



RESEARCH ARTICLE

Assessment of Activated Charcoal Vs Synthetic Toxin-Binders on Performance, Nutrient Utilization and Meat-Quality of Broilers Fed Infected Diets

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ABSTRACT

A total of one hundred and eighty day old broilers were used to determine the performance and carcass characteristics of broiler birds fed aflatoxin infected diet with or without toxin binders. Six diets were compounded where toxin-binder A, B, C and D were included in treatment 2, 3, 4 and 5 respectively. Treatment 1 (positive control) was infected and 6 (negative control diet) was left uninfected. The birds were randomly allotted into the six (6) dietary treatments of three replicates each, containing ten (10) birds per replicate in a completely randomized design. Parameters monitored were Average Daily Feed Intake (ADFI), Average Daily Weight Gain (ADWG) and Feed Efficiency Ratio (FER). At the beginning of 8th week of the experimental period, three birds per replicate were randomly selected, transferred to metabolic cage where acclimatization prior faecal matters collection for three days was observed. Faecal samples were dried and analyzed for proximate composition. The result together with other parameters was used to calculate the nutrient digestibility of the birds. The birds were starved for 12hours, weighed, slaughtered, dressed, cut to parts and weighed. Segment of breast muscles were analyzed for aflatoxin residue. Significant difference ($P < 0.05$) was recorded in the performance characteristics both at starter and finisher phases especially between those with binder and one without binder. Significantly different ($P < 0.05$) FER was obtained from birds fed infected diets at starter. No significant ($P > 0.05$) difference among ADFI except negative control diet which had lowest ($P < 0.05$) value (78.96g). No difference ($P > 0.05$) among average FER and cost per kg meat produced at finisher phase. Infected diet + binder B gave the best ($P < 0.05$) digestibility potential while others were similar ($P > 0.05$). Only the wing, breast and back cut parts were similar ($P > 0.05$) while others were significantly ($P < 0.05$) different. Abdominal fat was significantly ($P < 0.05$) reduced by the presence of binders in the infected diets. Meat samples from birds fed infected diet without binder had highest ($P < 0.05$) value (3.13ppb) of aflatoxin residue and least value (0.96 ppb) was obtained from negative control. No difference ($P > 0.05$) in the values obtained for treatment 3 and treatment 4. It could therefore be concluded that the aflatoxin residue present in the broiler meat obtained from birds fed all the binder were relatively lower than the safe level recommended by United Food and Drug Administration (UFDA) thereby making the meat safe for human consumption. Activated charcoal is also a promising binder in poultry diet containing aflatoxin.

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INTRODUCTION

Poultry is any avian class member that is reared or hunted for a useful purpose. These include domestic fowl,

duck, turkey, goose, quail, guinea fowl and pheasant. The major products from poultry keeping are meat and egg. Poultry production has been recognized as one of the fastest and most efficient means of attaining self-

sufficiency in animal protein, because of their short gestation interval, large numbers, fast growth rate, greater affordability, ease of raising as well as absence of taboos to production and consumption. Modern poultry production occurs primarily in enclosed buildings to protect the birds from harsh weather, predators and the spread of diseases from wild bird, the most interesting constraint is the feed which claims 70 percent of total production cost. Aside that, the feed can sometimes contain toxin which are dangerous to the poultry health and promote the manifestation of other diseases as well as claims their lives when ingested at a very high dose. There are many toxins in animal's feed but the most existing is the mycotoxin (Edds and Bortell, 1983).

Mycotoxins are toxic secondary metabolites produced by fungi. For centuries, these mycotoxins have been associated with quality degradation of many agricultural products which cause considerable changes in texture, flavour and colour. Although many toxins metabolized by moulds have been isolated through laboratory cultures from agricultural products, only seven have been found to have possible significant occurrence in naturally contaminated foods and feeds. These are aflatoxin, zearalenone, ochratoxin A, citrinin, trichothecenes putulin, penicillic acid and the ergot alkaloids. Among these mycotoxins, aflatoxin have gained considerable attention because they are the most toxic and potent carcinogen even in small quantities (Egal *et al.*, 2005). Lately, several approaches to avoid contamination such as decontamination and remediation of feed and feedstuffs have been proposed (Ledoux *et al.*, 1999). A variety of adsorbents such as bentonite (Rosa *et al.*, 2001), hydrated sodium calcium aluminosilicate (HSCAS) (Kubena *et al.*, 1993), *Sacharomyces cerevisiae* (Celik *et al.*, 2001) and activated charcoal (Jindal *et al.*, 1994) have been successfully utilized in detoxifying aflatoxin in contaminated feeds. Adsorbents are necessary and important and have great impact on improving animal production and health, providing security to consumers of animal products due to the reduction and/or removal of mycotoxins in these products. Activated charcoal is also a good absorbent and readily available than other binders, therefore investigated to establish its potential as a good binder and investigate the safe level of product(s) from such infected birds or fed infected feed or diet.

