

## Biochemical Responses of Yankasa Sheep to Experimental *Fasciola gigantica* Infection in Zaria, Nigeria

<sup>1</sup>J.Y. Adama, <sup>2</sup>O.J. Ajanusi, <sup>3</sup>N. Chiezey and <sup>2</sup>A. Lawal

<sup>1</sup>Department of Animal Production, Federal University of Technology, P.M.B. 65 Minna, Niger State, Nigeria

<sup>2</sup>Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, A.B.U. Zaria

<sup>3</sup>National Animal Production Research Institute, Shika, A.B.U Zaria

**Abstract:** A study was conducted to determine the biochemical responses of Yankasa ewes to experimental *Fasciola gigantica* infection for a period of 10 weeks. A total of 12 Yankasa ewes were used in the experiment and were obtained from the Reproduction Unit of the National Animal Production Research Institute, Shika-Zaria, Nigeria. 2 weeks baseline pre-infection data were collected and the ewes were later divided into two groups of infected and controls. The six animals in the infected group were each orally inoculated with 1200 *Fasciola gigantica* metacercariae and monitored for a period of 16 weeks. The pathogenic effects of *Fasciola gigantica* infection began to manifest as of 9<sup>th</sup> week post infection through clinical symptoms of bottle jaw, emaciation, depression and pallor of mucus membrane among the infected group. Eggs were demonstrated in faeces of the infected animals at 12<sup>th</sup> week post-infection. The pathogenic effect was also evident based on fluke biomass, mean fluke length and width, degree of liver damage, serum AST, ALT, ALP and electrolytes responses. There was an increased level of AST from the 4<sup>th</sup> week post-infection indicating greater damage to the liver parenchyma while the levels of ALT began to rise at the 9<sup>th</sup> week post-infection among the infected group indicating epithelial damage in the bile ducts. The findings of this study reveals the diagnostic potentials of liver enzymes in the early detection of ovine fasciolosis.

**Key words:** Biochemical responses, diagnostic potentials, *Fasciola gigantica*, Yankasa ewes, Nigeria, pathogenic effects

### INTRODUCTION

Fasciolosis which is an infection caused by either *Fasciola gigantica* or *Fasciola hepatica* is a major parasitic disease of livestock with over 700 million production animals at risk of the infection and world wide economic losses estimated at >US and 3.2 billion per annum (Spithill *et al.*, 1999). In temperate regions, *Fasciola hepatica* commonly infects sheep and cattle while in tropical regions *Fasciola gigantica* infects sheep, cattle buffalo and goats.

In Nigeria, small ruminants represent a very important national resource. Sheep are reared primarily for meat and play significant socio-economic roles in the lives of rural dwellers (Abdulmojeed and Isa, 2011). "Yankasa" breed is the predominant breed of sheep in the Guinea Savanna region of Nigeria (RIM, 1992) within which this study is been carried out.

The detection of fasciolosis infections in ruminants relies on the microscopic observation of fasciola eggs in the faeces of infected animals. However, early diagnosis by coprological examination is not possible because eggs are not found in the faeces until 10-12 weeks after infection, when flukes reach maturity and when hepatic injury has been pronounced (Urquhart *et al.*, 1996). Hence the need for diagnostic techniques other than faecal examination for the diagnosis of fasciolosis (Ahmed *et al.*, 2006). Many sheep breeds are susceptible to fasciola infection including most sheep selected for enhanced production traits such as wool production in merino sheep (Raadsma *et al.*, 2006). Similarly, research evidences exist that fasciolosis infection is highly prevalent in the study area among ruminant livestock (Schillhorn Van Veen *et al.*, 1980; Ulayi *et al.*, 2005). Therefore, this current study is aimed at determining the biochemical responses of Yankasa ewes to this disease condition which could be of tremendous assistance in the early detection of ovine fasciolosis in the study area.

## MATERIALS AND METHODS

**Experimental and animals:** Twelve (12) Yankasa ewes obtained from Reproduction unit of the National Animal Production Research Institute, Shika-Zaria, Nigeria, between 10-12 months were used. The experiment was conducted within a period of four months (April-July, 2010) at the Animal Reproduction unit of the National Animal Production Research Institute, Shika-Zaria, Nigeria. The animals each received concentrate feed at 300 g per ewe per day (Akinbamijo *et al.*, 1993). Hay, water and salt licks were given *ad libitum*. Baseline pre-infection data were collected and the ewes were ranked on the basis of live weight and body condition score (Ahmed *et al.*, 2006) and randomly assigned to two treatment groups.

