.3 | 42.5 | 5.7 |
| | | Rainy | 20 | 2 | 30 | 10.0 | 15.0 | 1.5 |
| | *S. gobroni* | Dry | 68 | 2 | 24 | 2.9 | 12.0 | 0.3 |
| | | Rainy | 92 | 1 | 8 | 1.1 | 8.0 | 0.1 |
| | *S. ocellifer* | Dry | 10 | 3 | 600 | 30.0 | 200.0 | 60 |
| | | Rainy | 20 | 1 | 450 | 5.0 | 450.0 | 22.5 |
| | *S. schall* | Dry | 20 | 6 | 20 | 30.0 | 3.3 | 1.0 |
| | | Rainy | 10 | 4 | 10 | 40.0 | 2.5 | 1.0 |
| ***W. youdeowii*** | *S. clarias* | Dry | 29 | 3 | 15 | 10.3 | 5.0 | 0.5 |
| | | Rainy | 40 | 2 | 5 | 5.0 | 2.5 | 0.1 |
| | *S. eupterus* | Dry | 30 | 2 | 704 | 6.7 | 352.0 | 23.5 |
| | | Rainy | 20 | 1 | 296 | 5.0 | 296.0 | 14.8 |
| ***W. kainji*** | *S. budgetti* | Dry | 20 | 2 | 11 | 10.0 | 5.5 | 0.6 |
| | | Rainy | 10 | 1 | 4 | 10.0 | 4.0 | 0.4 |
| | *S. clarias* | Dry* | 29 | 4 | 10 | 13.8 | 2.5 | 0.3 |
| | *S. eupterus* | Dry* | 30 | 3 | 82 | 10.0 | 27.3 | 2.7 |
| | *S. sorex* | Dry | 20 | 2 | 18 | 10.0 | 9.0 | 0.9 |
| | | Rainy | 12 | 2 | 2 | 16.6 | 1.0 | 0.2 |
| ***Procamallanus laeviconchus*** | *S. clarias* | Dry* | 29 | 3 | 46 | 10.3 | 15.3 | 1.6 |
| | *S. eupterus* | Dry | 30 | 1 | 6 | 3.3 | 6.0 | 0.2 |
| | | Rainy | 20 | 2 | 12 | 10.0 | 6.0 | 0.6 |
| | *S. nigrita* | Dry | 40 | 1 | 8 | 2.5 | 8.0 | 0.2 |
| | | Rainy | 40 | 2 | 12 | 5.0 | 6.0 | 0.3 |
| | *S. schall* | Dry | 20 | 2 | 7 | 10.0 | 3.5 | 0.4 |
| | | Rainy | 10 | 2 | 3 | 20.0 | 1.5 | 0.3 |
| | *S. xiphias* | Dry | 5 | 2 | 20 | 40.0 | 10.0 | 4.0 |
| | | Rainy | 25 | 4 | 7 | 16.0 | 1.8 | 0.3 |

** No parasites were recovered in the rainy season*

The conditions (higher contact between infective stage of parasite and fish host, crowding and slow flow) existing in the dry season in lotic habitats are to a large extent replicated in static culture systems and in lentic habitats and explain the high prevalence of parasites in fish from these habitats (Onwuliri and Mgbemena, 1987).

The high infection of the mochokids with species of *Wenyonia* suggests their importance in the fishery of the group. *W. synodontis* is perhaps more important than *W. youdeoweii* and *W. kainji* as it parasitizes a very wide spectrum of the mochokids. The stomach contents – mainly aquatic insect larvae, plant matter and mud with associated load of worms, including oligochaete worms – of the mochokids, especially *S. eupterus, S. schall, S. ocellifer, S. sorex* and *S. clarias*, reveal the presence of intermediate hosts of caryophyllaeid tapeworms (HMGE, pers. obs.). Though no observable damage was evident even in heavily parasitized *S. eupterus* and *S. ocellifer*, the fact that they were weak, moved sluggishly and died earlier than others indicates stress, which possibly stems from some injury, including impairment of physiological functions. There is need for a more penetrating investigation to determine whether weakness and death were due to opportunistic infections, disruption of vital physiological processes or hitherto undetected physical damage. Such investigation may also determine why no discernible damage occurs in the stomach mucosa to which *P. laeviconchus* attaches by its buccal capsule, even in heavy infections. Engorgement of blood by *P. laeviconchus* may lead to anaemia in heavily parasitized fish.

