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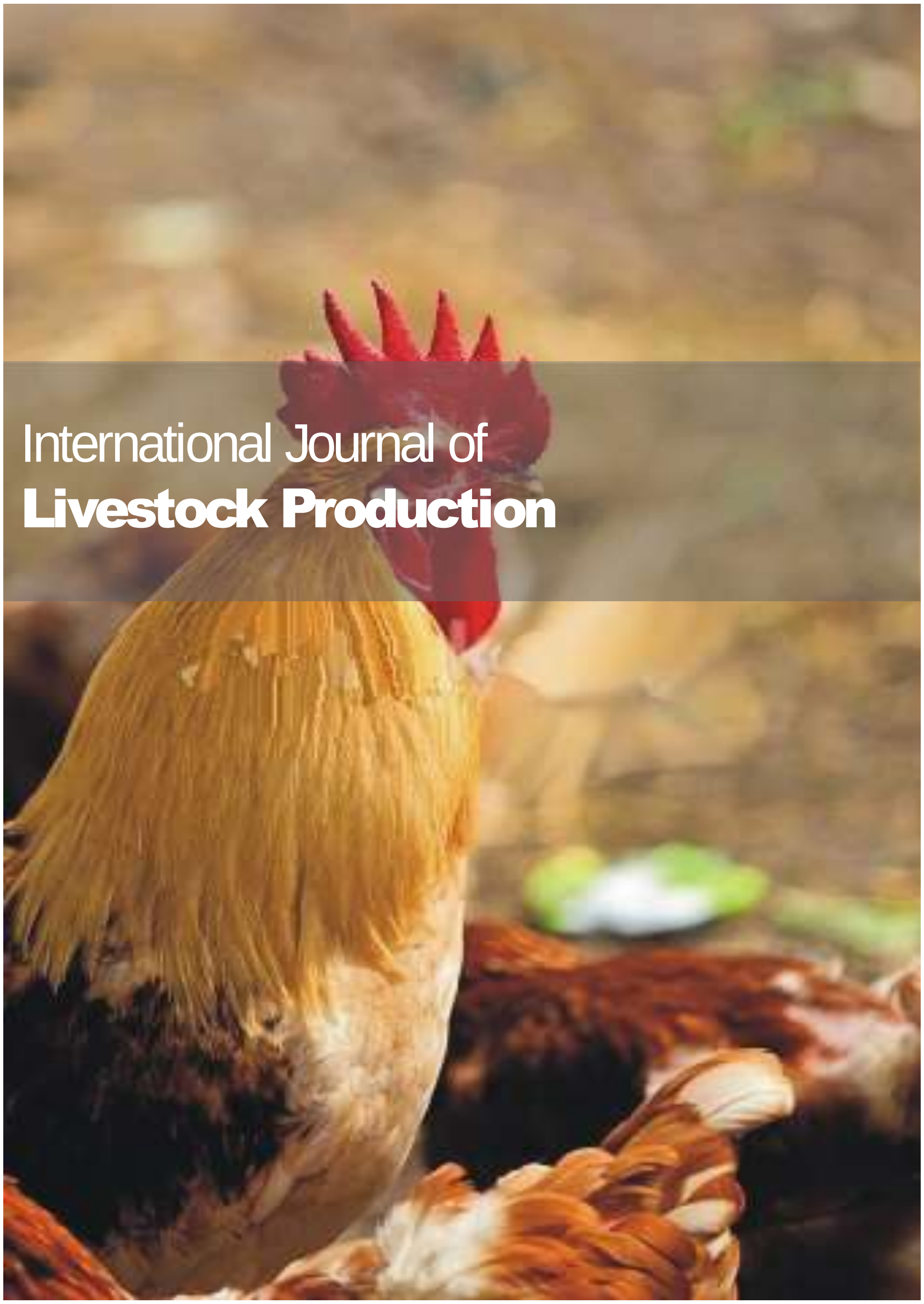

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Full Length Research Paper

Toxin and toxin-binders affecting the performance, organs, haematology and histological characteristics of broilers fed with infected diets

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The potency of four varieties of toxin binders (labeled A, B, C and D) on the physiological status of broiler birds fed with diets infected with aflatoxin was investigated. Six experimental diets were formulated: Diet 1 was infected with aflatoxin without binders, Diets 2 to 5 were infected but binders A, B, C or D were added, while Diet 6 was the control diet without infection. 180 birds were equally and randomly assigned to the 6 treatments and raised for 8 weeks. Their weights and feed consumptions were monitored. After eight weeks, 3 birds per replicate were randomly selected, starved and slaughtered. Their organs were obtained and weighed. Their blood and liver samples were collected for histological examination. Only the animals fed with control diet had significant difference ($p<0.05$) in the average daily feed intake at starter phase. While T5 (infected diet + activated charcoal) had significantly higher ($p<0.05$) feed intake and best feed conversion ratio (3.44) at finisher phase. Kidney proportion of birds from T1 was significantly ($p<0.05$) higher than others while control had the least value (0.53%). Hemoglobin, lymphocyte and heterophils were not influenced ($p>0.05$) among blood parameters. Histological observation of liver revealed inflammation of hepatocyte. Conclusively, the use of activated charcoal as toxin binder gave optimum performance compared to the other binders.

Key words: Aflatoxin, infected feed, physiology, toxin-binder.

INTRODUCTION

Poultry is by far the largest group of livestock and is estimated to be about 14,000 million consisting mainly of chickens, ducks, and turkeys (Udoh and Etim, 2007). It is the most commonly kept livestock and over 70% of those keeping livestock are reported to be keeping chickens (Udoh and Etim, 2007). Poultry production is of considerable significance to the rural as well as national economy; it is an important source of animal protein (FOS, 1999). Chicken species constitute about 98% of the total poultry production in Africa (Guèye, 2003). This has however prompted researchers to look into broiler rearing and its feeding. Mycotoxins are toxic secondary metabolites of certain fungi and cause illness or death when ingested by animals or human beings (Qazi and

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Fayyaz, 2006) especially when the ingestion is above the lethal/tolerance level. Mycotoxin contamination is very costly for the animal industry and it is of significant importance to investigate its safety concern because of the potential mycotoxin residue in meat, dairy and egg (Pandey and Chauhan, 2007; Denli et al., 2009). The most significant economic cost of mycotoxin in poultry is reduced growth rate and high mortality rate in farm animal (Alaa et al., 2015). It is also classified as human carcinogen (Talebi et al., 2011). Cereal grains and their by-products are important ingredients in poultry feed ration; however many of supplied cereals intended for animal feed are frequently contaminated with mycotoxins (Gowda et al. 2008).

One of the most toxic mycotoxins is aflatoxin. Aflatoxins (AFs) are toxic secondary metabolites produced by *Aspergillus* spp. They are natural contaminants of poultry feed ingredients such as maize, millet, rice, peanut meal, and cottonseed meal (Reddy et al., 2000). The increasing knowledge and awareness of aflatoxin as a potent source of health hazards to both man and farm animals make producers, researchers and government organizations to intensify efforts on preventive management and decontamination technologies to minimize the content of aflatoxin in food and feed (Galvano et al., 2005). In order to reduce the toxic and economic impact of aflatoxin, established regulations and legislative limits have been set for aflatoxin in poultry feed. Many countries follow a maximum acceptable level of 20 ppb for aflatoxin in poultry feed (CAST, 2003). Pre and post-harvest contamination can be reduced by using appropriate agricultural practices. However, the contamination is often unavoidable and remains a serious problem associated with many agricultural commodities, and this emphasizes the necessity for a suitable process to inactivate the toxins (Galvano et al., 2005). Since the beginning of the 1990s, adsorbent-based studies have been reported to be effective in minimizing aflatoxin contamination in feed (Ibrahim et al., 2000).

A possible strategy to minimize unavoidable effect of afflatoxins could be the use of toxin binders in feed. The active ingredient(s) are mostly synthetic, not readily available and differ from one binder to the other (Rafiu et al., 2014); this makes their effectiveness varies from one to the other. The present investigation focuses on evaluation of potency of various available toxin binders in poultry diets compared to activated charcoal which is more available and affordable even in rural areas.

MATERIALS AND METHODS

Test ingredients

Various toxin binders were procured and labeled as A, B, C and D. According to the manufacturers, Binder A contains Hydrated Sodium Calcium Aluminosilicates (HSCAS) as the active ingredient; Binder B contains Bentonite/Montmorillonite Yeast cell walls, Binder C contains Aromatic Polyphenols and Binder D contains Activated charcoal.

Toxin production and analysis

Toxin was produced by the inoculation of fungus *Aspergillus flavus* which was carried out using semovita. Moistened semovita was stored in a dark cupboard to enable rapid spoilage. The organism was then isolated and cultured on a Petri dish using potato dextrose agar (PDA) as the growing medium. It was incubated at 27°C for 6 days. Semi-synthetic medium containing 2 g yeast extract and 20 g sucrose in every 100 ml of distilled water (all inside fermentation bottle) was used as basal fermenting medium for the organism to produce toxin. Fermentation bottles were sterilized in an autoclave at 121°C for 15 min to remove or eliminate any form of contamination. The fermenting medium was allowed to cool to about 45°C following sterilization after which the organisms were inoculated in a sterile environment, placed in a shaker and allowed to stand for 6 days.

Experimental diets

Six experimental diets containing the same crude protein and metabolizable energy (MJME/kg) were formulated for the starter phase and finisher diets (Table 1). Five diets (1- 5) were infected with the prepared toxin. Binders A, B, C and D were incorporated into diets 2, 3, 4 and 5, respectively. The toxin binders (binders A, B, C and Activated charcoal) were included in the diets at the rate of 1, 1.5, 2.25 and 10 g/kg of A, B, C and D (activated charcoal) respectively as recommended by the respective manufacturers.

Experimental birds

One hundred and eighty (180) days old commercial broiler chicks were procured and weighed. They were randomly and equally allotted into six (6) treatments of 3 replicates of ten chicks each, making a total of 30 birds in each treatment under a completely randomized design.

Data and samples collection

Average feed intake, body weight gain and feed conversion ratio were estimated from related data that were recorded.

Blood samples

At the end of the experiment, blood samples were collected from three birds per replicate and drained into two differently labeled tubes for haematological and serum investigation. The blood samples for haematological parameters were collected into tubes pretreated with Ethylene Diamine Tetra Acetic acid (EDTA) anti-coagulant, while samples for serum indices were collected into tubes without EDTA pre-treated. Investigated serum biochemical indices include total protein (TP), albumin, cholesterol, alanine amino transferase (ALT), aspartate amino transferase (AST), alkaline phosphatase (ALP) while analyzed haematological indices include white blood cell (WBC) counts, red blood cell (RBC) counts, packed cell volume (PCV), lymphocyte, platelet and hemoglobin.

Liver samples and organs weight

Liver from sampled birds was obtained, fixed in 20% formalin solution, taken to the laboratory, stained and further processed for

Table 1. Gross composition of experimental broiler diets (starter and finisher).

Ingredients	Starter diets						Finisher diets					
	T_1	T_2	T_3	T_4	T_5	T_6	T_1	T_2	T_3	T_4	T_5	T_6
Maize	55.00	55.00	55.00	55.00	55.00	55.00	50.00	50.00	50.00	50.00	50.00	50.00
Soy bean meal	15.00	15.00	15.00	15.00	15.00	15.00	14.00	14.00	14.00	14.00	14.00	14.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	15.00	15.00	15.00	15.00	15.00	15.00
Groundnut cake	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	4.50	4.50	4.50	4.50	4.50	4.50
Oyster shell	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Aflatoxin	+	+	+	+	+	-	+	+	+	+	+	-
Binders	-	*	**	***	****	-	-	*	**	***	****	-
Cal. Analysis												
Crude protein	20.61	20.61	20.61	20.61	20.61	20.61	20.09	20.09	20.09	20.09	20.09	20.09
Metabolizable energy	2868.9	2868.9	2868.9	2868.9	2868.9	2868.9	2654.00	2654.00	2654.00	2654.00	2654.00	2654.00

histological characteristic. The weights of the organs (liver, kidney, spleen, whole gizzard, empty gizzard, heart, proventriculus and lungs) were measured using a sensitive weighing balance. Then their relative weights to live body weight were determined and documented.

Statistical analysis

All data collected were subjected to one- way analysis of variance (ANOVA) using SAS (2000) software package; significant means were separated using Duncan's multiple range test of the same package.

RESULTS

Performance of the birds fed with infected diets incorporated with various binders

Table 2 shows the average daily weight gain among the treatments at starter phase. The obtained values varied from 35.12 g in treatment 4 (diet infected with mycotoxin + binder C) to 21.85 g in treatment 3 (infected diet + binder B). There was no significant difference (p>0.05) in the average daily feed intake at starter phase for all treatments except treatment 6 (control) where the feed intake was significantly lower (p<0.05). Different trend was observed at finisher phase, where feed intake of treatment 6 (control) was statistically similar (p<0.05) to the infected diets except treatment 5 which had a significantly higher feed intake (173.57 g). Feed conversion ratio of treatment 3 (infected diet + binder B) was statistically higher (p<0.05) than others while the best value (2.83) was recorded from treatment 4. At finisher phase, no statistical (p>0.05) difference was observed in all the treatments. However, treatment 5 (infected diet + binder D) had a superior value (3.44). Likewise best average daily feed intake was obtained from treatment 5 though statistically similar (p>0.05) to other except treatments 4 and 6.

Organ characteristics of birds fed with infected diet with different toxin binders

The live weight of the birds from treatment 3 (Binder B) was significantly lower (p<0.05) than treatments 5 (Binder D), 4 (Binder C) and 6 (Control) but statistically similar (p>0.05) to treatments 1 (negative control) and 2 (infected diet + Binder A). However, treatment 6 (control) recorded the highest value (2116 g) while the least (1698 g) was obtained from treatment 3

Table 2. Performance characteristics of broiler chicken under treatments.