**Isolation and preservation of infective materials:** *Fasciola gigantica* metacercariae were obtained from naturally infected *Lymnaea natalensis* snails collected at A.B.U Zaria dam and other small streams in Zaria environs.

Collected snails were taken to Departmental parasitology laboratory, Faculty of Veterinary Medicine, A.B.U Zaria where they were crushed in water using petridishes and snail tissues removed. The swimming cercariae were viewed under a microscope and left to attach to the petridish; after which they were left in water in petridish for 3 days at room temperature to become infective (Ajanusi, 1987). Just before infections, metacercariae were examined under stereomicroscope to ascertain their viability.

**Animal infection:** The 12 animals were randomly divided into two groups of six animals each representing infected and control group. Each of the animals in the infected group were inoculated orally with 1200 *Fasciola gigantica* metacercariae as described by instead of (Ajanusi, 1987).

### Post infection monitoring:

**Parasitology:** 5 g faecal samples were collected from the rectum of each animal every week as from week 1 post-infection and fluke egg count was performed using sedimentation technique as described by Urquhart *et al.* (1996).

**Live weight changes:** Live weight changes were monitored bi-weekly for a period of 10 weeks after 2 weeks pre-infection monitoring.

**Serum enzyme and electrolyte assay:** 5 mL of blood was collected in test tubes not containing anticoagulants. There after, the serum was obtained for liver enzymes assay and for the determination of serum electrolytes.

Liver enzymes and electrolytes such as sodium, potassium, phosphorus, chloride, Bicarbonate, urea and albumin were assessed spectrophotometrically using (Bayer Express Plus Clinical Chemistry Analyzer).

**Neecropsy:** To recover the immature flukes from the parenchyma, the liver was cut into small pieces and suspended in physiological saline at room temperature and it was then gently squeezed. The suspension was strained and the flukes recovered were counted and recorded. Ten intact worms were randomly picked from each of the dead sheep and their length and width was measured with transparent ruler (Egualle *et al.*, 2009).

**Statistical analysis:** Statistical analysis was carried out using SAS (2002). The biochemical parameters of the infected group were compared with those of the controls. Data is expressed as mean  $\pm$  standard error of mean. Values of  $p < 0.05$  were considered significant.

## RESULTS

**Clinical observations and parasitology:** Clinical symptoms such as bottle jaw, emaciation, depression and pallor of mucus membrane were seen as of 9<sup>th</sup> week post-infection in the infected group. The infected sheep started egg shedding at 12<sup>th</sup> week post-infection with a high mean Egg per Gram count (EPG) of  $530 \pm 96.44$  obtained at the 12<sup>th</sup> and 13<sup>th</sup> weeks post-infection respectively.

**Mean live weight changes:** The Cumulative changes in body weight over the duration of the experiment are shown in Fig. 1. All animals gained weight during the entire experimental period to a certain degree as a consequence of being on *ad libitum* feed intake and at a young growing age. However, there was a significant drop in the mean weight of the infected animals from the 6<sup>th</sup> week post-infection where as there was a progressive increase in the mean weight of the controls throughout the period of the experiment.

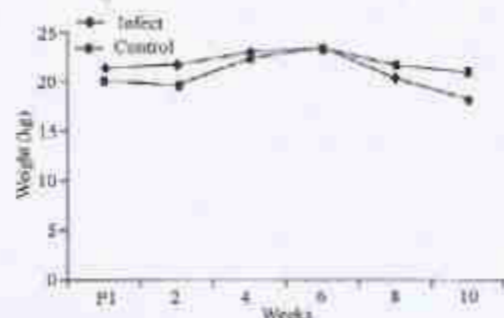


Fig. 1: Weight changes obtained from *Fasciola gigantica* infected yankasa sheep and their controls.