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# FISHERIES STATUS AND FISHING GEARS OF A WEST AFRICAN ARID ZONE LAKE

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**ABSTRACT**

***The lake Alau fisheries of the North East zone of Nigeria, Maiduguri contains relatively low fish species exploited artisanally by 365 fishers in all the sampled stations. Station 4 has the highest mean number of fishers (275 ± 21.30) while station 2 has the least mean number (35 ± 9.30). A total of one thousand, eight hundred and thirty one (1831) fish specimens were sampled. The major fish species were from the families; Characidae, Cichlidae, Mochokidae, Schilbeidae, Mormyridae, Cyprinidae, Clariidae, Bagridae, Centropomidae, Polypteridae and Osteoglossidae. The most dominant family observed was the Cichlidae. The species composition recorded was 28 in all the studied stations. Heterotis niloticus was dominant with mean number of 40.4 ± 1.1.28 and percentage composition of 11.2 %. Sex ratio of 1 male to 0.95 female was recorded for Heterotis niloticus. Multi gears fishing were observed. The percentage composition of fishing gears observed were in the order of clap net (33 %), cast net (20 %), gill net (20 %), long line (11 %), Mali trap (15 %) and seine net (1 %). There was a steady increase in number of fishers employing nets of various kinds. Lake Alau fisheries can be rated as over fished due to the pressure of fishers and the quality of their catches.***

**Keywords:** Arid zone, Fisheries resources, Fishing gears, *Heterotis niloticus*

## INTRODUCTION

The tropical freshwater fish fauna of Nigeria contains many fish species exploited commercially or artisanally. The fish fauna of Nigeria waters has been studied more in comparison to those of other tropical nations. Fish landing from capture fisheries has over the years been recording a tremendous decline with no regards to the ever increasing world population (Anpe, 2001).

Much work has been reported on fish composition and fisheries of many tropical water, for example South America waters (Lowe McConnell, 1994 and Junk, 1984) and Africa inland waters (Welcome, 1974, 1979) among others. For the African lakes, Cambray (1990) reported that many of these studies were centered on the exploitable adults and relatively large fish species.

Status on the biological and economic importance of lake fisheries includes those of Okedi (1971), Oguzie (1982) and Beadle (1981). A combination of circumstances makes these fishes uniquely vulnerable to over exploitation due to habitat degradation or simply poor management. Ochumba and Manyale (1992) observed that freshly caught fish are the most delicious, a treaty for royalty among the fishing tribes, and secondly, a strong consumers preference, which make them the most valuable prized fishes.

In Nigeria, Onwuka (2001) reported that the issues of increased fish production among the artisanal fishers have been of great concern to the government, local organization and fisheries experts globally. The fish products in lake Alau, Borno State of Nigeria, play important role in meeting fish protein need of Borno State and some other states in the country contributing above 25 % of the total domestic fish supply in Nigeria.

Fishery management requires a good knowledge of fishing gears. There is great divergence in the efficiency of different forms of fishing gear, in their adaptability to certain conditions, and in their desirability for specific job (Eyo and Akpati, 1995).

Traditional fishing arts have been developed over the years to adapt to local body conditions; the species of fish desired and targeted size. The most successful fishing methods of an area or a region are those that have stood the test of time (Eyo and Akpati, 1995).

There have been very few studies on aspects of the fisheries of lake Alau. These studies were limited to the preliminary investigation on the fisheries and catch assessment survey (Bankole, 1994), parasites of *Clarias gariepinus* (Idowu, *et. al.,* 2002) and limnological characteristics (Idowu, 2004), physico-chemical characteristics (Idowu, *et. al.,* 2004) of the lake.

Lake Alau is one of the major tourist attraction sites of Borno State and is held in great esteem both by tourist and the indigenes. Also being the largest and nearest water body to Maiduguri metropolitan that supplies domestic water to various localities, the management of the Borno River Basin Development Authority were able to create some visible fisheries impact around the water body with good roads for easy access by tourist, fishers and their patronizers (CBDA, 1984).