Parameter	T_1	T_2	T_3	T_4	T_5	T_6	SEM(±)
				Starter			
ADWG (g)	27.93^{b}	31.17^{ab}	21.85^{c}	35.12^{a}	32.61^{ab}	30.49^{ab}	1.04
ADFI (g)	96.12^{a}	96.49^{a}	98.21^{a}	97.98^{a}	99.93^{a}	78.96^{b}	1.47
FCR	3.52^{b}	3.11^{b}	4.63^{a}	2.83^{b}	3.13^{b}	2.75^{b}	0.15
				Finisher			
ADWG (g)	43.29^{ab}	47.21^{ab}	45.51^{ab}	42.54^{ab}	50.39^{a}	39.86^{b}	1.19
ADFI (g)	164.05^{ab}	165.71^{ab}	164.40^{ab}	152.50^{b}	173.57^{a}	149.64^{b}	2.81
FCR	3.79	3.51	3.61	3.58	3.44	3.75	0.09

^{abc}Means on the same row with different superscripts were significantly (<0.05) different.
ADWG: average daily weight gain, **ADFI:** average daily feed intake, **FCR:** feed conversion ratio.
SEM: standard error of mean **T1:** Infected diet, **T2:** Infected diet + binder A **T3:** Infected diet +binder B**T4:** Infected diet + binder C**T5:** Infected diet + binder D**T6:** Control diet (uninfected).

(infected diet + Binder B).

Liver proportion had no significant difference (p>0.05) for all treatments except treatment 2 (infected diet + Binder A) which had significantly higher (p<0.05) value (2.67%) compared to others. The spleen and the proventriculus showed no difference for all treatments as it could be observed from Table 3. There was significant (p<0.05) difference in the values for whole gizzard and empty gizzard with infected + Binder B based diet (treatment 3) having the highest values of 3.41 and 2.61%, respectively while least values of 2.57 and 1.98% were obtained from treatment 4 (infected + Binder C) and treatment 5 (infected + Binder D), respectively. The obtained values for heart revealed a significant difference (p<0.05) among all treatments. Treatment 1 (infected diet without binder) recorded the highest value of 0.87% for kidney proportion while treatment 6 (control) had the least value of 0.53% and the treatments were significantly different (p<0.05).

Haematological and serum characteristics of broiler birds fed infected diets with inclusion of different binders

Table 4 revealed that there was significant difference (p<0.05) among treatments mean values of packed cell volume (PCV). The highest value (26.00%) was obtained from treatment 3 (infected diet + Binder B) and was statistically higher (p<0.05) than treatments 2, 4, 5, and 6. However, the least value (19.00%) was recorded by treatment 6 (control). Red blood cell (RBC) count values obtained from all treatments were statistically similar (p>0.05) except treatment 1 (infected diet without binder) that had least value of 3.19×10^6 mm^3 which was significantly lower (p<0.05) than others (Table 4). Meanwhile, a different trend was observed in white blood cell (WBC) count where treatments 1, 3 and 5 were significantly higher (p<0.05) than other treatments including the control. Monocyte count showed significant difference (p<0.05) among the treatment means. The highest value (3.50%) was obtained from treatment 4 (infected + Binder C), followed by treatments 6 (control) and 2 having a value of 3.00%. The least value (1.00%) was obtained from treatment 1 (infected diet without binder).

A significant difference (p<0.05) in albumin values was recorded only between negative control and the infected diets (Table 4). The total protein value of treatment 4 (Binder C) was significantly higher (p<0.05) than treatments 1, 3 and 6 but similar (p>0.05) to treatments 2 and 5 which were also similar to treatments 1 and 6. Least value (2.11 g/dl) was obtained from treatment 3. Creatinine was significantly different (p<0.05). Treatment 5 recorded the highest value (0.87 mg/dl) while treatment 3 (Binder B) had the least value (0.74 mg/dl). Treatments 1, 3, 4 and 6 had similar (p>0.05) cholesterol level while treatments 2 and 5 were also observed to be similar (p>0.05); however, treatment 1 (infected diet without binder) and treatment 4 (infected diet + Binder C) recorded significantly (p<0.05) higher values compared to others while treatment 5 (Binder D; Activated charcoal) had the least value for cholesterol (87.18 mg/dl).

Histological observation of the liver

Generally, there were alterations in the histological structure of the liver samples which ranged from gradual hepatic cell inflammation, mild inflammation to severe inflammation of the hepatocytes. Although the morphological alteration was observed in all the livers, the inflammations are limited to certain portions as other areas showed normal liver hepatocytes. Liver sample obtained from birds placed on infected diet without binder showed a characteristic inflammation of hepatocytes

Table 3. Organ characteristics of broiler chicken fed contaminated diet with inclusion of different toxin binders.

Parameter	T_1	T_2	T_3	T_4	T_5	T_6	SEM(±)
Live weight (g)	1840.00^{ab}	1941.67^{ab}	1698.00^{b}	2011.00^{a}	2062.67^{a}	2116.00^{a}	42.65
Liver (%)	2.26^{b}	2.67^{a}	2.24^{b}	2.07^{b}	2.07^{b}	2.17^{b}	0.05
Spleen (%)	0.11	0.15	0.16	0.13	0.15	0.14	0.01
Proventiculus (%)	0.38	0.40	0.44	0.36	0.49	0.41	0.02
Wgizzard (%)	2.63^{b}	2.95^{ab}	3.41^{a}	2.57^{b}	2.72^{b}	3.07^{ab}	0.78
Egizzard (%)	2.20^{ab}	2.33^{ab}	2.61^{a}	2.07^{b}	1.98^{b}	2.04^{b}	0.70
Heart (%)	0.46^{b}	0.47^{ab}	0.48^{ab}	0.61^{a}	0.34^{bc}	0.28^{c}	0.26
Kidney (%)	0.87^{a}	0.69^{b}	0.73^{b}	0.60^{bc}	0.70^{b}	0.53^{c}	0.02
Lungs (%)	0.74^{a}	0.60^{b}	0.67^{ab}	0.60^{b}	0.67^{ab}	0.74^{a}	0.01

[abc]Means on the same row with different superscripts were significantly different (p<0.05).
WGizzard: Whole gizzard, EGizzard: Empty gizzard.

Table 4. Haematological indices of broiler chicken fed contaminated diet with inclusion of different toxin binders.

Parameter	T_1	T_2	T_3	T_4	T_5	T_6	SEM(±)
	Haematological indices						
PCV (%)	23.00^{ab}	21.50^{bc}	26.00^{a}	22.50^{bc}	20.00^{bc}	19.00^{c}	0.58
Hb (g/dl)	9.45	8.60	8.00	9.15	9.70	8.90	0.25
RBC (10^6mm^3)	3.19^{b}	3.88^{a}	3.97^{a}	4.03^{a}	4.25^{a}	3.94^{a}	0.09
WBC (10^3mm^3)	21.60^{a}	16.68^{bc}	20.23^{a}	14.00^{c}	22.13^{a}	19.80^{ab}	0.64
Lymph (%)	63.50	59.00	61.00	60.50	63.50	63.50	1.19
Heterophil (%)	32.00	34.50	36.00	31.00	29.50	29.50	1.07
Monocyte (%)	1.00^{c}	3.00^{ab}	1.50^{c}	3.50^{a}	2.50^{b}	3.00^{ab}	0.18
Eosinophil (%)	3.50^{a}	2.00^{b}	1.50^{b}	4.00^{a}	$4..00^{a}$	4.00^{a}	0.26
Platelet(10^6/dl)	301.00^{a}	137.50^{cd}	224.50^{b}	120.50^{d}	199.00^{bc}	131.50^{cd}	13.74
	Serum parameter						
TP (g/dl)	2.17^{bc}	2.35^{abc}	2.11^{c}	2.70^{a}	2.56^{ab}	2.23^{bc}	0.06
Alb (g/dl)	1.30^{a}	1.17^{b}	1.22^{b}	1.17^{b}	1.20^{b}	1.18^{b}	0.01
AST (IU)	154.95^{c}	163.08^{bc}	154.97^{c}	171.46^{abc}	185.33^{a}	176.17^{ab}	2.78
ALT (IU)	6.56^{ab}	6.40^{ab}	8.56^{a}	5.44^{b}	5.20^{b}	5.88^{ab}	0.39
CRT (mg/dl)	0.78^{bc}	0.82^{ab}	0.74^{c}	0.78^{bc}	0.87^{a}	0.84^{a}	0.01
ALP (g/dl)	310.27^{a}	302.15^{a}	281.69^{ab}	212.18^{c}	251.52^{b}	260.36^{b}	7.25
CHOL (mg/dl)	115.69^{a}	96.79^{bc}	108.34^{ab}	116.67^{a}	87.18^{c}	104.17^{ab}	2.71

[abcd]Means on the same row with different superscripts were significantly different (p<0.05).
PCV: Packed cell volume, **Hb**: Haemoglobin, **RBC**: Red blood cell, **WBC**: White blood cell, **Lymph**: Lymphocyte **TP**: total protein, **Alb**: Albumin, **AST**: Aspartate amino transferase, **ALT**: Alanine amino transferase, **CRT**: Creatinine, **ALP**: Alkaline phosphatase, **CHOL**: Cholesterol.

around the portal vein, as it could be rightly observed at x100 magnification under electronic microscope (Figure 1). Figure 2 show liver from birds placed on infected diet + Binder A. There was a severe inflammation of hepatocytes around the portal vein. Figure 3 reveals the histological changes of liver obtained from birds placed on infected diet + Binder labeled B. It shows mild and gradual inflammation of hepatic cells, under electronic microscope with a view at x100 magnification. Figure 4 shows the observation of liver from birds placed on infected diet +Binder C based treatment. The sample showed little inflammation of hepatic cells at the portal vein at x100 magnification level. Figure 5 reveals the observation of liver from birds placed on infected diet + activated charcoal. The sample showed mild inflammation of hepatic cells around the portal vein. Figure 6 shows cross sectional view of broiler liver fed non-infected diet (control or treatment 6). It showed a gradual inflammation of hepatocytes around the portal vein at x100 magnification, despite not infected.

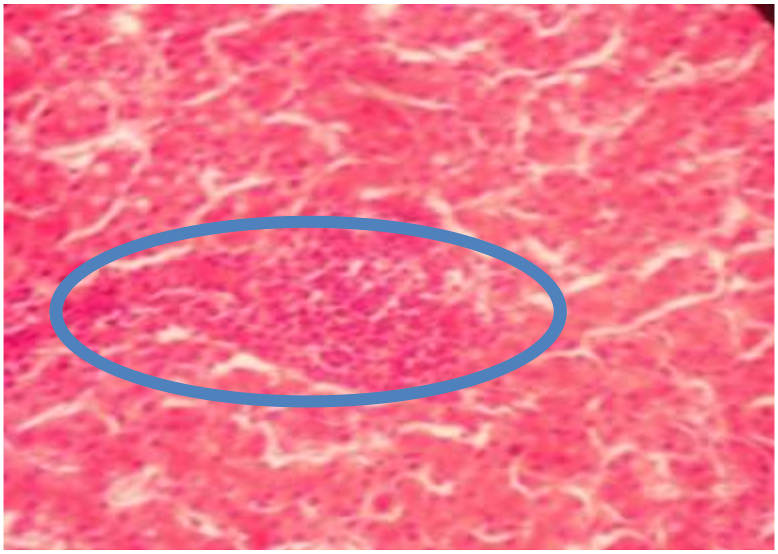

Figure 1. Section of broiler liver fed infected diet without binder showing inflammation of hepatic cells (X 100 stained with H and E, Haematoxylin & Eosin).

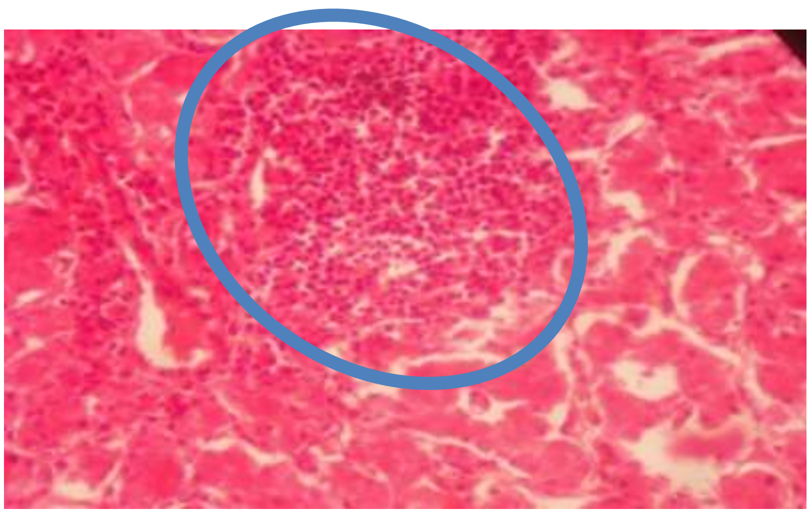

Figure 2. Section of broiler liver fed infected diet + Binder A (HSCAS) showing severe inflammation of hepatocytes. (X 100 stained with H and E, Haematoxylin & Eosin).

DISCUSSION

There is loss of energy availability in the feed when feeding birds with aflatoxin infected diet (Verma et al., 2007). When there is loss of energy in feed, the birds tend to consume more in order to meet up with their energy requirement. Probably, this was one of the factors responsible for the high feed intake observed in all the infected diets at starter phase. But at finisher phase, consumption rate of birds on infected diets was observed to be in a definite trend. Treatment 1 (infected diet without binder) was statistically similar ($P>0.05$) to other dietary treatments. This suggested that the birds might have developed resistance to the effect of mycotoxin or that the administration of anti-oxidants such as vitamins as anti- stress during the period of feeding trial might have helped in reducing the effect of aflatoxin as it was reported that antioxidants seem to be chemo-preventive against common mycotoxin (Gowda and Ledoux, 2008). Treatment 5 (infected diet + activated charcoal) had the least feed conversion ratio with a value of 3.44 though statistically similar to others. It made the best use of the

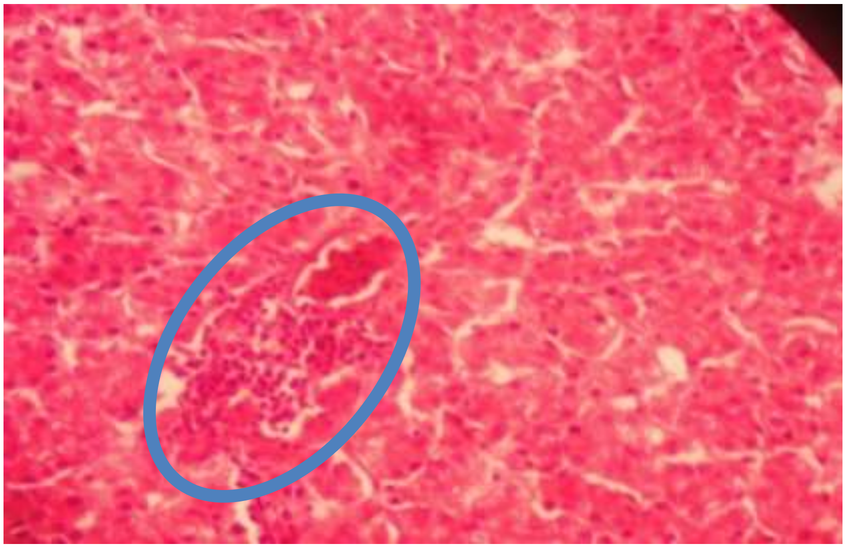

Figure 3. Section of broiler liver fed infected diet + Binder B (Bentonite/Montmorillonite Yeast cell walls) based diet showing a gradual inflammation of hepatocytes. (X 100 stained with H and E, Haematoxylin & Eosin).