Table 1: Serum alanine amino transferase (ALT) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variables (WK)	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	12.58±0.79	11.33±0.48	1.35	0.211	NS
P <sub>2</sub>	11.83±1.19	11.83±1.19	0.60	0.561	NS
P <sub>4</sub>	12.16±0.83	10.83±0.79	1.16	0.271	NS
P <sub>6</sub>	15.16±1.35	11.83±0.79	2.13	0.06	NS
P <sub>8</sub>	10.67±0.33	10.33±0.33	0.71	0.49	NS
P <sub>10</sub>	13.50±0.62	10.83±0.54	3.24	0.01	*
P <sub>12</sub>	10.83±0.48	10.50±0.50	0.48	0.64	NS
P <sub>14</sub>	10.50±2.13	10.33±0.49	0.48	0.64	NS
P <sub>16</sub>	12.00±2.41	10.33±0.49	0.68	0.51	NS
P <sub>18</sub>	15.33±0.49	10.47±0.65	6.30	<0.001	**
P <sub>20</sub>	16.83±0.60	10.50±0.56	7.69	<0.0001	**

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 2: Serum aspartate amino transferase (AST) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variables (WK)	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	74.25±3.48	74.58±2.31	-0.08	0.94	NS
P <sub>2</sub>	75.33±3.28	76.67±5.20	-0.22	0.83	NS
P <sub>4</sub>	73.16±6.47	72.50±4.08	0.09	0.93	NS
P <sub>6</sub>	93.67±3.06	89.00±4.97	0.08	0.44	NS
P <sub>8</sub>	99.33±1.20	70.33±2.54	10.33	<0.0001	**
P <sub>10</sub>	99.13±0.40	70.67±4.08	6.94	<0.0001	**
P <sub>12</sub>	99.33±0.88	70.67±2.59	10.48	<0.0001	**
P <sub>14</sub>	97.83±1.74	70.33±2.88	8.17	<0.0001	**
P <sub>16</sub>	62.83±19.8	970.67±2.5	38.17	<0.0001	**
P <sub>18</sub>	94.16±1.04	70.00±3.02	7.56	<0.0001	**
P <sub>20</sub>	94.50±0.85	71.50±3.28	6.78	<0.0001	**

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 3: Serum alkaline phosphatase (ALP) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variable	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	20.41 ± 3.05	21.33 ± 2.18	-0.24	0.81	NS
P <sub>2</sub>	20.83 ± 3.67	23.50±2.26	-0.62	0.55	NS
P <sub>4</sub>	20.00 ± 3.34	19.16±5.32	0.13	0.89	NS
P <sub>6</sub>	24.16±1.45	18.33±0.95	3.36	0.007	*
P <sub>8</sub>	26.00±1.77	20.67±2.46	1.76	0.12	NS
P <sub>10</sub>	30.83±2.56	21.00±2.50	2.75	0.021	*
P <sub>12</sub>	26.83±1.85	22.50±1.96	1.61	0.14	NS
P <sub>14</sub>	31.16± 1.10	22.00 ±1.80	4.32	0.001	**
P <sub>16</sub>	34.00±0.45	22.50±2.04	5.49	0.0003	**
P <sub>18</sub>	26.83±1.72	23.50±2.34	4.58	0.001	**
P <sub>20</sub>	37.67± 1.89	23.67± 2.26	4.25	0.0008	**

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 4: Serum albumin levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variable	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	3.17±0.27	2.98±0.18	0.60	0.57	NS
P <sub>2</sub>	3.10±0.41	2.93±0.24	0.35	0.73	NS
P <sub>4</sub>	3.23±0.14	3.01±0.14	1.07	0.31	NS
P <sub>6</sub>	3.20±0.18	3.38±0.11	-0.085	0.41	*
P <sub>8</sub>	2.95±0.07	2.62±0.54	0.61	0.55	NS
P <sub>10</sub>	2.37±0.05	3.15±0.14	5.10	0.0005	*
P <sub>12</sub>	2.40±0.03	3.10±0.13	-4.79	0.0007	NS
P <sub>14</sub>	2.52±0.10	3.13±0.12	-3.73	0.003	**
P <sub>16</sub>	2.47±0.15	3.38±0.13	-4.62	0.001	**
P <sub>18</sub>	2.30±0.04	3.33±0.15	-6.35	<0.0001	**
P <sub>20</sub>	1.7±0.06	3.02±0.12	-8.45	<0.0001	**