## MATERIALS AND METHODS

**The Study Area:** Lake Alau was created in 1985 by damming river Ngadda about 22 km from Maiduguri, along Maiduguri – Bama road. It is located between latitude $13^0$N and $14^0$N and longitude $12^0$E and $13^0$E. It has a total surface area of 56 $km^2$. Being located in the North-East arid zone, the climate is Sahelian with three distinct seasons. The rainy season starts from July to October, cold dry harmattan winds from November to February and a very hot dry season with extreme temperature of about 42 $^0$C from March to June. It has a mean depth of 10 m, with an effective storage capacity of 54,000 $cm^3$ (CBDA, 1986; Bankole, 1994; Idowu, *et. al,* 2002 and Idowu, 2004). The water temperature values ranged from 23 $^o$C to 27 $^o$C, depth varied from 2.85 m to 17.23 m, water current was between 19.62 cm/sec and 26.71 cm/sec, Secchi disc transparency ranged from 0.26 m to 0.42 m, pH varied from 6.59 to 7.29, conductivity was between 118.41 homs/cm and 131.45 homs/cm, free $CO_2$ ranged from 2.55 mg/l to 3.06 mg/l, Biochemical oxygen demand (BOD) are between 4.30 mg/l and 5.31 mg/l and nitrate-nitrogen concentration are between 30.30 mg/l and 47.0 mg/l. Generally, the physico-chemical characteristics of lake Alau fall within the productive values for tropical lakes. This strongly indicates that the lake is unpolluted.

**Assessment of Fisheries Status and Fishing Gears:** The study was carried out for over a 12 month period running from September 2001 to August 2002. The lake was demarcated into five stations. The stations were sampled twice monthly for ichythyofauna. Sampling was by (a) direct observations and record of the fish species, fishers and fishing gears used and (b) constructed interviews of the fishers at their landing sites. All the fish species landed were counted and recorded. Selected fish species were preserved in ice and labeled for laboratory identification and analysis (Bankole, *et al.,* 1994). Identification of the fish species was according to Reed, *et al*. (1967), Trewaves, *et al.* (1972) and Teugels, *et al.* (1992). Voucher specimens preserved in normalized 10 % formalin were deposited in the Museum of Natural History, Department of Zoology, University of Nigeria. The fish assemblage structure, species abundance and percentage composition were calculated. Species richness (Odum, 1971; Peck and Forsyth, 1982) and diversity index (Shannon, 1948) were also calculated.

## RESULTS

The total number of fish specimen studied was 1831 out of which 375 were from Station 1, 365 from station 2, 374 from station 3, 373 from Station 4 and 353 from 5. The highest fish population was recorded in the months of January and February. The sex ratio during the study period was 1 male to 0.95 female. Twelve fish families were identified from the five stations thus: Characidae, Cichlidae, Mochokidae, Schilbeidae, Mormyridae, Cyprinidae, Clariidae, Bagridae, Centropomidae, Polypteridae, Malapteruridae and Osteoglossidae (Table 1). The percentage composition of the fishes family indicated that the cichlids were the most abundant followed by the clariids in all the stations sampled.

**Table 1: Percentage composition of each family per station**

| FAMILY | STATION | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **Cichlidae** | 17 | 17 | 16 | 16 | 17.2 |
| **Clariidae** | 14.4 | 14 | 13 | 11 | 14.7 |
| **Morymyridae** | 10 | 12.6 | 11 | 10.7 | 13 |
| **Characidae** | 8.5 | 11 | 1 | 4.8 | 4.5 |
| **Mochokidae** | 9.3 | 7.9 | 11 | 9.7 | 9.1 |
| **Osteolgossidae** | 8 | 7 | 11 | 14.7 | 14 |
| **Schilbeidae** | 7 | 6.7 | 7.5 | 5.4 | 6.2 |
| **Bagriidae** | 6.4 | 6 | 5 | 7 | 4.2 |
| **Cyprinidae** | 5 | 5.1 | 4.3 | 5.6 | 7.6 |
| **Malapteruridae** | 5.9 | 5.1 | 4 | 6.7 | 2.8 |
| **Polypteridae** | 4.8 | 3.9 | 5.9 | 4.3 | 2.8 |
| **Centropomidae** | 3.7 | 2.8 | 4 | 4.3 | 2.8 |