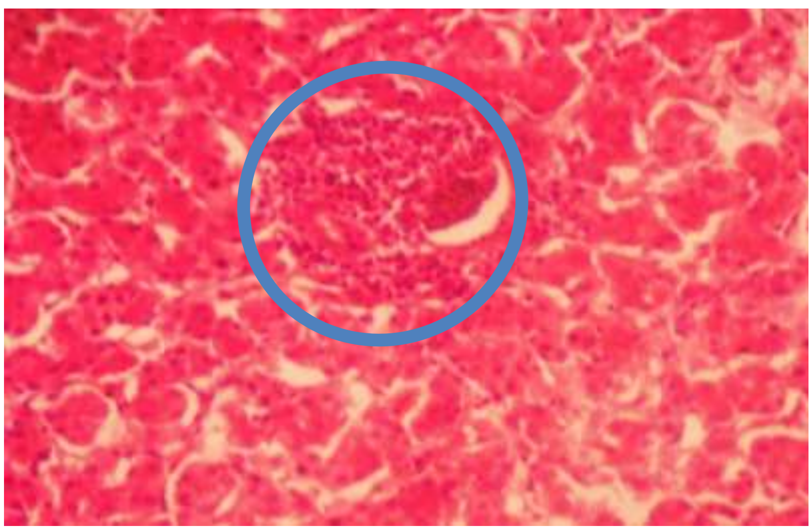

Figure 4. Section of broiler liver fed infected diet + Binder C (Aromatic Polyphenols) Showing little inflammation of hepatic cells around the portalvein. (X 100 stained with H and E).

feed having the leading value of average daily weight gain of 50.39 g. Growth rate is the most significant cost/effect of mycotoxin in poultry (Gowda et al., 2008). Despite the moderate consumption rate obtained from treatment 1(infected diet with no binder), it had the highest feed conversion ratio (3.79) expressing the negative effect of the toxin and toxin concentration in the diet (Qazi and Fayyaz, 2006). This supported the work of Tedesco et al. (2004) that contamination of aflatoxin in broiler feed causes poor feed conversion ratio (FCR) and poor feed utilization. However, the infected diets with incorporated binders had better FCR values, even than the control diet (uninfected), notably expressing the positive effects of various binders on feed utilization.

The observed growth rate showed a reduction in treatments 1 up to 5 when compared to treatment 6 and justified the report of Shi et al. (2009) that aflatoxin contaminated feed causes aflatoxicosis and is characterized by decreased weight gain of the livestock. The higher proportion ($p<0.05$) of the kidney to live

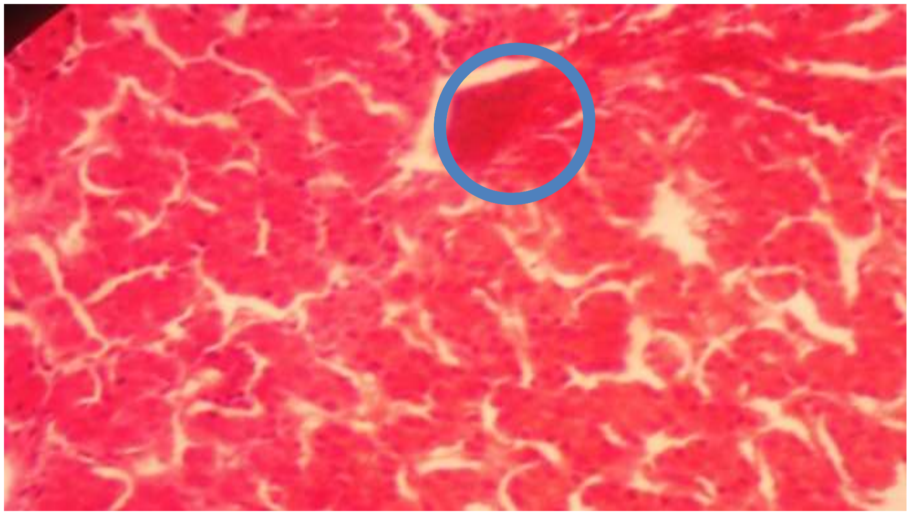

Figure 5. Section of broiler liver fed infected diet + Binder D (Activated Charcoal) based diet showing mild inflammatory cells. (X 100 stained with H and E, Haematoxylin & Eosin).

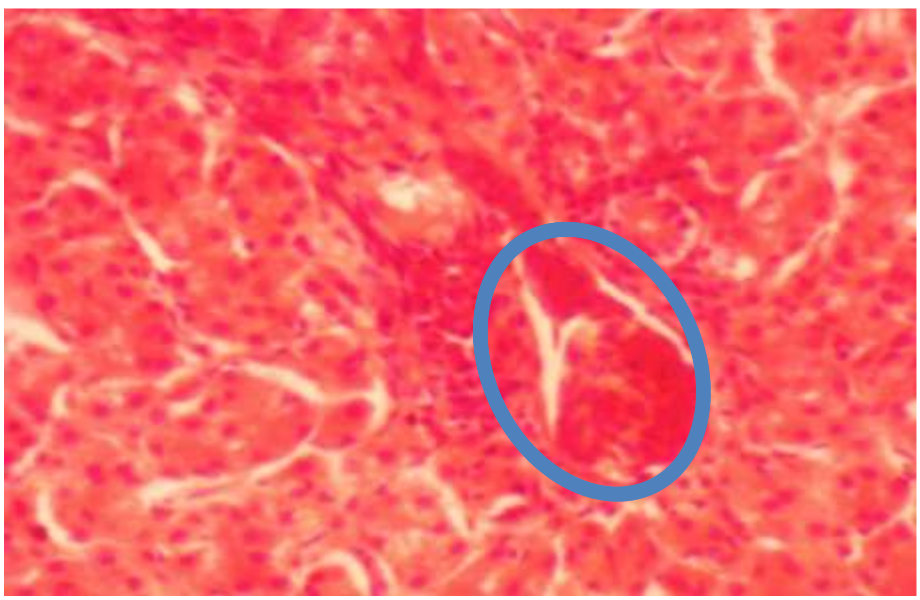

Figure 6. Section of broiler liver fed non- infected diet (control) showing gradual inflammation of hepatocytes around the portal vein. (X 100 stained with H and E, Haematoxylin and Eosin).

weight obtained from treatment 1 (infected diet without binder) and similar variation obtained from other treatments fed infected diets were suggested to be as a result of aflatoxin consumption, as aflatoxin can cause productive deterioration which is associated with kidney abnormalities and impaired immunity (Oguz et al., 2003). The liver is the main target and a key player of aflatoxicosis in poultry (Diaz and Murcia, 2011). The relative weights of liver were statistically similar (p>0.05) for all the treatments except treatment 2; which translates that the infected diets, those incorporated with binders as well as the control were the same. Researches have revealed that relative weight of liver increased as the aflatoxin ingestion was 200 ppb and more significantly increased at higher aflatoxin level (Saleh et al., 2013). Therefore, the little or no change in the liver proportion of the dietary treatments compared to the control could be as a result of the low exposure level which had little (p>0.05) effect on the liver proportion.

Red blood cells are made up of proteins. The range of red blood cell count (4.25 - 3.19) recorded in this work was within the range of 2.90- 4.10 ($x10^6 mm^3$) recommended by Paggot (1992). However, lower red blood cell observed in treatment 1 might be the effect of aflatoxin consumption as it has been reported by Cassel et al. (2012) that the level of protein and vitamins in feed should be increased as toxin affects protein synthesis which in turn is the building block of the RBC component of the blood. Monocytes play important role in healing process thus; they increase in number during healing process. The average monocyte count for poultry bird is 2.00% (Paggot, 1992). It was therefore suggested that the increase in monocyte count above 2.00% in treatments 2, 3, 4, 5 which were infected diets with inclusion of the binders, activated charcoal inclusive and treatment 6 (Control) probably indicated that healing process was demanding though may be mild as no mortality was recorded in these treatments. However, the least monocyte count (1.00%) obtained from treatment 1 (infected diet with no binder) is a pointer that the birds were more stressed by the effect of the toxin ingested.

There was a significant ($p<0.05$) difference in albumin value of all the treatments with the highest value recorded at treatment 1 (negative control). The value of total protein obtained showed significant difference ($p<0.05$). However, all fall within the range of 2.11 to 2.70 g/dl. This range was found to be in accordance with the report of Cassel et al. (2012) that the level of protein and vitamins in feed should be increased as toxin binds vitamins and affects protein synthesis. Cholesterol is mostly synthesized by the liver, it aids efficient metabolism, that is, it is essential for the body to produce vitamin D. Consumption of infected diet by birds has a significant influence on the liver; the normal synthesis of cholesterol is thereby affected as it was observed from treatment 1 (infected diet without binder) where the value obtained was significantly ($p<0.05$) higher which consequently leads to a higher cholesterol deposition than other treatments. Out of all the binders, activated charcoal seemed to be more efficient when blood cholesterol is considered. Blood cholesterol indicates the level of deposition of fat into the adipose muscles in the liver.

The histological effects of toxicosis include liver necrosis, hepatic cell degeneration and inflammation of hepatocytes. The varying degree of alterations (inflammations) in the histological structure of all the liver samples (as observed from the plates) could be due to the level of aflatoxin in the diet, which may or may not be sufficient enough to cause morphological actions such as necrotic lesions and cell degeneration. This is because the biological effects of mycotoxins depend on the ingested amounts, number of occurring toxins, duration of exposure to mycotoxins and animal sensitivity (Yiannikouris and Jonany, 2002).

CONCLUSION AND RECOMMENDATION

The results of the study had shown that inclusion of activated charcoal as a binder in an aflatoxin contaminated diet gave an encouraging performance and feed conversion value than the other binders. Although all the liver samples showed varying degree of inflammations, samples from birds placed on activated charcoal proved to have reduced inflammatory cells. It could therefore be recommended that the use of activated charcoal available at 10 g/kg diet should be more encouraged rather than other synthetic binders. Alternatively, the binder could be used instead of none especially when the status of the diet could not be ascertained as it has proved to be the most efficient and economical approach of preventing and counteracting aflatoxicosis in poultry.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Effects of snail offal meal on performance of broiler chickens

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The study investigated the effects of inclusion of various levels of snail offal meal (SOM) on the performance of broiler chickens. The study was carried out in the animal farm of the Department of Animal Science, Nnamdi Azikiwe University, Awka Anambra State. The experiment was designed on a 4×3 Completely Randomized Design (CRD) with four dietary treatments having 0, 2.5, 5 and 7.5% inclusion of SOM over a period of eight weeks. Twelve birds (12) were assigned to each of the dietary treatment and each replicated three times such that each replicate has four birds. The diet with 0% snail offal meal served as the control. The birds were housed in pens measuring 2 × 2 × 2.5 m^3. A total of forty eight birds were used for the experiment. Twelve birds were assigned to each of the dietary treatment and each replicated three times such that each replicate has four birds. The diet with 0% snail offal meal served as the control. Results obtained showed that there was a progressive increase in weight gain over time in all the dietary treatment. The highest mean weight gain was recorded in the broilers subjected to treatment with 2.5% inclusion level of SOM. For the feed intake, the highest fed intake was recorded in the treatment with 2.5% SOM inclusion level followed by 7.5% inclusion level while the least was observed in treatment with 5% SOM inclusion level. For the linear body measurements, the highest thigh increase was recorded in treatments with 2.5 and 7.5% SOM inclusion level. For the carcass weight measurement, the broiler chicken fed different levels of SOM recorded high performance in their cut up parts. The treatment with inclusion of 2.5% has the highest mean weight of the cut up parts namely thigh, breast, defeathered and eviscerated while the least was recorded in the treatment with 7.5% SOM inclusion level. For the organ weight measurement, the broiler chicken in treatment with 2.5% SOM inclusion had the highest mean weight of the organs: liver, pancreas, heart, lungs, gizzard, caeca and small intestine while the least was observed in treatment 0% inclusion. The study recommends that waste from micro livestock such as snail should be incorporated in the diets of broiler birds to partially replace fishmeal in poultry feed formulation.

Key words: Linear body measurement, carcass weight, organ weight, growth performance.

INTRODUCTION

Animal production in the tropics is adversely affected by high cost and inadequate feed supply (Ahaotu et al., 2013). Feed contribute over 60% of total cost of animal production resulting in low yields and high cost of production. Reduction of feeding cost is therefore a fundamental issue in poultry production. The high cost of feed is also linked to reliance of on conventional feed resources. Fish meal has been used as a source of dietary animal protein. Incidentally, the direct competition between man and poultry for fish has led to the scarcity, high cost and adulteration of fishmeal. This may be achieved by using a less expensive non-conventional feed resources in poultry diets, as for example animal by products and offals such as sardine fish silage (Al-Marzooqi et al., 2010), poultry offal meal and crayfish waste meal (Asafa et al., 2012; Ologhobo et al., 2012) and shrimp waste meal (Caires et al., 2010). Snail offal meal (SOM) is an important ingredient that can replace the fish meal in feedstuffs. Its proximate analysis shows that it has a nutritive value that corresponds to fishmeal. In Nigeria, farming of snails is practiced to sustain livelihoods (Ayodele, 1992). Snails have high nutritional values (Yusuf, 1998). The making of snail meat is accompanied by production of large quantities of offal that are difficult to dispose, and that quickly spoils and emit offensive odour (Lincoln et al., 2004). However, until now inclusion of snail offal meal in poultry diets have not been adequately investigated. This paper reports results from experiments on feeding of snail offal to poultry.

MATERIALS AND METHODS

Study area

The study was carried out in the animal farm of the Department of Animal Science, Nnamdi Azikiwe University, Awka Anambra State. The farm is located between geographical coordinates 6° 10' 0" North, 7° 4' 0" East. Average temperature is between 29 and 34°C and annual rainfall of 1000 to 1500 mm with two seasons (rainy and dry season) (Ewuim, 2004).