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 5: Serum potassium (K) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variables (WK)	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	4.56±0.27	4.70±0.27	-0.37	0.72	NS
1	4.65±0.48	4.93±0.48	0.42	0.69	NS
2	4.47±0.35	4.47±0.18	0.00	1.000	NS
3	4.60±0.24	3.90±0.42	1.45	0.18	NS
4	4.60±0.17	4.40±0.13	0.90	0.39	NS
5	4.63±0.44	4.31±0.18	0.67	0.62	NS
6	4.83±0.29	4.47±0.18	1.07	0.31	NS
7	4.83±0.24	4.21±0.27	1.69	0.12	NS
8	5.18±0.27	3.51±0.75	2.09	0.01	**
9	5.48±0.28	4.33±0.19	3.43	0.006	**
10	7.98±1.32	4.45±0.11	2.67	0.02	*

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 6: Serum sodium (Na) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variables (WK)	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	146.75±3.24	151.33±2.25	-1.67	0.130	NS
1	146.83±5.06	149.50±6.08	-0.34	0.741	NS
2	146.67±2.20	157.17±3.68	-2.45	0.031	NS
3	148.50±2.63	146.33±2.20	0.63	0.540	*
4	143.50±2.14	147.67±1.11	-1.73	0.120	NS
5	150.50±3.44	143.00±1.63	1.97	0.080	NS
6	145.83±2.37	146.17±2.12	-0.10	0.920	NS
7	154.50±1.61	145.67±1.73	3.75	0.004	*
8	150.50±2.46	142.33±1.89	2.63	0.030	*
9	152.00±1.79	143.50±1.28	3.86	0.003	**
10	152.50±2.15	144.00±1.00	3.58	0.008	**

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 7: Serum bicarbonate (HCO<sub>3</sub>) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variables (WK)	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	25.35±0.91	24.41±0.75	0.77	0.460	NS
1	22.83±1.38	24.83±1.17	-1.11	0.290	NS
2	27.83±1.94	24.00±0.93	1.78	0.120	NS
3	19.83±1.40	21.50±2.24	-0.63	0.541	*
4	21.33±1.58	25.67±2.04	-1.68	0.121	NS
5	19.17±1.17	21.83±0.91	-1.80	0.101	NS
6	20.17±2.44	27.00±3.46	-1.61	0.140	NS
7	20.17±1.62	22.50±1.52	-1.05	0.320	NS
8	18.67±1.49	22.33±1.56	-1.69	0.120	NS
9	19.00±1.97	20.67±0.80	-0.78	0.450	NS
10	22.00±2.21	20.00±0.45	0.89	0.390	NS

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 8: Serum chloride (Cl) levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E					
Variables (w k)	Infected	Control	t-value	p-value	LS
P <sub>0</sub>	102.33±0.86	100.58±1.74	0.90	0.390	NS
1	101.00±1.73	100.67±1.90	0.13	0.890	NS
2	103.67±2.28	100.50±2.06	1.03	0.320	NS
3	103.17±1.74	105.17±2.48	-0.66	0.520	NS
4	88.67±4.389	4.17±3.27	-1.0	0.300	NS
5	107.67±5.39	103.17±2.16	0.77	0.400	NS
6	88.00±4.899	3.67±3.57	-0.94	0.370	NS
7	111.67±2.86	102.50±1.20	2.95	0.014	NS
8	111.67±2.86	102.50±1.20	2.95	0.010	**
9	110.83±1.81	104.50±1.48	2.71	0.020	**
10	114.17±1.62	109.50±2.77	1.46	0.170	NS

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 9: Serum urea levels obtained from *Fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E		t-value	p-value	LS
Variables (WK)	Infected			
P <sub>0</sub>	27.58±1.42	27.00±2.67	0.22	NS
1	30.83±1.83	30.50±2.01	0.12	NS
2	24.33±1.20	23.50±2.06	0.22	NS
3	23.00±2.90	21.33±0.61	0.56	NS
4	22.50±2.99	21.00±0.68	0.49	NS
5	19.83±0.45	22.00±2.86	-0.76	NS
6	20.33±3.27	22.67±0.71	-0.70	NS
7	21.83±2.23	23.33±1.12	-0.58	NS
8	21.83±2.21	22.17±1.30	-0.31	NS
9	23.00±2.31	23.17±1.89	-0.06	NS
10	23.17±2.30	23.17±1.89	0.00	NS