The family Centropomidae had the least percentage composition in all the stations. A total of 28 centropomid fish species were recorded from all the stations. Table 2 showed the mean abundance and the percentage composition of each species as pooled from all the sampled stations. *Heterotis niloticus* dominated the overall catch with the highest mean value of 40.4 ± 12.78 with the percentage composition of 11.2 %. This was followed by *Hemichromis fasciatus* (18.6 ± 0.59 mean abundance and 5.1 percentage composition). Other records were *Sarotherodon galilaeus* (18.2 ± 2.05 mean abundance and 5.0 percentage composition), *Malapterus electricus* (18.0 ± 5.87 mean abundance and 5.0 percentage composition), *Polypterus senegalensis* (16.0 ± 4.47 mean abundance and 4.4 percentage composition), *Schilbe mystus* (14.6 ± 3.58 mean abundance and 4.0 percentage composition), *Clarias macromytax* (13.6 ± 2.07 mean abundance and 3.6 percentage composition), *Lates niloticus* (13.4 ± 2.41 mean abundance and 3.7 percentage composition) among others. The least species was *Hyperopsis bebe* (5.60 ± 1.51 mean abundance and 1.5 percentage composition). Homogeneous distribution of fish in all the sampled stations was observed (Table 3). The families Clariidae, Cichlidae and Morymyridae had the highest number of genera and species (four species each) while Mochokidae and Characildae had three species, Schilbeidae, Bagridae and Cyprinidae had two species and Centropomidae, Polypteridae, Malapteruridae and Osteoglossidae had only one species. Table 4 shows the assemblage parameters of the fish families in relation to stations. Diversity index of 0.64 was calculated for stations 2 and 5, 0.63 for station 1 and 0.62 for stations 3 and 4. The species richness was highest in station 5 (4.38). Other records were station 4 (4.28), stations 3 and 1 (4.27) and station 2 (4.30). The Shannon's index showed that stations 1 and 4 had 1.04, followed by 1.03 in station 3 and station 5 had the least value of 0.998.

**Table 2: Means Abundance and percentage composition of fish species in lake Alau**

| Species | Means Abundance | % Composition |
|---|---|---|
| ***Heterosis niloticus*** | 40.4 ± 12.78 | 11.2 |
| ***Hemichromis fasciatus*** | 18.6 ± 0.59 | 5.1 |
| ***Sarotherodon galilaeus*** | 18.2 ± 2.05 | 5 |
| ***Malapterus electricus*** | 18.0 ± 5.87 | 5 |
| ***Polypterus senegalensis*** | 16.0 ± 4.47 | 4.4 |
| ***Schilbe mystus*** | 14.6 ± 3.58 | 4 |
| ***Clarias macromytax*** | 13.6 ± 2.07 | 3.6 |
| ***Lates niloticus*** | 13.4 ± 2.41 | 3.7 |
| ***Bagrus bayad*** | 13.2 ± 2.28 | 3.6 |
| ***Mormyrus delicious*** | 13.2 ± 2.17 | 3.6 |
| ***Synodontis nigrita*** | 12.8 ± 2.17 | 3.5 |
| ***Clarias gariepinus*** | 12.6 ± 3.13 | 3.4 |
| ***Oreochromis niloticus*** | 12.0 ± 2.51 | 3.3 |
| ***Mormyrus rume*** | 12.0 ± 2.45 | 3.3 |
| ***Clarias anguillaris*** | 12.0 ± 2.0 | 3.3 |
| ***Labeo couble*** | 11.8 ± 5.40 | 3.3 |
| ***Alestes nurse*** | 11.6 ± 5.03 | 3.2 |
| ***Gnathonemus petersii*** | 11.4 ± 3.91 | 3.1 |
| ***Synodontis filamentus*** | 11.4 ± 2.97 | 3.1 |
| ***Tilapia zilli*** | 10.0 ± 4.69 | 2.8 |
| ***Synodontis batensoda*** | 10.0 ± 1.41 | 2.8 |
| ***Europius niloticus*** | 9.20 ± 0.84 | 2.5 |
| ***Heterobranchus bidorsalis*** | 8.80 ± 3.19 | 2.4 |
| ***Alestes dentex*** | 8.60 ± 4.04 | 2.4 |
| ***Labeo senegalenis*** | 8.60 ± 3.13 | 2.4 |
| ***Chrysicthys awatus*** | 8.20 ± 2.49 | 2.3 |
| ***Hydrocynus forskali*** | 6.0 ± 3.08 | 1.7 |
| ***Hyperopisus bebe*** | 5.60 ± 2.51 | 1.5 |

The fishing gears identified during the study period included baited and unbaited Malian traps which constitute about 15 % of the total gears recorded. Clap net had the highest percentage occurrence of 33 %. Seine nets were found to have the least occurrence of 1 %. Figure 1 shows the percentage number of fishing gears recorded in lake Alau. Fish were caught more by clap nets during the dry and the flood seasons. The total number of fishers observed per station varies drastically. Station 4 has the highest number of fishers (275) and fishing boat (155) followed by Station 1 which had 60 fishers and 50 fishing boats (Table 5). Fishing intensity was high during the non flooding periods than the flooding periods. Among the fishers both genders were involved in the fisheries with the male gender dominating the pre and fish harvesting sectors and the female gender dominating the post harvest preservation and marketing sectors.