The poultry house has an area of 100 m^2 and the snail pens were placed in roofed enclosure and protected from direct rain and sunlight. There were plantain trees and rich vegetation around the farm to minimize wind and temperature effects.

Experimental animal

Forty eight (48) two weeks old Anak broiler chicks purchased from Sunchi farms and Hatchery Emene, Enugu State were used in the experiment. They were transported to the study site in the evening of the same day of purchase to avoid stress and death of the birds. The birds were given routine vaccinations.

Experimental feed material

The snail offal of the species *Archachatina marginata* consisted of heart, kidney and loop of intestine and reproductive tracts including residual snail eggs. The snail offal was extracted from the shell by manual breaking of the shell with a hammer after the edible parts were removed. The snail offal collected from Ochanja market, Onitsha in Anambra State. The offals were initially sun dried for three days before further oven drying at controlled temperature of 100°C for 4 h at Department of Zoology Laboratory. The dried snail offal was ground to powder in the laboratory with an electric blender (QASA grinder and blender) and sample analyzed for its proximate composition (Table 1). The test feeds were formulated and mixed at in a privately owned feed milling industry known as Farm Associates Mill, Enugu. Proximate analysis for each of the experimental diets (starter and finisher) was assessed (Tables 2 and 3).

A 4×3 Completely Randomized Design (CRD) with four dietary treatments having 0, 2.5, 5 and 7.5% inclusion of snail offal meal (SOM) was used in the experiment. Twelve birds (12) were assigned to each of the dietary treatments, replicated three times such that each replicate had four (4) birds. The diet with 0% snail offal meal served as the control. The birds were housed in pens measuring 2 × 2 × 2.5 m^3. The birds were fed and water was given *ad libitum* for eight weeks.

Chicks weights were obtained using a precision weighing balance weekly (CAMRY EC- 201), feed conversion ratio by dividing the feed consumed by the weight gain all in grams at the end of the experiment; the feed intake was measured as the difference between the quantity of feed given and the quantity left over on daily basis, feed efficiency ratio was calculated by dividing the weight gain (g) by the feed consumed (g) at the end of the experimental period, the linear body measurements were taken using a metre rule and tailors tape on weekly intervals. All measurements were taken to the nearest 0.1 cm, the total body length was taken as the length from the tip of the beak to the uropigeal gland, shank length was taken on the length between the knee and the Regiotarsus taken on the right limb, thigh length is the length between the hip bone and that of the knee on the right limb, wing length is the length from the base of the shoulder to the tip of the longest primary feather, girth is the circumference of the body at the tip of the pectus, the carcass and organ characteristics was also assessed at the end of the experimental period. These were done by starving the birds overnight but water was made available. The birds were weighed, slaughtered by severing the jugular vein and allowed to bleed thoroughly according to the methods recommended by Odunsi et al. (1999). One bird per replicates were scalded at 75°C in water bath for about 30 s before defeathering and then the birds were reweighed to know the feather weight by difference. The dressed chicks were later eviscerated; the wings were removed by cutting anteriorly severing at the humeo-scapular joint. The cuts were made through the rib head to the shoulder girdle; the back was removed intact by pulling anteriorly. The wings, thigh, breast and organs were dissected from each carcass and weighed separately with a sensitive electronic scale. The carcass and body organs weight were taken on a fresh basis. Data generated was subjected to Analysis of Variance (ANOVA). Duncan's new multiple range test was used to determine the level of significance among the treatments at 5% probability.

RESULTS AND DISCUSSION

The result of proximate composition of the snail offal meal used in feed formulation is shown in Table 1. The result showed that SOM have high crude protein content, good fibre and fat contents for poultry feed formulation.

The composition of the experimental diets are shown in Table 3 while the proximate analysis of the experimental diets (Table 2) did not show significant difference though

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Table 1. Proximate composition of snail offal meal (g/kg dry matter).

Parameter	Amount (g/kg)
Crude protein	50.85
Crude fiber	4.27
Fat	9.73
Ash	9.74
Nitrogen free extract	25.41

Table 2. Proximate composition of the experimental diets.

Parameter	Broiler	Starter			Broiler	Finisher		
	T1	T2	T3	T4	T1	T2	T3	T4
	(0%)	(2.5%)	(5%)	(7.5%)	(0%)	(2.5%)	(5%)	(7.5%)
Crude protein %	23.50	23.45	23.41	23.62	20.10	20.05	20.01	20.23
Crude fiber %	3.40	3.48	3.57	3.59	3.10	3.18	3.27	3.29
Ether extract %	3.95	3.94	3.93	3.99	4.00	3.99	3.98	4.04
Ca%	1.84	1.79	1.75	1.75	1.84	1.79	1.75	1.75
P%	1.06	1.03	0.98	0.97	1.03	1.00	0.96	0.94
Lysine	1.50	1.67	1.83	2.02	1.26	1.42	1.59	1.78
Methionine	0.69	0.68	0.67	0.68	0.65	0.64	0.63	0.64
Energy (ME Kcal/kg)	2802.47	2780.42	2758.37	2743.25	2904.47	2882.42	2860.37	2845.25

**T1 contains 0% SOM inclusion (control diet), T2: 2.5% SOM inclusion, T3: 5% SOM inclusion, T4: 7.5% SOM inclusion.

Table 3. Gross composition of the experimental diet.

Parameter	Broiler	Starter			Broiler	Finisher		
	T1	T2	T3	T4	T1	T2	T3	T4
	(0%)	(2.5%)	(5%)	(7.5%)	(0%)	(2.5%)	(5%)	(7.5%)
Maize	50	50	50	50	60	60	60	60
Soybean cake	30	30	30	28.5	20	20	20	20
Fish meal	6	3.5	1	0	6	3.5	1	0
Snail offal meal	0	2.5	5	7.5	0	2.5	5	7.5
Wheat offal	4	4	4	4	4	4	4	4
Palm kernel cake	5	5	5	5	5	5	5	5
Bone meal	4	4	4	4	4	4	4	4
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100

**T1 contains 0% SOM inclusion (control diet), T2: 2.5% SOM inclusion, T3: 5% SOM inclusion, T4: 7.5% SOM inclusion.

the crude protein of starter diets are higher than that of the finisher diets and all the parameters are in line with other literature reports for tropical climates. The result of weight gain (Table 4) shows significant difference (P<0.05) and that there was a progressive increase in weight gain over time in all the dietary treatment was also observed. The highest mean weight gain was recorded in the broilers subjected to treatment with 2.5% inclusion level of snail offal meal (SOM) followed by 5% inclusion level while the least was observed in treatment with 7.5% SOM inclusion level. The reason for this outcome could be due to the fact that crude protein in fishmeal that was

Table 4. Effect of SOM at various levels on weight, specific growth rate and feed intake of Broiler chicks.

Parameter	Treatment inclusion			
	T1 (0%)	T2 (2.5%)	T3 (5%)	T4 (7.5%)
Initial weight (g)	557.14±27.78	561.42±34.31	509.63±24.13	422.21±33.21
Final weight (g)	2700.00±23.33	2847.22±17.34	2741.67±21.21	2500.00±13.6
Mean weight gain (g)	2142.86±25.21[b]	2285.80±18.31[a]	2232.04±19.21[a]	2077.79±19.31[c]
Feed conversion ratio	0.266[c]	0.277[a]	0.245[d]	0.274[b]
Feed efficiency ratio	3.757[a]	3.608[c]	4.073[d]	3.638[b]
Feed intake(g)	570.33±21.32[b]	633.41±25.21[a]	547.94±17.43[c]	571.06±23.43[b]

**Rows with different superscripts are significantly different; T1 contains 0% SOM inclusion (control diet), T2: 2.5% SOM inclusion, T3: 5% SOM inclusion, T4: 7.5% SOM inclusion.

Table 5. Effect of SOM at various levels on the linear measurement of broiler chickens.

Parameter (cm)	Treatment inclusion level			
	T1 (0%)	T2 (2.5%)	T3 (5%)	T4 (7.5%)
Thigh length	6.37 ±2.51	8.44 ±2.77	6.37 ±4.29	8.44 ±2.77
Shank length	4.58 ±1.63	5.57 ±4.29	6.99 ±2.14	6.37 ±4.23
wing length	12.25 ±4.64	18.99 ±2.14	16.10 ±5.95	18.33 ±2.14
Body length	21.73 ±9.29	26.74 ±5.00	23.33 ±8.26	28.74 ±5.10
Girth	9.28 ±4.19	9.33 ±2.86	7.37 ±4.29	10.33 ±4.86

**T1 contains 0% SOM inclusion (control diet), T2: 2.5% SOM inclusion, T3: 5% SOM inclusion, T4: 7.5% SOM inclusion.

being replaced with a higher quality protein from snail offals is well known to have a superior protein quality and amino acid profile content which agrees with the findings of Asafa et al. (2012), Ologhobo et al. (2012) and Al-Marzooqi et al. (2010). The highest feed conversion rate of 0.277 was recorded in treatment T2 followed by treatment T4 (0.274), treatment T1 (0.266) while the least FCR of 0.245 was observed in treatment T3 which implies that the lower the feed conversion ratio, the better the food conversion efficiency of each experimental diets. Also, the higher the feed efficiency ratio as recorded in treatment T3 shows that they have high/better efficiency potential to convert feed to appreciable body mass as evident in good weight gain of the broiler chickens subjected to various inclusion levels of SOM (Table 4).

For the feed intake, the highest fed intake was recorded in the treatment with 2.5% SOM inclusion level followed by 7.5% inclusion level while the least was observed in treatment with 5% SOM inclusion level. The observations agreed with the findings of Tacon et al. (2007) who reported that using weight gain as criterion for evaluation, the incorporation of snail meal of *Achatina* species in the diet of chicks replacing the fishmeal on weight basis showed that at 10% level of inclusion snail meal, it had no deleterious effect on the chicks.

For the linear body measurements (Table 5), the highest thigh increase was recorded in treatments with 2.5 and 7.5% SOM inclusion level. The shank length recorded the highest increase in treatment with 5% SOM inclusion level while the least was observed in treatment with 0% SOM inclusion level. Birds in treatment with 2.5% SOM inclusion level was significantly (P<0.05) the highest in terms of wing increment, back length increase was the highest in treatment with 0% SOM inclusion level; girth increase was significantly (P<0.05) the highest in treatment with 7.5% SOM inclusion level while the least was observed in 5% SOM inclusion level and the total body length was significantly (P<0.05) the highest in treatment with 7.5% SOM inclusion level while the least was observed in treatment with 0% inclusion level. This agreed with the findings of Asafa et al. (2012), Ologhobo et al. (2012) and Sethi and Chawla (1994) that incorporated snail offal at the level of 25, 50, 75 and 100% in the diets of layers replacing the fishmeal on nitrogen basis.

In terms of carcass weight measurement (Table 6), the broiler chicken fed different levels of SOM recorded high performance in their cut up parts. The treatment with inclusion of 2.5% has the highest mean weight of the cut up parts namely thigh, breast, defeathered and eviscerated while the least was recorded in the treatment with 7.5% SOM inclusion level. The mean weight of wing was the highest in treatment with 0% SOM inclusion while the lowest was recorded in 5% SOM inclusion. This observation was in agreement with the findings of Akinmutimi and Onenm (2008).

In terms of organ weight measurement (Table 7), the broiler chicken in treatment with 2.5% SOM inclusion had

Table 6. Summary of the mean of defeathered, eviscerated and cut up parts weight measurement (g).

Treatment	Defeathered	Eviscerated	Thigh	Breast	Wing
T1 (0%)	$2750±100^{b}$	$1700±200^{b}$	$572.10±2.00^{c}$	$637.03±1.95^{c}$	$275.83±2.84^{d}$
T2 (2.5%)	$3500±100^{c}$	$2600±200^{c}$	$830.33±1.52^{d}$	$869.50±2.00^{d}$	$250.27±1.61^{c}$
T3 (5%)	$2400±100^{a}$	$1300±200^{a}$	$520.00 ±2.00^{a}$	$523.00±2.00^{b}$	$191.40±2.00^{b}$
T4 (7.5%)	$2320±100^{a}$	$1400±200^{ab}$	$524.90±2.00^{b}$	$229.03±1.95^{a}$	$184.87±1.25^{a}$

**Columns sharing different superscripts are significantly different (P<0.05); T1 contains 0% SOM inclusion (control diet), T2: 2.5% SOM inclusion, T3: 5% SOM inclusion, T4: 7.5% SOM inclusion.

Table 7. Summary of the findings on the organ weight measurement.

Organs (g)	T1 (0%)	T2 (2.5%)	T3 (5%)	T4 (7.5%)
Kidney	$5.10±0.200^{c}$	$1.30±0.200^{a}$	$1.90±0.200^{b}$	$1.70±0.200^{b}$
Liver	$69.73±0.643^{b}$	$120.40±0.529^{d}$	$61.27±1.617^{a}$	$102.27±2.411^{c}$
Lungs	$4.00±0.200^{c}$	$6.40±0.200^{d}$	$2.70±0.200^{a}$	$3.60±0.200^{b}$
Pancreas	$8.27±2.411^{a}$	$17.60±0.608^{c}$	$13.13±0.321^{b}$	$14.80±0.200^{b}$
Caeca	$12.00±2.00^{a}$	$18.40±2.000^{b}$	$30.50±2.000^{c}$	$20.07±2.050^{b}$
Gizzard	$72.07±1.531^{a}$	$102.20±2.307^{b}$	$70.97±1.361^{a}$	$73.93±1.721^{a}$
Heart	$13.87±0.757^{a}$	$18.03±1.050^{c}$	$16.50±0.200^{b}$	$13.67±0.666^{a}$
Crop	$77.40±1.709^{c}$	$23.67±1.258^{a}$	$75.40±3.460^{c}$	$31.07±1.901^{b}$
Small intestine	$130.47±1.450^{b}$	$160.43±0.814^{d}$	$140.07±1.102^{c}$	$107.07±2.101^{a}$

**Rows sharing different superscripts are significantly different (P<0.05); T1 contains 0% SOM inclusion (control diet), T2: 2.5% SOM inclusion, T3: 5% SOM inclusion, T4: 7.5% SOM inclusion.

the highest mean weight of the organs: liver, pancreas, heart, lungs, gizzard, caeca and small intestine while the least was observed in treatment 0% inclusion. The mean kidney and crop weight was the highest in control (0%) SOM inclusion. The significant difference (P<0.05) in the organ weight of broiler chicken between the dietary treatment and control concurred with the report of Philip et al. (2014) who fed broiler chicken with rumen epithelial scrapping meal in replacement for fish meal.