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 10: Total Protein (TP) levels obtained from *fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E		t-value	p-value	LS
Variables (WK)	Infected			
P <sub>0</sub>	6.25±0.13	6.56±0.30	0.92	NS
1	6.27±0.14	6.68±0.26	1.33	NS
2	6.0±0.21	6.7±0.32	1.82	*
3	5.88±0.27	7.25±0.49	2.45	**
4	5.6±0.26	7.6±0.38	4.32	**
5	5.74±0.35	7.54±0.29	3.86	**
6	5.58±0.22	7.53±0.49	3.58	**
7	5.31±0.24	7.55±0.49	4.06	**
8	4.91±0.39	7.5±0.24	5.66	**
9	4.5±0.55	6.61±0.40	3.17	*
10	4.14±0.50	6.8±0.39	4.07	**
11	5.94±0.41	6.94±1.54	0.70	NS
12	2.7±1.20	7.2±0.40	3.32	**
13	2.0±0.70	7.2±1.40	3.62	**
14	2.72±1.74	7.88±1.75	2.93	*
15	2.65±1.68	7.93±0.1	3.14	*
16	2.01±2.6	6.98±0.49	3.67	*

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

Table 11: Eosinophil counts obtained from *fasciola gigantica* infected yankasa ewes and their controls

Mean±S.E		t-value	p-value	LS
Variables (WK)	Infected			
P <sub>0</sub>	1.16±0.60	1.75±0.30	0.88	**
1	2.5±0.34	0.16±0.16	6.14	**
2	4.1±1.02	1.0±0.41	2.71	*
3	3.7±1.14	0.6±1.22	2.64	*
4	3.3±0.23	0.3±1.22	2.36	**
5	0.5±0.22	0.3±0.42	0.42	NS
6	4.5±0.21	0.5±1.03	3.93	**
7	3.8±0.62	1.5±0.1	2.40	*
8	2.0±1.83	1.1±1.11	0.80	NS
9	0.00±0.01	1.0±0.61	1.58	NS
10	1.3±0.30	0.6±0.51	1.12	NS
11	0	0.5±0.5	1.00	NS
12	0	0	0	NS
13	0.00±0.80	0.8±0.8	0	NS
14	0	0	0	NS
15	0	0	0	NS
16	0	0	0	NS

P<sub>0</sub>: 2 weeks pre-infection record; ±: Standard error of mean; \*: Level of significance at 5% (p<0.05); \*\*: Highly significant (p<0.01); LS: Level of significance; NS: Not Significant (p>0.05)

**Serum enzyme and electrolyte assay:** The results of enzyme and electrolyte assay are shown in Table 1-9. The infected groups showed detectable increase in AST levels from the 4<sup>th</sup> week post-infection. Infected groups had

significantly elevated levels of AST compared to the controls (p<0.01). Elevated level of ALT, as an indicator of epithelial damage in the bile ducts, began to rise significantly (p<0.01) from the 9<sup>th</sup> week post-infection



among the infected group compared to the controls. There was a significant ( $p < 0.05$ ) rise in the levels of ALP among the infected group from the 7<sup>th</sup> week post-infection period. All serum electrolytes except bicarbonate and urea showed elevated levels from the 7<sup>th</sup> week post-infection. Serum Albumin levels began to drop significantly among the infected group from the 7<sup>th</sup> week post-infection while mean Total Plasma Protein (TPP) had a significant ( $p < 0.05$ ) drop in the infected group from the 2<sup>nd</sup> week to the end of the experiment (Table 10). Eosinophilia predominates at the early period of the experiment among the infected group (Table 11).

**Necropsy:** The mean total of immature worms recovered from the liver of the four infected animals was  $1129 \pm 12$  at 10<sup>th</sup>-12<sup>th</sup> week post-infection with a corresponding high percentage recovery ranging from 92 to 96%.