## DISCUSSION

The species richness of each of the stations studied in Lake Alau compares favourably with those of Tiga reservoirs (Bankole, 1991), Tatabu flood plain (Daddy, *et al.,* 1991) and lake Busumtwi, Ghana (Whyte, 1975). In an earlier report, Bankole (1994) recorded 19 fish species in lake Alau. Our report of 28 fish species for the lake is an improvement over the 19 species recorded for 1994 and may be attributed to the sampling techniques adopted and the duration of sampling. Lake Alau showed a preponderance of cichlid species. In each of the station there were more cichlid than fishes from other families. Four species *Sarotherodon galilaeus. Hemichromis fasciatus, Oreochromis niloticus* and *Tilapia zilli* were

**Table 3: Species distribution per station in Lake Alau**

| SPECIES | STATION | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **CICHLIDAE** | | | | | |
| ***Sarotherodon galilaeus*** | + | + | + | + | + |
| ***Hemichromis fasciatus*** | + | + | + | + | + |
| ***Oreochromis niloticus*** | + | + | + | + | + |
| ***Tilapia zilli*** | + | + | + | + | + |
| **MORMYRIDAE** | | | | | |
| ***Mormyrus delicious*** | + | + | + | + | + |
| ***Mormyrus rume*** | + | + | + | + | + |
| ***Gnathonemus petersii*** | + | + | + | + | + |
| ***Hyperopisus bebe*** | + | + | + | + | + |
| **MOCHOKIDAE** | | | | | |
| ***Synodontis batensoda*** | + | + | + | + | + |
| ***Synodontis nigrita*** | + | + | + | + | + |
| ***Synodontis filamentus*** | + | + | + | + | + |
| **CLARIIDAE** | | | | | |
| ***Clarias macromytax*** | + | + | + | + | + |
| ***Clarias anguillaris*** | + | + | + | + | + |
| ***Clarias gariepinus*** | + | + | + | + | + |
| ***Heterobranchus bidorsalis*** | + | + | + | + | + |
| **CHARACIDAE** | | | | | |
| ***Alestes dentex*** | + | + | + | + | + |
| ***Alestes nurse*** | + | + | + | + | + |
| ***Hydrocynus forskali*** | + | + | + | + | + |
| **SCHILBEIDAE** | | | | | |
| ***Schilbe mystus*** | + | + | + | + | + |
| ***Europius niloticus*** | + | + | + | + | + |
| **BAGRIDAE** | | | | | |
| ***Bagrus bayad*** | + | + | + | + | + |
| ***Chrysicthys awatus*** | + | + | + | + | + |
| **CYPRINIDAE** | | | | | |
| ***Labeo couble*** | + | + | + | + | + |
| ***Labeo senegalenis*** | + | + | + | + | + |
| **CENTROPOMIDAE** | | | | | |
| ***Lates niloticus*** | + | + | + | + | + |
| **POLYPTERIDAE** | | | | | |
| ***Polypterus senegalensis*** | + | + | + | + | + |
| **MALAPTERURIDAE** | | | | | |
| ***Malapterus electricus*** | + | + | + | + | + |
| **OSTEOGLOSSIDAE** | | | | | |
| ***Heterosis niloticus*** | + | + | + | + | + |

evenly distributed in all stations. Their abundance is attributed to their adaptation to lentic aquatic environmental qualities, productivity of the lake and changes in hydrological regime of the lake (Idowu, *et al.,* 2004). Dun (1989) reported that cichlids apparently requires swam habitat with plenty of organic matters for swamping and feeding of fry. They must have abundant food to thrive upon as the tendencies for most cichlids to breed early during the floods at the margin of the advancing water have been demonstrated (Dun, 1989). Their prolific breeding status couple with parental care can also contribute to the dominance of cichlids in the lake.