Conclusion

The study showed that snail offal meal can be used as a protein feed ingredients in broiler chicken diets. The study recommends that the best dietary treatments are the 2.5 and 5% SOM inclusion levels owing to the better weight gain and feed conversion potential of the treatment diets. Therefore, further research is necessary to improve the feed quality and to determine if snail offal meal can completely replace fishmeal in poultry feed formulation as this will encourage waste to wealth creation.

CONFLICT OF INTERESTS

We hereby declare that there was no conflict of interest.

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International Journal of Livestock Production

Full Length Research Paper

Major causes of chicken mortality in and around Hawassa City, Sidama Zone, Southern Ethiopia

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A cross sectional study was conducted from November 2017 to March 2018, to assess major causes of chicken mortality and identifying parasite types in and around Hawassa city, Southern Ethiopia. One hundred sixty respondents were selected using multistage sampling technique. Questionnaire and laboratory data were analyzed using STATA version 14. Among the respondents 34% kept their chicken extensively while 52 and 14% used semi-intensive and intensive chicken production system respectively. From 73% of the respondents with separate chicken house, 70% practiced house cleaning. Out of the total respondents; 23, 72 and 5% practiced scavenging, scavenging with supplement and commercial feed for their chicken respectively and 55% of them with free access to water. Only 12% practiced vaccine for the health management of their chicken and 64% dispose dead chicken anywhere in the environment but 34 and 2% bury and burn dead chicken respectively. According to respondents; disease, mismanagement, predator, cannibalism and bad weather condition were reported as major causes of chicken mortality. Out of total 64 fecal samples, 50, 4.5 and 45.5% from local, cross and exotic breeds were found parasite positive respectively. About 63.6, 18.2 and 18.2% of the parasites were detected from chicken reared under extensive, semi-intensive and intensive production system respectively. Six parasite types were mainly identified from Hawassa city and its surrounding. Therefore, chicken improvement program in and around Hawassa city should work intensively to minimize the constraints of the sector and then to increase the production and productivity of chicken.

Key words: Chicken, disease, Hawassa, management practices, mortality, parasite.

INTRODUCTION

Animal production in general and chicken production in particular plays an important socioeconomic roles in developing countries. Chicken production provides significant contribution to human food production (Kebede et al., 2017). This is being subjected to great pressure to satisfy the demand for animal protein required by the continued increase in human population (Safari et al., 2004). Additionally, it is an interesting tool to respond rapidly to poverty gaps if chickens are included in rural development strategies (Jarso, 2016).

The total chicken population of Ethiopia is estimated over 56 million, about 98% of which are kept under rural household conditions (CSA, 2014). About 96.6% representing native chicken of none descriptive breeds,

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0.55% hybrid chicken and 2.84% exotic breeds of chickens mainly kept in urban and peri-urban areas of the country (CSA, 2014). Chicken husbandry in an intensive system is also practical in some urban and per urban areas and only represents 1% of the total population in the country however, having this huge number of chicken, their production and productivity is significantly low (Addis et al., 2014).

Chicken production sector has been adversely affected by a variety of constraints; of these chicken mortalities due to diseases play the major role of hampering its development. This is estimated to be ranging from 20 to 50%, but it may rise as high as 80% during epidemics (Addis et al., 2014). Some published information on the constraints to backyard chicken production in Ethiopia indicated that it is characterized by high mortality caused by disease, predators, and poor management and nutrition. Out of which, infectious diseases are one of the most important cause of mortality in village chicken (Jarso, 2016). Parasitism is one of the major problems which inflict heavy economic losses to the chicken in the form of retarded growth, reduced weight gain, decreased egg production, diarrhea and obstruction of intestine, poor feathers, replacement birds that take long to reach maturity, morbidity and mortality (Negash et al., 2015).

To develop successful chicken production strategy in Ethiopia as general and in and around Hawassa city as particular, comprehending the various causes of chicken mortality and identification of major parasite types are pre-conditions. However, there were gaps in previous studies dealing with causes of chicken mortality and identification of major parasite types in and around Hawassa city. This study was conducted to identify parasite types and major causes of chicken mortality, and also to provide basic information to different stakeholders to take measure on disease prevention and control.

MATERIALS AND METHODS

Description of the study area

The study was conducted in and around Hawassa city. It is the capital city of SNNPRS and located at 07°02 22 N to 38°29 16 E and an altitude of 1,690 m above sea level. The area have an average annual temperature and humidity of 22°C and 64% respectively. It is located 275 km south of Addis Ababa in Ethiopian Great Rift Valley. The total human population of the area is 399,461 (199,768 male and 199,693 female) (CSA, 2014) and the city has a total of eight sub-cities and 32 Kebeles.

Sampling method

Local, cross and exotic breeds of chicken reared under different farming systems in 8 purposively selected villages of the Hawassa city and its surrounding were included.

Study design

Questionnaire and laboratory based cross-sectional type of study was conducted in different farming systems of 160 chicken rearing households/farms from 8 kebeles of Hawassa town and its surrounding.

Sample size and sampling technique

The purposive sampling technique was used to select the sample included under this study. From the 8 sub cities 4 sub cities were randomly selected for this study. Then from the 4 sub cities 8 villages were included purposively based on the availability of chicken population in the area. These kebeles named as Alamora, Chefekoti jebessa, Daka, Dato, Fara, Hiteta, Tesso and Tullo were included in this study. Then, a formal list of household were categorized based on production system, flock size, breed and history of chicken mortality were also considered. From each kebele 20 farmers were selected for questionnaire survey based on willingness of the respondents that made a total of 160 households. In addition to questionnaire survey, 8 of the 20 households from each kebele randomly considered for parasitological fecal examination which made a total of 64 fecal samples from the study area.

Questionnaire survey

Semi-structured questionnaires were prepared and administrated to collect information on chicken production from each selected household. Before the formal interview the prepared questionnaire was tested on 2 of selected chicken rearing households from each Kebele. Then the questionnaire was improved and finally formal interview was carried out.

Fecal sample collection and isolation of parasite eggs

Fresh fecal droppings were collected from chicken houses to isolate the parasite eggs. During fecal samples collection; date, household characteristics, production system and breed of each sampled chicken was recorded. For this study a total of 64 fecal samples were collected. Twenty one from chicken reared under extensive production system, 29 from chicken reared under semi-intensive production system and 14 from chicken reared under intensive production system. Nineteen of the fecal samples were collected from local breed, 5 from cross breed and 40 from exotic breed were collected during the study period and transported to Hawassa university veterinary parasitological laboratory using coded formalin containing screw capped plastic bottles (Annex 1). Parasite eggs were isolated using fecal flotation technique (Annex 2).

Data management and analysis

Questionnaire data and fecal examination result were entered in to Microsoft-Excel spread sheet for management, and then the data was analyzed by using STATA version 11.0 for Windows (Stata Corp. College Station, TX, USA) and finally the table was constructed and the proportion of the respondents was done by using descriptive statistics. In all the analyses, confidence levels at 95% were calculated, and a $P < 0.05$ was used for statistical significance level.

Questionnaire survey result

Characteristics of respondents in the study area

In the study area proportion of female respondents was

Table 1. Characteristics of respondents in and around Hawassa town.

Variable	Category	Frequency	Proportion (%)
Sex	Male	67	42
	Female	93	58
Age	Young	72	45
	Adult	88	55
Education status	Illiterate	34	21
	Primary school	38	24
	Secondary school	45	28
	College and university	43	27

Table 2. Flock characteristics of chicken in and around Hawassa town.

Variable	Category	Frequency	Proportion (%)
	< 50	152	95
Flock size	50-500	2	1
	>500	6	4
	Local	50	31
Breed	Cross	16	10
	Exotic	94	59

higher than males and detail characteristics of the respondents (Table 1).

Flock characteristics

Dominantly respondents used small flock size of chicken. Among different types of breed reared in the study area, exotic breeds are dominant (Table 2).

Production system and housing condition

Semi-intensive type of production system was highly practiced in the study area. Separate chicken house provision and regular cleaning was provided by most respondents and practiced three feeding mechanisms in the study area. Scavenging with supplement type of feeding mechanism was the dominant one. In addition to feeding, chicken owners also practiced three categories of daily watering frequencies for their chicken as shown in Table 3.

Health management practices

Only 12% of chicken owners practiced vaccine for the disease control of their chicken. Regarding dead chicken disposal, few numbers of farmers used to bury or burn the dead chicken (Table 4).

Major causes of chicken mortality

Among the five major causes of chicken mortality, disease is identified as the primary for chicken mortality as shown in Figure 1.

Laboratory fecal examination result

Parasite identified within breed

Out of total 64 fecal sample examined, 22 were found positive for different parasite types. Six different eggs of parasitic species were isolated from different breeds of chicken, among the isolated parasitic eggs, Coccidia spp (36.4%) was dominantly detected as shown in Table 5. From the Laboratory results, chicken under extensive production system were highly parasite positive thank the others (Figure 2).

The association between risk factors and occurrence of parasitic diseases

Statistically significant association was observed between

Table 3. Chicken production system and management practice in and around Hawassa town.

Variable	Category	Frequency	Proportion (%)
Production system	Extensive	54	34
	Semi-intensive	84	52
	Intensive	22	14
Separate chicken house	No	43	27
	Yes	117	73
Feeding mechanism	Only scavenging	37	23
	Scavenging with supplement	115	72
	Commercial feed	8	5
Frequency of watering	Once/day	19	12
	Twice/day	53	33
	Free access	88	55

Table 4. Health management practices in and around Hawassa town.

Variable	Category	Frequency	Proportion (%)
Vaccination	No	141	88
	Yes	19	12
Action taken to dead chicken	Buried	54	34
	Burned	4	2
	Throw elsewhere	102	64

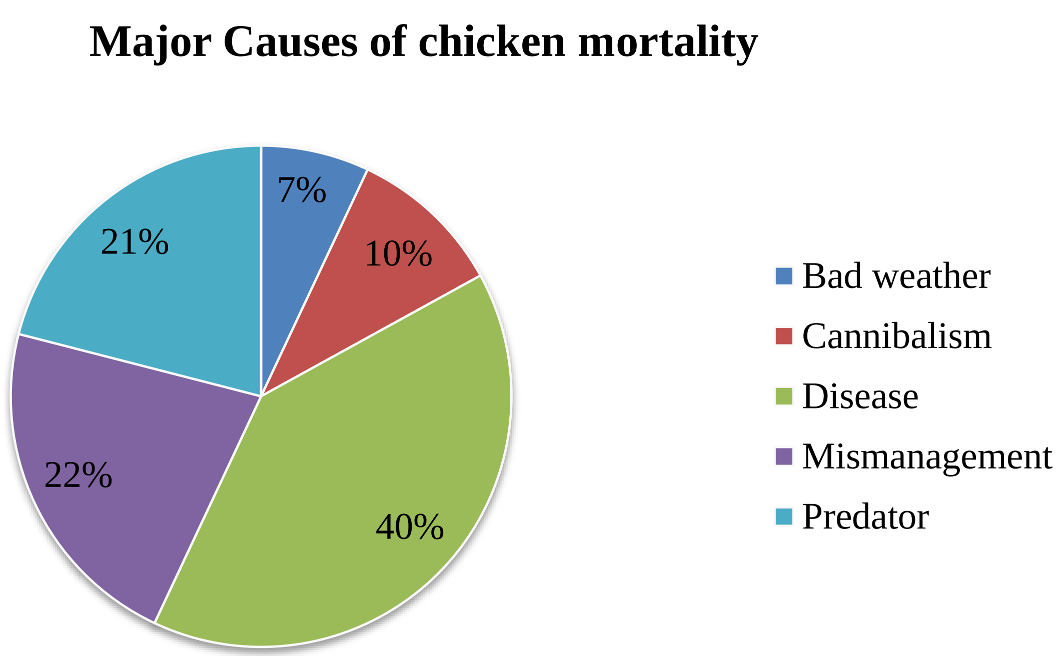

Figure 1. Major causes of chicken mortality in and around Hawassa town.

Table 5. Parasite eggs detected from different breeds of chicken.

Parasite eggs detected	Breed			Total
	Local	Cross	Exotic	
Ascaridia galli	4	0	1	5(22.7%)
Capillaria spp.	2	0	0	2(9.1%)
Coccidia spp.	1	0	7	8(36.4%)
Heterakis galinarium	1	0	1	2(9.1%)
Raillietina spp.	2	1	1	4(18.2%)
Syngamus tracheae spp.	1	0	0	1(4.5%)
Total (%)	11(50%)	1(4.5%)	10(45.5%)	22(100%)

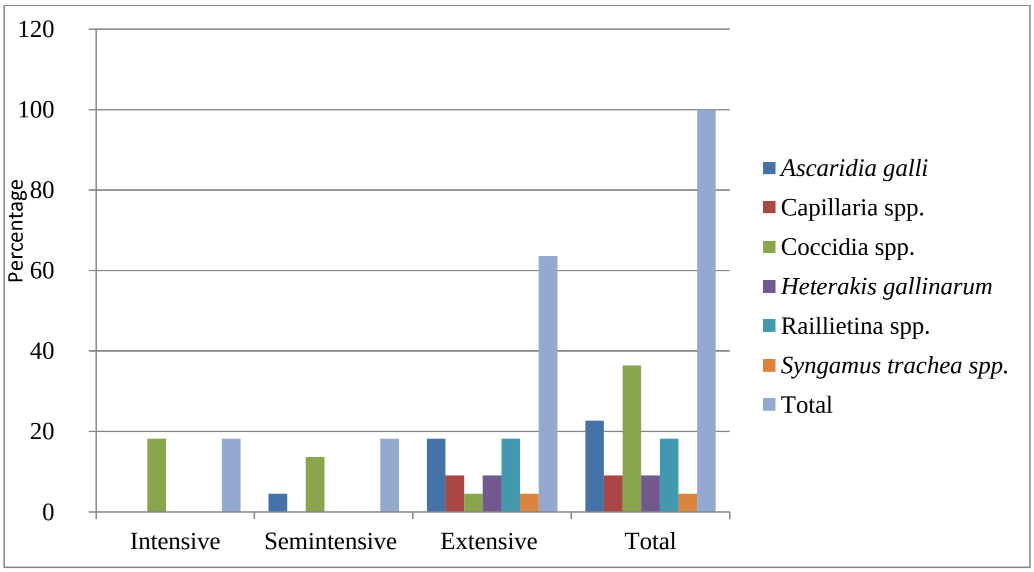

Figure 2. Occurrence of parasitic diseases under different production systems.