The mean length/width of flukes recovered from the livers of the infected dead sheep is shown in Fig. 2. Mean parasite length/width increase with time as the values obtained increased progressively from the 10<sup>th</sup>-12<sup>th</sup> week post-infection.

## DISCUSSION

Earlier studies have shown that the pathogenic effects of *Fasciola gigantica* infection in some breeds of sheep began to manifest as early as 7-10 weeks of infection resulting in death even with few parasites (Ahmed *et al.*, 2006; Ajanusi, 1987). This may be in contrast to other findings that *Fasciola gigantica* is slower to develop in ruminant hosts and takes greater than 14 weeks following infection to reach the bile ducts (Wiedosari and Copeman, 1990). In this current study, pathogenic effects of *Fasciola gigantica* infection began to manifest as of 9<sup>th</sup> week post-infection through clinical symptoms of bottle jaw, emaciation, depression and pallor of mucus membrane in some infected animals while mortalities were experienced between 10-12 weeks in four animals in the infected group. Similarly, there was a significant drop in the mean live weight of the infect group compared to the controls from the 6<sup>th</sup> week post-infection due to the effects of fluke burden.

Eggs were demonstrated in faeces of the infected animals at 12<sup>th</sup> week post-infection. The high mean egg count (EPG) of  $530 \pm 96.44$  obtained in this study showed a good measure of host-parasite relationship (Spithill *et al.*, 1997).

Based on fluke biomass, mean fluke length/width, degree of liver damage, serum AST, ALT, ALP and serum electrolytes responses, this experiment suggests that *Fasciola gigantica* infection among Yankasa sheep is evidently pathogenic in the first 10 weeks of infection. This is evident with the increased levels of AST from the 4<sup>th</sup> week post-infection indicating greater damage to the liver parenchyma (Meusen *et al.*, 1995). The levels of ALT were beginning to rise at the 9<sup>th</sup> week post infection

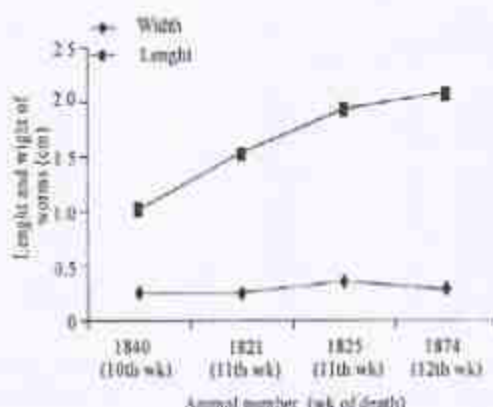


Fig. 2: Mean length/width of recovered worms from *Fasciola gigantica* infected yankasa sheep

indicating epithelial damage in the bile ducts (Chauvin *et al.*, 1995). Serum ALP is known to be excreted via the bile duct. Its elevation which was observed to be significant as from the 7<sup>th</sup> week post infection may have been synchronized with the arrival of flukes to the bile ducts constraining biliary clearance (Ahmed *et al.*, 2006). Elevated potassium, sodium and chloride levels of the infected sheep are suggestive of cellular damage (Eckert *et al.*, 1977). A drop in the level of albumin from the 7<sup>th</sup> week post-infection which correlates with the low total plasma protein levels may be associated with liver damage (Cheung and Jickman 2002). Similarly, a high rise of mean circulating eosinophil numbers at the early period of the experiment also correlates with the elevated levels of the liver enzymes depicting a greater degree of damage to the liver tissues.

The high percentage recovery (92-96%) of immature flukes from the dead animals compared with the infective dose given, suggests a uniform viability of parasite establishment, an indication that yankasa sheep have demonstrated low resistance to *Fasciola gigantica* infection (Ajanusi, 1987). A slower maturation of *Fasciola gigantica* is also manifested by the finding of smaller, immature flukes in the liver parenchyma of dead sheep as from the 10-12<sup>th</sup> week post-infection (Spithill *et al.*, 1999). The findings of this study revealed the potentials of liver enzymes in association with serum electrolytes being used as a measure of early warning signs in the detection of ovine *Fasciola gigantica* infection prior to the detection of eggs in the faeces of infected animals.

## ACKNOWLEDGMENT

This study was supported by the National Animal Production Research Institute, Ahmadu Bello University, Zaria Nigeria.