**Table 4: Assemblage parameters of the fish families in relation to stations in lake Alau**

| STATIONS | DIVERSITY INDEX $M/N^{½}$ | SPECIES RICHNESS | SHANNON INDEX |
|---|---|---|---|
| **1** | 0.63 | 4.27 | 1.04 |
| **2** | 0.64 | 4.30 | 1.02 |
| **3** | 0.62 | 4.27 | 1.03 |
| **4** | 0.62 | 4.28 | 1.04 |
| **5** | 0.64 | 4.38 | 0.98 |
| **Pooled data** | 0.28 | 3.68 | 1.03 |

In terms of relative abundance and species composition and *Heterotis niloticus* clearly dominated other fish species. The vast reed vegetation that is found along the fringes of the lake affords these species a good breeding and nursery ground as well as cover from predators. The *Clarias* species that were found includes *Clarias gariepirius, C. anguillaris* and *C. macromystax*, their sizes were found to be smaller due to the mesh size selection of the fishing gears. The relative abundance and species percentage composition of *Hyperopisus bebe* was very low when compared with other species. King (1989) and Udoidiong and King (2000) reported the ability for mormyrids to adapt to fluctuations of hydrometeorological variables accounted for their occurrence and that their success could also be attributed to presence of suitable habitats.

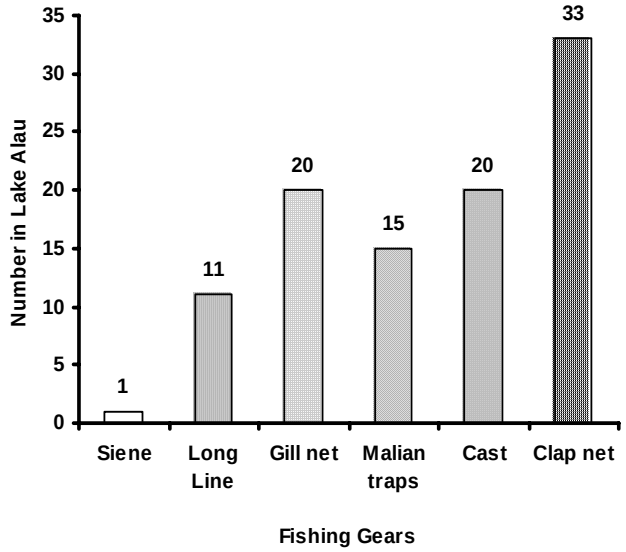


**Figure 1;The number of fishing gears in lake Alau**

**Table 5: Mean number of fishers and fishing boats observed at each station in lake Alau**

| STATION | NUMBER OF FISHERS | NUMBER OF FISHING BOAT |
|---|---|---|
| 1 | 60 ± 3.7 | 50 ± 1.52 |
| 2 | 35 ± 4.25 | 15 ± 1.02 |
| 3 | 55 ± 4.25 | 50 ± 2.50 |
| 4 | 275 ± 10.30 | 155 ± 11.25 |
| 5 | 55 ± 2.20 | 30 ± 1.25 |

Species richness and diversity was observed to increase in all stations. There were no significant differences ($P > 0.05$) between the calculated values in all the stations. This may be attributed to increased living space leading to increased number of microhabitats. According to Odum (1971) and Udoidiong and King (2000) diversity is higher in old communities than newly established ones. Lake Alau, over the past twenty has attended the status of being classified as a lake with old communities. The impacts of high fishing levels on the species are mentioned in Bankole, *et. al* (1994). Generally, there has been decline in abundance of medium and large fish species due to the high fishing effort. The fisheries of lake Alau can be considered over-fished. Over fishing has brought about changes in species composition and this have important implication for the fisheries.

From this study, it was observed that the family *Clariidae, C. gariepirius, C. anguillaris* and *C. macromystax* which were highly valued has been greatly reduced and has been replaced by less valued herbivorous species of cichlids. Estes (1979), Meido and Carracsco (2000) observed that heavy exploitation could lead to shift in maturity of many species. The same situation was observed in this study. Increase in the number of fishers exploiting the fish resources of the lake led to reduction in catch per unit effort.

Visual observation of the catches from the fishers revealed that juveniles caught were wasted by the fishers using gears with small mesh size. Eyo and Akpati (1995) reported that fishing-out has negative consequences and was capable of killing the fishery. Furthermore, the numbers of the fishers fishing in the lake far exceeded the FAO recommendation for tropical lakes. Station 4 has the highest number of fishers (275) when compared to other stations studied. Fishers had no license, thus the fishery was open to all and no management regulations were enforced.

The dominance of the clap net as the major gear in all stations that it is the easiest and the cheapest gear that could be afforded by the fishers whose livelihood depend on these resources. The implication of this is that harvest will be greater than the natural rate at which these species can replenish themselves. There was no fish management programme through restocking of over exploited species. Significant increase in yield can be obtained from lake Alau fishery, if gears with large mesh sizes are introduced and enforced and small mesh gears banned as a rehabilitative measure. Furthermore, the restocking and introduction of new species into the lake should be considered.

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