Table 6. The association between risk factors and the occurrence of parasitic diseases.

Risk factor	Category	Chicken examined	Positive	P-value	CI (95%)
	Cross	5	1		
	Local	19	11	0.047	0.00437-0.75803
	Exotic	40	10		
Production system	Extensive	21	14	0.329	-0.56453-0.19203
	Semi-intensive	29	4		
	Intensive	14	4		

local and exotic breed on parasitic diseases occurrence (P<0.05) (Table 6).

DISCUSSION

In the present study, the highest number of households reported small flock size of chicken. This is similar with the work of Muhammad et al. (2010) who reported highest number of households owned small flock size. This is due to the fact that small flock size is cheaper and easy to manage than large flock size. In the current study area, the highest number of households used exotic chicken breeds (59%). This report contrast with the report of Mohamed et al. (2016) from Jigjiga Zone, reported 65% of the households used local breeds of chicken. Dessie and Ogle (2001) from central highlands of Ethiopia, reported the dominant indigenous breed with some exotic breed. Getu and Birhan (2014) from North Gondar, Ethiopia, reported all households used only pure indigenous chickens. The reason for the dominance of exotic chicken breed in the present study might be due to the availability of exotic chicken breed multiplication and distribution center in the study area.

Semi-intensive production system is being practiced by most respondents in this study area. This report in line with the report of Mazengia et al. (2012), reported 61.5% of respondents used semi-intensive production system and contrast with the report of Salo et al. (2016), Mohamed et al. (2016) and Addis et al. (2014), reported 90, 93.3 and 63% of households used extensive production system respectively. The dominance of semi-intensive production system in the present study area is due to high population and urbanization, housing demarcated by fence from outside area. Therefore, including chicken all individual property protected from theft and other accidents, so chicken only allowed scavenging inside the fenced area termed as semi-intensive production system.

High number of households managed their chicken in separate chicken houses and cleans regularly. This report in line with the report of Mazengia et al. (2012) and Mohamed et al. (2016) reported 81.5 and 85.4% of households used to manage their chicken in Separate chicken house respectively. While it contrasts with the report of Salo et al. (2016), 76.7% of the households have no separate chicken house. Dessie and Ogle (2001) from central highlands of Ethiopia reported (88.5%) households kept chicken inside the family dwelling at night. In the present study the higher proportion of households practiced chicken house cleaning. The major use of separate chicken house and house cleaning practiced from current study area is due to the presence of high literate population who has knowledge for better care of chicken.

Majority of the households used Scavenging with supplement feeding mechanism for their chicken. This report agree with report of Mohamed et al. (2016) who report more than 80% of the households supplement their chicken with one hand full of grain twice per day. This might be due to highest number of households practiced semi-intensive production system, chicken have no chance to forage wide area. Free access water was provided by most households for their chicken. This report contrast with report of Salo et al. (2016) who reported high number of households provided water for their chicken only once/day.

The minimum level of health management practices (12%) was observed in current study. This report is in line with the report of Addis et al. (2014) who reported only 30% of households practiced vaccine. The current report might be due to dominance of small flock size in the study area and paid less attention on chicken health management practice. Regarding biosecurity practice, small proportion of households used to bury (34%) or burn (2%) the dead chicken, while the rest throw elsewhere (64%). This report in line with report of Addis et al. (2014) who reported 82% of households throw the dead chicken elsewhere. Different reports also confirmed that dead birds not properly disposed, pose a danger to other flocks and farms and cause soil, air and water pollution. This might be due to lack of biosecurity awareness in the study area.

Five major causes of chicken mortality were reported. Among the causes, disease identified as the primary and followed by mismanagement, predator, cannibalism and bad weather condition. Jarso (2016) also reported disease as the primary cause of chicken mortality while, Tesfu (2007) stated predators as the major constraint to chicken production followed by disease. The current report may be due to improper disposal of dead chicken practiced by most chicken owners in the study area, aggravated disease as a primary major cause of chicken mortality.

Ascaridia galli (22.7%), Capillaria spp. (9.1%), Coccidia spp. (36.4%), Heterakis gallinarum (9.1%), Raillietina spp. (9.1%) and Syngamus trachea spp. (4.5%) are majorly identified parasites. Addis et al. (2014) from Bahir Dar Zuria District, Ethiopia; Awuni (2002) from Ghana; Kumer et al. (2015) from India and Solanki et al. (2015) from Gujarat, similarly reported these chicken parasites. Semi-intensive management of the chicken in the study areas is majorly contributed for the prevalence of different parasite types.

Statistically significant association was observed between breed and parasitic diseases occurrence (P<0.05). This report in line with the report of Gebeyeh and Yizengaw (2017) and Negash et al. (2015) from Ethiopia, reported significant association between breeds of chicken on prevalence of Coccidia infection (P< 0.05). The present report could be connected with the fact that local breeds of chicken dominantly reared under extensive production system could possibly get regular infection with the variety of parasites when they fed on open space environment on intermediate hosts of the parasites.

Conclusions

In conclusion chicken production plays vital role in the livelihood of households' living in and around hawassa city. Diseases were identified and accepted as the major cause for the mortality of chicken kept under the study areas. Poor disposal practices of dead chicken in the study area might be the reason for the disease to be the major cause of chicken mortality. In addition to disease; mismanagement, predator, cannibalism and bad weather also reported as causes of chicken mortality. There should be awareness creation and training of chicken owners about biosecurity and other health management practices. Moreover, detailed studies should be carried out to investigate the disease problems prevailing in Hawassa town and its surrounding.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Effects of sources of dietary protein supplemented to oat-vetch hay mixture on milk yield and milk composition of crossbred dairy cows

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The experiment was conducted in Debre Zeit Agricultural Research Center with the objective of evaluating the effects of sources of dietary protein supplemented to oat-vetch mixture hay on milk yield, milk composition and profitability in lactating crossbred dairy cows. Four high grade cross bred (Holstein Friesian × Boran) dairy cows with similar lactation stage (mid lactation) and parity were used. The experimental diets were T1 (ad libitum oat-vetch hay + noug seed cake), T2 (ad libitum oat-vetch hay + cottonseed cake), T3 (ad libitum oat-vetch hay + linseed cake) and T4 (ad libitum oat-vetch hay + mixture of the three oil seed cakes). A 4 × 4 Latin square design was used for the feeding experiment with four dietary treatments assigned to animals at random initially. The animals were offered hay at a rate sufficient to allow for a 20% refusal and the amount of concentrate offered was at 0.5 kg/l of milk in all treatments. The concentrate mix consisted of 33% oil seed cakes (OSC), 66% wheat bran and 1% salt. Treatment effects on milk yield, milk fat, milk protein, lactose and total solids were significantly different (P<0.05). Economic analysis showed that T2 based supplementation was feasible than the remaining dietary treatments. Therefore, it can be concluded that T2 can optimize both biological and economic response of dairy cows.

Key words: Cottonseed cake, dairy cow, linseed cake, milk, noug seed cake, oat-vetch, wheat bran.

INTRODUCTION

Ethiopia's stricken economy is based on subsistence agriculture accounting for almost half of the gross domestic product (GDP), 60% of exports, and 80% of total employment (Exxun, 2008). The sub-sector also accounts for 19% to the export earnings (BoFED, 2006). Livestock production contributes 30 to 35% of the GDP and more than 85% of farm cash income. In this respect, milk production is playing a vital role in the livelihoods of the people of Ethiopia.

Inadequate and unbalanced feed supplies are the major

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Table 1. Experimental treatments.

Treatment	Treatments description	Supplements feeding level (kg/L of milk/day)
Treatment 1 (T_1)	*Ad* O-V + NSC (33 %) + WB(66%) + salt (1%)	0.5
Treatment 2 (T_2)	*Ad* O-V + CSC (33%) + WB (66%) + salt (1%)	0.5
Treatment 3 (T_3)	*Ad* O-V + LSC (33%) + WB (66%) + salt (1%)	0.5
Treatment 4 (T_4)	*Ad* O-V + NSC (11%) + CSC (11%) + LSC + (11%) + WB (66%) + salt (1%)	0.5

Ad O-V = *Ad-libitum* oat-vetch hay; NSC = Noug seed Cake; LSC = Linseed Cake; CSC = Cottonseed Cake; WB = wheat bran; d = day.

technical problem that results in low total milk output, reduced milk yield per cow and reduced replacement stock (Ahmed et al., 2003). Feeds rich in energy, protein, and minerals are important for optimum milk production and reproductive efficiency. Milk composition is also influenced significantly by dietary factors (De Peters, 1992). However, cattle are predominantly fed on natural pastures and crop residues. Thus, due to the scarcity as well as poor quality of feeds available, the productivity of crossbred animals is very low. In order to exploit the production capacity, the crossbreds require not only more feed, but also feeds of better quality. If these facts are not taken into consideration properly, the cross bred dairy animals will suffer from under feeding and they will also produce below their capacity (Mohamed et al., 2010).

Most dairy farmers in Ethiopia heavily rely on agro-industrial byproducts than mixed concentrates. The mix of available concentrate feeds also largely depends on the availability of the materials and quantity than the quality of nutrients and animal requirement. The most commonly used feed resources for dairy animals are natural grass and legume hay, wheat bran and middling, and noug seed (*Guizota abyssinica*) cake (Staal and Shapiro, 1996). Although cottonseed cake is one of the available oil seed cakes widely used as protein source in Ethiopia, it is rarely utilized in commercial dairy farming system as compared to fattening operation. Hence, information on its potential in improving productive and reproductive performances of dairy cattle is limited. Nevertheless, there is a considerable interest in protein sources that are slowly degraded in the rumen. These relatively resistant protein sources can have special value for lactating cows and for young growing ruminants whose protein requirements are relatively high (Tamminga, 1979).

In response to this, empirical analysis of the adoption of forage in dairy farms in mixed farming systems has taken place in Debre Zeit area where forage technology has been introduced in association with improved dairy production. The empirical results suggest that the potential for adoption of improved forage is high where both livestock productivity and response to improved feed technology are high, as with crossbred cows and where production is more market-oriented, as with dairy (Mohamed et al., 2010). However, little work has been done on determining the level and type of supplementation to be used with improved forages such as oat-vetch mixture hay in a way it optimizes the performance and profitability of dairy production. Therefore, the objective of this study was evaluating the effects of sources of dietary protein supplemented to oat-vetch mixture hay on milk yield, milk composition and economic feasibility in lactating crossbred dairy cows.

MATERIALS AND METHODS

The study area

The study was conducted in Debre Zeit Agricultural Research Center (DZARC), which is located 45 km south east from Addis Ababa. The area has an altitude of about 1900 m.a.s.l. The maximum and minimum temperature received is 24.3 and 8.9°C, respectively and the mean annual rainfall of the area is 851 mm.

Experimental animals

Four lactating crossbred cows (Boran × Holstein Friesian) with similar lactation stage (mid lactation) and different parities (third, fourth, fifth and sixth) were used. The cows were for a period of 112 days, that is, four periods of 28 days each. The first 14 days of each period involved the adaptation of the animals to the treatment diets. Measurements and data collection were conducted during the remaining 14 days of each period. The cows were fed and watered individually. Milking was conducted by hand twice per day at 6:00 am in the morning and at 3:00 pm in the evening.

Experimental diets

The basal feed used for the experiment was oat-vetch mixture hay. The animals were supplemented with concentrate feed, composed of noug seed cake, linseed cake and cottonseed cake separately mixed with wheat bran at a ratio of 33:66 oil seed cakes to wheat bran and 1% salt across the treatment. The concentrate mixtures were based on the requirement for major nutrients of lactating crossbred cows with milk yield of 8 to 10 L/day and a butter fat content of 4.5% as recommended by ARC (1990) when fed at the rate of 0.5 kg/l of milk. The hay was offered at a rate sufficient to allow for a 20% refusal (Table 1).

Experimental design

A 4 × 4 Latin square design was used for the feeding experiment with four dietary treatments assigned to each animal, but one dietary treatment per period. The dairy cows were adapted to each of the diet for a period of 14 days that is between each period, followed by a period of 14 days of data collection.

Milk yield and milk composition

Individual cow milk samples from morning and evening for seven days of the experiment were taken and placed in a clean plastic cup, after placing it in icebox and taken to laboratory for milk composition analysis. The milk samples were analyzed for fat, protein, total solids, and lactose contents. Lactoscan® (Page and Pedersen, international Ltd USA, 2004) instrument was used for milk composition analysis.

Partial budget analysis

A simple partial budget analysis was conducted on the basis of calculation of the total cost of supplement feeds [cottonseed cake (CSC), Noug seed (*Gizotia abyssinica*) cake (NSC) and linseed cake (LSC)] and basal diet (oat- vetch), and considering milk sales price and labor cost during the experimental period gained from the result (Upton, 1979). The milk price was fixed based on the market price of milk. The prices of the supplements and oat-vetch for treatment were obtained from the current market price during the experimental period. In the analysis, the total return (TR) was determined by the difference between milk selling and feed cost in each treatment across the four period. The net income (NI) was calculated by subtracting total variable cost (TVC) from the total return (TR).

NI = TR-TVC

The change in net income (NI) was calculated as the difference between the change in total return (TR) and the change in the total variable cost (TVC):

ΔNI = ΔTR-ΔTVC

The marginal rate of return (MRR) measures the increase in net income (NI) associated with each additional unit of expenditure (TVC).

Statistical analysis

Collected data from milk yield and compositions, live weight changes, apparent digestibility, voluntary dry matter (DM) and nutrient intakes were coded as deemed necessary and entered into the Microsoft excel program and summarized. Data analysis was carried out using the mixed procedure of SAS (2004). Treatment means were computed using the LSMEANS option and separated using comparisons of least squares mean. The following model was used to analyze the effect of supplementation of oil seed cakes on feed intake, apparent digestibility, body weight change, milk yield, and milk composition.

$Y_{ijkl} = \mu + C_i + P_j + T_k + e_{ijkl,}$

Where, Y_{ijkl} = response from i^{th} cow, during p^{th} period to k^{th} treatment; μ = population mean; C_i= i^{th} cow effect (i= 1, 2, 3, 4); P_j = j^{th} period effect (j=1, 2, 3, 4); T_k = t^{th}treatment effect (k = 1, 2, 3, 4) and
e_{ijkl} = Residual error.