# REFERENCES

- Abdulmojeed, Y. and A.I. Isa, 2011. Multivariate Analysis of Morphostructural Characteristics in Nigerian Indigenous Sheep, *Intl. J. Anim. Sci.*, 10: f17do; 10.
- Ahmed, I.M., A.G. Ambali and S.S. Baba, 2006. Haematological and Biochemical responses of balami sheep to experimental *Fasciola gigantica* infection. *J. Food Agric. Env.*, 4(2): 71-74.
- Ajanusi, O.J., 1987. Life cycle and clinico-pathological effects of *Fasciola gigantica* in the sheep. M. Sc. Thesis, Ahmadu Bello University Zaria, pp: 4-117.
- Akinbami, O.O., A. Lahlon and S. Tembely, 1993. Fasciolosis and nutrient metabolism in pregnant sheep. Small Ruminant Research Net workshop.
- Chauvin, A., G. Bouvet, C. Boulard, 1995. Humoral and cellular immune responses to *Fasciola hepatica* experimental primary and secondary infection in sheep. *Intl. J. Parasitol.*, 25: 1227- 1241.
- Cheung, K. and P.E. Jickman, 2002. Liver Function. Clinical Chemistry: Theory Analysis Correlation. 4th Edn., Elsevier Sci. Inc., Chap. 27.
- Eckert, E.J., H. Keller, J. Hosli and U. Hess, 1977. Subaente fasciolose beim rind. *Schweiz. Arch. Tierheilkd.*, 119: 135-148.
- Eguale, T., C.A. Mekonnen and H. Chaka, 2009. Evaluation of Variation. In susceptibility of three Ethiopian sheep breeds to experimental infection with *Fasciola hepatica*. *smi Anim Res.*, Vol. 3, DOI: 10.1016/J. small rumres. 2008 12.017.
- Meusen, E., C.S. Lee, M.D. Rickard and M.R. Brandon, 1995. Cellular responses during liver fluke infection in sheep and its evasion by the parasite. *Parasit. Immunol.*, 17: 35-45.
- Raadsma, H.W., N.M. Kings Ford, T.V. Spitchill and D. Piedrafita, 2006. Host responses during experimental infection with *Fasciola gigantica* or *Fasciola hepatica* in Merino sheep. I. comparative immunological and plasma biochemical changes during early infection. *Vet. Parasitol.*, 143: 275-286.
- RIM, 1992. Nigerian Livestock Resources Four Volume Report to the Federal Government of Nigeria by Res. Invent and Managt. Limited. Urban Reports and Commercially Managed Livestock Report.
- SAS, 2002. Statistical Analysis system for window version 8.2 SAS Inc. Copy righted.
- Schillhorn Van Veen, T.W., D.O. Folaranmi, S. Usman and I. Idhaya, 1980. Incidence of liver fluke infections, *F. gigantica* and *hospes* in ruminants in Northern Nigeria. *Trop. Animl. Hlth. Prod.*, 12: 97-104.
- Spithill, T.W., D. Piedrafita, P.M. Smooker, 1997. Immunological approaches for the control of fasciolosis. *Intl. J. Parasitol.*, 27: 1221-1235.
- Spithill, T.W., P.M. Smooker and D.B. Copeman, 1999. *Fasciola Gigantica: Epidemiology, Control, Immunology and Molecular Biology*. In: Dalton, J.P. (Ed.), Fasciolosis. CAB Pub. Oxon, UK, 15: 525.
- Ulayi, B.M., B. Umaru-Sule and S. Adamu, 2005. Prevalence of *Dicrocoelium hospes* and *Fasciola gigantica* infections in cattle at slaughter in Zaria, Nigeria. *J. Anim. Vet. Adv.*, 6(9): 1112-1115.
- Urquhart, G.M., J. Armour, J.L. Duncan, A.M. Dunn and F.W. Jennings, 1996. A Text Book of Veterinary Parasitology. 2nd Edn., Blackwell Publishing Professional, ISBN: 0632040513.
- Wiedosari, E. and D.B. Copeman, 1990. High Resistance to experimental infection with *Fasciola gigantica* in Javanese thin tailed sheep *Vet. Parasitol.*, 37: 101-111.