RESULTS AND DISCUSSION

Body weight change of cows

The effect of dietary treatments on body weight change was significantly (p<0.05) different. Linseed cake based supplement resulted in the highest (4.25 kg) followed by cotton seed cake (3.25 kg) and T4 (3.00kg) based supplement. There was no weight loss across the whole treatments. The absence of weight loss during all periods indicate that all the supplements together with the basal diet provided sufficient nutrient to the animal above the maintenance requirement (Table 2).

Cows on all dietary treatments in the present study have a positive change in body weight. The positive weight change across the all treatments is attributed to the fact that supplementing cows with different types of oil seed cake with wheat bran do not have any negative effect on body weight change.

The highest (p<0.05) body weight change was observed when linseed cake was supplemented to the animals. This might be attributed to the fact that linseed cake produce rapid gain and excellent finish and it is more useful for fattening animals than dairy animals (Adugna, 2008). Similarly, cows supplemented with cottonseed based concentrate showed the second highest weight gain, this is because of the fact that cotton seed cake is also an excellent protein supplement for fattening animals and is practically equal to linseed meal for fattening in addition to increasing milk yield and milk composition.

Milk yield and composition

The highest (7.97 kg) milk yield was obtained from cows supplemented with cottonseed cake (T2) followed by the group supplemented with (T4) mixtures of the three oil seed cakes (7.17 kg). Similarly, there were significant (p<0.05) treatment effects on milk fat, milk protein, lactose and total solids (p<0.01). Cows fed T2 diet showed relatively the highest (4.44%) milk fat content followed by T4 (4.32%) and T1 (4.16) whereas the least (3.95%) was recorded for those cows fed diet T3. Similarly, cows fed T4 diet produced 0.955, 0.564 and 0.28% more lactose than T3, T2, and T1 supplement diet consumed cows, respectively.

The mean daily milk yield (6.95 kg/day) from the present trial was almost similar to the value of 6.66 kg/day reported by Khalilli et al. (1992) for crossbred cows fed a basal diet of oat-vetch hay supplemented with a concentrate at the rate of 2.5 kg/day. Likewise, the mean daily milk yield of 6.95 kg/day from the present trial is also comparable to the value of 6.2 kg/day milk yield reported by Varvikko and Khalilli et al. (1993) for crossbred cows fed a basal diet of oats-tagasaste forage supplemented with a concentrate at the rate of 2.5 kg/day (Table 3).

Cow milk production and milk composition are governed by nutritional values of feeds. Quality protein supplement based on protein requirements of cows for maintenance and milk production, improve milk production due to the effects on feed digestibility and dry

Table 2. Average body weight change of dairy cows fed with different experimental diets over the experimental period.

Treatment	Number of cows	Live weight change (kg/cow)
T1	4	2.50[b]
T2	4	3.25[ab]
T3	4	4.25[a]
T4	4	3.00[b]
Mean		3.25
SL		*
SEM		0.33

[ab]Means with different superscripts within column are significantly different ($p < 0.05$).

Table 3. Milk yield and composition of dairy cows fed with different experimental diets.

Treatment	Milk yield (kg/d)	Milk composition			
		Fat (%)	Protein (%)	Lactose (%)	TS (%)
T1	6.47[b]	4.16[bc]	2.91[a]	4.16[b]	12.32[b]
T2	7.97[a]	4.44[a]	2.94[a]	4.18[b]	12.72[a]
T3	6.17[bc]	3.95[c]	2.82[b]	4.03[b]	11.62[c]
T4	7.17[ab]	4.32[ab]	2.92[a]	4.35[a]	12.30[b]
Mean	6.95	4.22	2.89	4.18	12.24
SL	*	*	*	*	**
SEM	0.39	0.08	0.02	0.05	0.02

[abc]Means with different superscripts within column are significantly different ($p<0.05$).

matter intake. Toolsee and Boodoo (2002) noted 11 to 30% increases in milk production when cows were supplemented with a ration containing CSC at a percentage of 33% which is in line with the present study.

The mean values of lactose (4.18%) and total solids (12.24%) can fairly be compared with values of 4.10 and 12.66% reported by Zelalem (1999) in cross dairy cows fed hay supplemented with concentrate. Similar to the present study, Petit (2010) reported that feeding diets with whole or crushed or micronized linseed had significant effect on the milk protein content in dairy cows during mid-lactation. The mean milk protein content (2.89%) in the present study was in line with the value (2.81%) reported by Adebabay (2009) in local cows fed treated wheat straw supplemented with noug seed cake. Similarly, Hayaz et al. (2013) reported 2.77±0.09% milk protein from cows fed 35% of CSC in a ration which was almost similar to the current study. Milk protein content throughout the four treatment groups in this study was lower than the expected. The lower percentage of milk protein in the present study can be attributed to the total mix ration intake or may be due to usual inverse relationship between milk and the content of milk solid components (Olafadehan, 2008). According to Klusmeyer et al. (1990) milk protein content depress with increased in forage intake. Likewise, Looper (1997) noted that dietary manipulation results in milk protein concentration changing approximately 0.60 percentage units. However, milk protein content and yield could also be increased by improving the profile of amino acid in microbial protein, by reducing the amount of surplus protein in the diet, and by increasing the amount of fermentable carbohydrate in the diet.

The present result showed that supplementing animals with cottonseed cake had significantly higher milk fat content as compared to other oil seed cakes. Therefore, cottonseed cake is an excellent oil seed cake used to improve milk production and milk composition constituents in lactating dairy cows. Similar to the present study, James et al. (2010) had concluded from his study that supplementation of CSC has significantly ($P < 0.05$) increased the milk fat content. In general feeding supplement based on CSC to smallholder subsistence dairy cows may have an advantage since the system is based on sale of butter fat than liquid milk. However, this could be also of value in countries where milk sale is based on fat percent.

Partial budget analysis

The effects of feeding different oil seed cakes (NSC, CSC and LSC) as protein sources and oat-vetch hay on net

Table 4. Profitability of milk production from cows fed with concentrate mix based on different oil seed cakes.

Parameter	Treatment			
	T1	T2	T3	T4
O-V hay consumed (Kg/cow)	481.00	493.92	474.88	474.32
Concentrate consumed (Kg/ cow)	181.44	222.32	173.6	192.64
Total feed consumed(Kg/cow)	662.44	716.24	648.48	666.96
Milk yield (kg/cow/d)	6.47	7.97	6.17	7.17
TVC/treatment (birr)	3818.79	3927.26	3950.17	3893.73
Gross income (ETB)	4347.84	5355.84	4146.24	4818.24
Net return (net income)	529.05	1428.58	196.07	924.51
Change in total return (TR)		1008	-201.6	470.4
Change in net income (∆NI)		-899.53	-332.98	395.46
Change in total variable cost (∆TVC)	-	108.5	131.38	74.94

1 kg NSC =4 ETB, 1 kg CSC = 4.5 ETB, 1 kg LSC = 8 ETB, 1 kgWB = 2.5 ETB, 1 kg Oat-vetch = 2.5 ETB, T1 = NSC + WB + ad libitum oat-vetch mixture hay; T2 = CSC + WB + ad libitum oat-vetch mixture hay; T3 = LSC + WB + ad libitum oat-vetch mixture hay; T4 = NSC + CSC+ LSC + WB + ad libitum oat-vetch mixture hay; ∆TVC = change in total variable cost; ∆NI = change in net income; MRR = marginal rate of return.

return (NR) and marginal rate of return (MRR) are presented in Table 4. The result obtained from partial budget analysis indicated that cottonseed cake supplementation (T2) has higher net return followed by T4, T1 and T3 respectively. The lowest net return was obtained from cows supplemented with linseed cake (T3) supplementation. Although there were some variations in net return, there was no loss.

The variation in net return between treatments occurred due to price difference between the three oil seed cakes, the amount of total feed intake per treatments and total milk yield per treatment. The result showed that the net return in the present study was, 1428.58 (T2), 924.51(T4), 529.05(T1) and 196.07(T3) ETB, indicating that the net return order was T2 > T4 > T1 > T3. In general from the current experiment, T2 tends to be more economical without affecting body weight, milk yield and milk composition.

Conclusion

Depending on availability and price of those supplements, using cottonseed cake as a protein supplement for oat-vetch hay basal diet is preferable in milk yield and composition compared to other treatments. However, protein supplementation should consider prices of added protein supplement versus increases in milk yield and also availability of those protein sources.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Urban poultry production systems and constraints of local and exotic chickens reared in Yirgalem and Hawassa Towns, Ethiopia

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Rearing of chicken plays important roles on both the rural and urban economy of Ethiopia. This study was conducted to assess urban poultry production system and productive performance of local and exotic chickens reared at Yirgalem and Hawassa towns of Southern Ethiopia. Stepwise purposive sampling method followed by random sampling was used to select the respondents. In total, 180 respondents were selected based on their experience in chicken production. The results of the study indicated that most of the respondents reared the chickens using backyard production system. Most of the respondents (77.8%) reared chicken using both free range and semi intensive management system. All the respondents provided supplementary feed, while majority of them provide water to their flock. The findings also showed only 38.3% of the respondents provided separate houses for their flock. The Major constraints in the study areas which affected the flock were diseases (Newcastle and coccidiosis), followed by adaptability especially for exotic chickens. It was concluded that the management system of chickens in the study areas were well, compared to rural management system; nonetheless it needs further work on their better health care, scientific nutrition and management. It was also observed that the contributions of the exotic chickens to the livelihood and food security of the rearers are significant.

Key words: Constraint, exotic and local chickens, Southern Ethiopia, Urban poultry production.

INTRODUCTION

In spite of global and regional economic growth, food insecurity remains a pressing problem in many parts of the world and this is true especially in Africa. It is reported that the urbanization in Africa are currently lower than the other regions of the world and is expected to result in an increase in the urban population from 40 to 56% by 2050 (Hussein et al., 2016). The UN-HABITAT (2006) reports indicated that the percentage of urban residents in Sub-Saharan Africa (SSA) is expected to increase from 30 to 47% of the total population, between the year 2005 and 2030.

This will be coupled with several critical challenges associated with the development of urban policies, especially in terms of ensuring household food security.

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Finding of a study by Beall and Fox (2007) indicates that that as the world's urban population grows, so will be the population of the urban poor. The overall cost of supplying, distributing and accessing the availability of food is likely to increase as the number of urban households escalate (Tschirley et al., 2015). The condition of the resource challenged (urban) is quite disturbing as almost all of them derive their nutritional requirements from the market (Thomas, 2013). Thus, it becomes imperative to strengthen the urban agriculture, which to a certain extent can provide a realistic solution to overcome the critical food insecurity as is being observed in many parts of the developing world (Van Veenhuizen, 2006).

In all these aspects, rearing of chickens can create additional income besides consumption of eggs can help improve nutritional security to the most vulnerable sections of the urban resource challenged specifically, pregnant and nursing mothers, old and infirm people, growing children and those who are suffering from immune compromising diseases (Ruxton, 2013). It has widely been reported that chickens are the most widely kept livestock species in the world (Moreki et al., 2010). In the developing countries, indigenous chickens are widely distributed in almost all the rural and peri-urban areas where they play the important role of income generation and food production (Moreki et al., 2010).

In Ethiopia, the evolution of the poultry sector (in recent times) has highlighted the growing importance of small and medium-scale producers residing in the urban and peri-urban areas (FAO, 2008). Even if the indigenous chickens are better to adapt the harsh environment, they are tolerant to many diseases and are good brooders, but they are poor in their reproductive performance. Therefore, in order to improve the performance of the local chicken the exotic chicken were imported such as White and brown Leghorns, Rhode Island Red, New Hampshire, Cornish, Australorp Light Sussex and others were then crossed with local chicken (Nigussie, 2011). Since then, the higher learning institutions, research organizations, the Ministry of Agriculture and certain Non-Governmental Organizations (NGO's) have disseminated many exotic breeds of chicken to rural farmers and urban-based small-scale poultry producers (FAO, 2008). Reports from Dirsha (2009), Tadesse et al. (2013), Akililu et al. (2013), Haftu (2016) and Aman et al. (2017) indicate that the exotic chicken such as Brown, Bovans Brown, Potchefstroom Koekoek and Sasso were distributed to smallholder farmers of some part of Ethiopia.

The importance of urban poultry production cannot be ruled out; however, there have been comparatively fewer studies on urban poultry production. The constraints for different ecotypes of the chickens raised in the urban surroundings too have rarely been studied. Therefore, based on the above background, the study was conducted to study the production system and constraints of local and exotic chickens in Hawassa and Yirgalem towns.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Hawassa city (7°03' latitude North and 38°28' longitude East at the elevation of the 1708 m a.s.l) and Yirgalem town (latitude and longitude of 6°45′N 38°25′E and an elevation of 1776 meters). Both locations are situated in the Sidama zone of the SNNPRs region of southern Ethiopia (IPMS, 2005). According to the report of FAO (2007), zone of Sidama, Hadiya and Gurage together accounts for about 43.6% and the urban area constitute 2.1% of the total regional indigenous chicken population of SNNPR.

Sampling techniques and sample size

Stepwise purposive sampling process was followed by random sampling procedure was used. From the eight sub-cities of Hawassa, three sub-cities were selected purposively based on the chicken populations of the area and as suggested by the authorities of the Bureau of Agriculture. The sub-kebeles within the sub-cities, two kebele too were purposively selected based on the chicken population. Furthermore, the respondents were selected based on their experience in chicken production and willingness to participate in the survey. From the identified individuals 20% (180 respondents) of them were randomly selected for the survey work (Kish, 1965). While from Yirgalem town, which has nine kebeles, the four kebeles were selected purposively based on the above-mentioned criteria. Among the selected kebeles, it was also purposively identified that the people who have local and exotic breed species have five or more chickens.

Data collection procedure

The study encompassed semi-structured questioners. The questioner was pretested and then administered to traditional poultry rearers and selected poultry owners to gather information on poultry production systems, constraints and opportunities related to the poultry production.

Statistical analysis

The qualitative and quantitative data collected from survey of urban poultry production systems were analyzed using SPSS version 16 (SPSS, 2007). The means of the quantitative traits were compared using Duncan Multiple Range Test (Duncan, 1995); while two-way ANOVA was used to compare the values across the two studied locations. As regards the qualitative traits, the values were compared using Chi-square test. The values were considered significant at 5% levels. A priority index was also used to rank the constraints of urban poultry production according to their severity and opportunities based on their relative importance using the following formula:

Priority index = (F1*4) + (F2*+3) + (F3*2) + (F4*1)/Ftotal
F1= Frequency of the first rank;
F2= Frequency of second rank;
F3 = Frequency of third rank;
F4= Frequency of fourth rank;
FT= Frequency of total respondents.

Table 1. Experience, breed type and sources of chicken in the study areas.

Variable	No. of respondents	Percent	(χ^2<0.05)
Average years you have reared chicken (Mean±SD.)	180	8.23±2.24	
Breed types of chickens (%)			
Local	50	27.8	
Sasso	61	33.9	
Bovans Brown	29	16.1	
Local and Bovans Brown	7	3.9	
Local and Sasso	28	15.6	
Sasso and Bovans Brown	2	1.1	
Sasso and Koekoek	3	1.7	
Source of the exotic chicken (%) (N=130)			
Government extension	105	58.3	**0.005**
Market	69	38.3	
Relative	6	3.3	
Age of the exotic chicken while start rear (%) (N=180)			**0.003**
Starter (0-8wks)	96	53.3	
Layer/hen	34	18.9	
Have no exotic chicken	50	27.8	

RESULTS AND DISCUSSION

Experience, chicken type, and its source of chicken in the study areas

The results from Table 1 indicate that most of the respondents in the study area are well experienced in rearing chicken. The findings further indicate that the three popular ecotypes of chickens namely Sasso, Bovans Brown and Koekoek these are besides the local ecotypes. The results also are indicative of the fact that the respondents received the exotic ecotypes from the governmental agencies followed by procuring the same from the nearby markets. This result indicate that most of the respondents rear the young cockerels/pullets while a few have procured the adult hens.

The results of the experience of rearing the chickens (Table 1) in the study areas are similar with reports of Melese and Melkamu (2014) and Nebiyu (2016). Alemayehu (2017) has report that having experience of livestock rearing plays an important role in improving the husbandry practices as the rearers are better aware of the disease symptoms, feeding and watering needs besides egg storage and incubation management. A highly significance difference (P<0.05) was observed on the sources and time (age) of the exotic chicken of the respondents to start rearing. This result similar with the findings of Aman et al. (2017) who reported that most of the village chicken owners in Wolaita zone and Kambata Tambaro zone were procured pullets from private farms and local cooperatives, while some received them from government authorities. Procurement of pullets over day old chicks ensures less chances of mortality from either diseases or parasites (Abraham and Yayneshet, 2010). The pullets, if procured from non-government organizations or from Bureau of Agriculture, can ensure that they have been vaccinated against the important diseases prevailing in the areas thereby resulting in better growth and lower mortality (Hawassa BoLF, 2016; Yirgalem BoLF, 2016).

Chicken production system in study areas

The results pertaining to the husbandry practices of the chickens reared in the study areas are presented in Table 2. The results from the table indicate that most of the respondents reared the chickens under traditional/ scavenging conditions without proper housing and management. This finding is in consonance with the observations of Mekonnen (2007). Backyard poultry rearing system has certain advantages and disadvantages, while the former is because the cost of feeding is significantly reduced, for they feed home grain and feeds from leftovers (FAO, 2007). The disadvantages being that the chickens are exposed to many diseases and parasites besides they may not be able to obtain balanced nutrition (Alemayehu, 2017). In the backyard chicken production system, the feed availability may not be sustainable all year around (Ravindran, 2013). Hence,

Table 2. Production and management system, and feed source of chicken in the study areas (N=180).

Variable	Location			(χ^2<0.05)
	Hw	Yr	Total	
Production system (%)				**1.000**
Traditional/backyard	97.8	97.8	97.8	
Small-scale commercial	2.2	2.2	2.2	
Management practice (%)				**0.150**
Free range (scavenging)	16.7	26.7	21.7	
Indoor rearing (intensive)	0	1.1	0.6	
Scavenging and indoor	83.3	72.2	77.8	
Source of feed (%)				**0.000**
Commercial feed	16.7	2.2	9.4	
Scavenging and supplementary feeds	24.4	3.3	13.9	
Scavenging and home by-product	14.4	26.7	20.6	
Home by-product, scavenging and supplementary feeds	44.4	67.8	56.1	

Hw = Hawassa, Yr = Yirgalem.

the respondents need to be made aware of scientific poultry husbandry practices including housing and feeding, presently the proportion being quite low. The respondents need to be appraised about the importance of modern poultry husbandry practices, which can enhance the productivity of the hens and the profitability of the venture (Moges et al., 2010).

Management practice of the chicken in the study areas

This result shows that most of the respondents (77.8%) allowed their chickens to scavenge during the daytime but housed them indoors after dusk. This may be to prevent the chickens from the vagaries of nature and predatory attacks. The rest of the respondents indicated that they either reared the chickens under free or solely in confinement. The result is in accordance with finding of Srinath (2009), who reported that the chickens in the study area are reared in a semi intensive manner where the chickens are kept in the fenced area and housed at the night. Although Ravindran (2013) reported that the feed is not available in the year around in scavenging management system; the study by Zelnter and Maurer (2009) indicates that the laying hen in a scavenging system may show beneficial behavioral elements, which are not possible in the poultry house. However, the values obtained from present findings are higher than form the observation of Aman et al. (2017) from Wolaita zone and Kambata Tambaro zone. Emebet (2015) also indicated that a few number (28.45%) of the farmers manage their chickens semi-extensively in South-West Showa and Gurage of Ethiopia.

Feeds and feeding system of chicken in the study areas

This result indicates that most of the respondents provide the chickens with food leftovers and feed supplements. The feedstuffs included home by-products or food leftovers (*injera*, bread, *kocho* and vegetables), scavenging and supplementary feeds such as maize, wheat, wheat bran (*Frushika*) and *kinche* (broken grains). However, some of the respondents (20.6%) also indicated that they provide only the food leftovers and rely on scavenging; While, for some of the respondents the only way by which their chickens sustain is by scavenging for feed. A highly significance difference (P<0.05) was observed on the feed sources of chicken in the study areas.

This findings indicate that besides food left and scavenging the respondents provide some supplementary feed, which is indicative of better feeding management. Provision of supplementary feed can ensure better productivity and the reproduction potential of the birds (Gezahegn et al., 2016). The supplementary feeds provided to the chickens in the study areas are similar observations of recorded by Wondu et al. (2013) from Northern Gondar of Ethiopia. The provision of supplementary feed can be correlated with better awareness and knowing the importance of the supplementary feeds among the respondents (Alemayehu, 2017). The results however show that supplementary feeds offered for the chicken in the study areas were those with high-energy content with low protein (Alemayehu, 2017). Imbalance between energy and protein form of feed is not desirable as it impairs with the utilization of either of them, high energy in feed will decrease feed intake, which lead to decrease egg production performance and quality (Nebiyu, 2016).

Watering system of the chicken in the study areas

This finding also indicate that 95.6% of the respondents provide water for their chickens'. This is an indicator of good husbandry practice, besides that they provide water adlib (86.1%) too indicates their concern about providing water to their flocks. While some of the respondents too indicated that they were not careful to provide water to their flocks, the numbers were too few and hence they need to be made aware of the importance of water as an important nutrient. This results related to provision of water among the chickens are in accordance with the observations of Desalew (2012) from East Shewa of Ethiopia.

Water is one of the most important but neglected of all the nutrients; both quality and quantity of water available to the chickens need to be optimum for overall improvement in productivity (Ravindran, 2013). The present findings (of provision of water adlib) are in accordance with the observations of Dirsha (2009) and Desalew (2012). However, the finding by Meseret (2010) also reported that water is provided at certain times of a day. This can have both beneficial and adverse effects, while the former is linked with the cleanliness and the later is linked with the welfare issues (Van Horne and Achterbosch, 2008).

Housing system of the chicken in the study areas

This finding shows the housing management prevalent among the poultry rearers in the study areas. The study indicates that the common method of keeping the chicken was to rear them in the kitchen (45.6%); some of the respondents (38.3%) constructing separate houses for the chickens followed this. This finding also shows that many of the respondents house their chickens in their kitchen, the value of observation being higher than those of Addisu et al. (2013) who reported only 20.92% of the chicken perched inside kitchen in North Wollo in Amhara region. Housing chickens in the dwellings of their owners can have consequences such as transmitting diseases and parasites among their owners (Bailey and Larson, 2013). Hence, the owners need to be appraised of the consequences of such housing. The results also show that many of the respondents (38.3%) provide separate dwellings for their flock, which is a good husbandry practice, provided the house is properly maintained and cleaned periodically and the study is similar with the finding of Ayalew and Adane (2013).

Health management of chicken in the study areas

This result shows that the discussion with the town veterinary health care experts indicate that there was the problem of health of the chicken in the study area and most prevalent disease is the Newcastle. The second important disease in the study areas were coccidiosis especially during high rainy season followed by Ecto-parasite. Due to these reasons, most of the respondents in the areas (56.1%) were practice culling or 43.6% takes culling as preventative major for their chicken. The difference (P<0.05) were observed in the study areas on the reason for culling chicken. Most of the respondents indicated culling of birds suffering from diseases, which these observations concur with the findings of Desalew (2012). This is one of recovering loss at times of disease outbreaks but can have adverse consequences as it assists in spread of diseases to locations, which are free from diseases. Getu and Birhanu (2014) reported that incoming chicken causes the disease rather than own flock in the study areas in Northern Gonder, Amhara region. Thus, the authorities should ensure that under such circumstances the movement of the birds (through traders or otherwise) is arrested. In case, the dead birds should be properly disposed, and that the carnivores and other animals/birds (Bailey and Larson, 2013) do not devour their carcasses.

The respondents of the study areas use both the modern veterinary medicines and ethno veterinary medicines. The ethno veterinary medicines was used for their chickens were by drenching or giving with feed the commonly used floral medicines, such as feto (*Brassica* spp), lemon (*Citrus*), red pepper (*Capsium* spp) and nech shinkurit (*Allium sativum*). The floral medicines as reported by the respondents were similar to those observed by Wondu et al. (2013) from urban areas of Northen Gonder. The similar authors also reported that the respondents from the area were also used Areke (local beverage) and Grawa (*Vernonea amygdalon*). Feleke et al. (2015) also reported the popularity of ethno veterinary medicaments from rural areas of Sidama province. The availability of traditional medicines may be ascribed to beliefs of the respondents towards such medicaments (Roberts, 1971).

Opportunities and constraints related to chicken production and marketing system in the study areas

The results presented in Table 3 indicates the opportunities of rearing chickens in the study areas, the major opportunities being access to market, followed by access to veterinary care (at Hawassa) and feed (at Yirgalem). The result pertaining to the major opportunities

Table 3. Opportunities for chicken production in the study areas (rank and index) (N=180).

Variable	Opportunities for Hawassa		Opportunities for Yigralem	
	PI	Rank	PI	Rank
Market access	0.48	1st	0.46	1st
Feed access	0.13	4th	0.26	2nd
Extension service	0.16	3rd	0.15	3rd
Veterinary service	0.23	2nd	0.13	4th
Total	**1.00**		**1.00**	

Priority index = (F1*4) + (F2*3) + (F3*2) + (F4*1) divided by the sum of all counted values mentioned by the respondents.

Table 4. Constraints for chicken production in the study area (rank and index) (N=180).

Variable	Constraints for Hawassa		Constraints for Yigralem	
	PI	Rank	PI	Rank
Lack of feed	0.102	4th		
Disease	0.32	1st	0.27	1st
Poor adaptability	0.31	2nd	0.25	2nd
Market	0.07	5th	0.15	4th
Awareness how to manage the chickens	0.198	3rd	0.22	3rd
Lack of improved breeds			0.11	5th
Total	**1.00**		**1.00**	

Priority index = (F1*5) + (F2*4) + (F3*3) + (F4*2) + (F5*1) divided by the sum of all counted values mentioned by the respondents.

related to both the studied locations (Table 3) indicate that the opportunities as indicated by the respondents are very encouraging, especially those accounting for the accessibility of veterinary and extension services, availability of feeds and marketing and the result is similar with the finding of Nebiyu (2016). The presence of all weather market is appealing as in many parts of the country (those predominated by the people practicing Orthodox Christianity) where market is seasonal (Ayalew and Adane, 2013; Emebet, 2016). Therefore, it is expected that the educated, unemployed and small-scale entrepreneurs' can take poultry farming as their means of livelihood. The opportunities at Yirgalem too are more or less similar with a slight deviation in their ranking, which show that there is a scope for improvement of Veterinary care, which is one of the existing factors assuring profitability of the chicken farming and it is similar with the findings of (Feleke et al., 2015; Nebiyu, 2016).

The results presented in Table 4 indicate the constraints for rearing chickens in the study areas, the major constraints being the occurrence of the disease, followed by adaptability (especial for exotic chickens). Due to these reasons, most of the respondents of the study areas preferred rearing only local chickens. The results presented in Table 4 indicate the constraints for rearing chickens in both study areas are similar with finding of Wondu et al. (2013). Aman et al. (2017) also revealed that constraints in poultry production in the study districts of the Wolaitta zone and Kambata Tambaro zone were disease followed by shortage of feeds.

In both locations, it would be better if the respondents can form self-help groups (SHG) or cooperatives which can help them procure feed (in bulk) from the factories besides availing credit facilities either from MFI (micro finance institutions) or banks (Ban et al., 2015). Establishment of such institutions can also help in arranging training programs besides also assist in marketing of the eggs, which can also assist in improving the poultry husbandry practices in the study areas. Importance of SHG's and cooperatives in improvement of livestock husbandry practices and marketing of livestock products have been reported by Varathan et al. (2012).

CONCLUSION AND RECOMMENDATION

The result of the present study on the urban poultry production and constraints as practiced in two selected towns of Southern Ethiopia. This study indicated that most of the households practiced both scavenging and indoor management with very few of them providing the necessities like proper housing and balanced feed. Chickens in the study area are reared for home consumption followed by those reared for income. Additional feeds were offered to the chicken besides scavenging; water was provided adlib to the chickens New castle and Coccidiosis diseases were a major threat and constraint to the profitability of the venture. Based on the above conclusion, the following recommendations were forwarded:

(i) In urban poultry production, the cage system is essential rather than back yard production to produce more in small space. Also, it could improve sanitary condition of the flock because it helps to prevent diseases like coccidiosis and endoparasites.
(ii) Feed and feeding system of the chicken should be corrected, by feeding chicken from local available materials.
(iii) The government extension work and regular refresher courses have to be conducted by the Universities/ Research stations for further training of the development for study area to appraise the rearers about managing the exotic chickens.
(iv) Government should create awareness on vaccination of chicken for the community, to provide wide spread vaccination against major poultry diseases in the study areas.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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