MATERIALS AND METHODS

Test Ingredients

Four varieties of toxin binders were procured and labeled; A, B, C and D. According to the manufacturers, Binder A contains HSCAS as the active ingredient; Binder B contains Bentonite/Montmorillonite Yeast cell walls while Binders C and D contain Aromatic Polyphenols and Activated charcoal, respectively.

Toxin Production and Analysis

Toxin was produced by the inoculation of *Aspergillus flavus* on semovita. The moistened semovita was stored in a dark cupboard to enable rapid spoilage. Organism (*A. flavus*) was then isolated and cultured on a petri dish using potato dextrose agar (PDA) as the growth medium. It was incubated at 28°C for 7 days. Semi-synthetic medium

containing 2g yeast extract and 20g sucrose in every 100ml of distilled water was used as basal fermenting medium for *A. flavus* to produce toxin. Fermentation bottles with 2g yeast extract and 20g sucrose were sterilized in an autoclave at 125°C for 15 minutes so as to remove any form of contamination. The fermenting medium was however allowed to cool to 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 (Yunus and Bohm, 2011).

Experimental diets

Six experimental diets containing the same percentage crude protein and metabolizable energy (MEKcal/kg) were formulated for the starter phase, likewise for finisher diets (Table 1). Five diets (1-5) were infected with the prepared toxin. Binders (A, B, C and D) were incorporated into diet 2, 3, 4 and 5 respectively.

Experimental birds and distribution

One hundred and eighty day old marshal strain of broiler chicks were procured and weighed. They were randomly allotted into six treatments of 3 replicates (10 chicks) each to make a total of 30 birds in each treatment. The birds and treatments were distributed using completely randomized design (CRD). The birds were managed intensively and necessary vaccinations and medications were applied. All the management practices (vaccination and medication) were carried out accordingly and as at when due.

Data collection

Growth performance

Daily feed intake, mean weight gain, average daily weight gain and feed efficiency ratio were estimated.

Procedure and parameters on nutrient digestibility

Nutrient digestibility was done at week eight, three birds were selected at random from each replicate and were transferred to the metabolic cage for faecal collection after four days acclimatization period was observed, feeds were weighed and given to the birds, the left over were collected, weighed and subtracted to calculate the actual feed intake, faecal voided by the birds were collected individually on daily basis and oven dried, replicates of the faecal samples were pulled together and grinded. Samples were analyzed in the laboratory for crude fibre, crude protein, ash content, ether extract and Dry matter digestibility.

Nutrient Utilization = $\frac{\text{Nutrient intake (g)} - \text{Nutrient in faeces (g)}}{\text{Nutrient intake (g)}}$

Nutrient intake = Quantity of feed intake x % nutrient
Nutrient in faeces = Quantity of faeces voided x % nutrient

Carcass Characteristics

At the end of experimental period, two birds from each replicate were randomly selected, tagged, and fasted for 12 hours, they were all weighed and slaughtered ensuring that the jugular vein was cut off. The birds were scalded before evisceration and determination of weights

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	11.00	11.00	11.00	11.00	11.00	11.00	10.00	10.00	10.00	10.00	10.00	10.00
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	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
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

*Premix: Vit A; 9,000IU, Vit D3; 1,250IU, Vit E; 7,000IU, Riboflavin. Vit; 600mg; Vit B3; 2,200mg; Vit. B5; 14,000mg, Lysine; 12,000mg, Methionine; 6,500mg, Choline chloride; 240,000mg; Mn; 6,000mg; Fe; 35,000mg, Cu; 5,000mg, I2; 1,100mg, Se; 100mg, Anti-oxidants; 125,000mg; +: diet infected with toxin, -: Diet without binder, *: Binder A, **: Binder B, ***: Binder C and ****: Binder D

of the following carcass; drumsticks, back, breast, head, wings, shanks, neck, thigh and abdominal fat.

Meat quality

Meat sample from the breast part of all the slaughtered birds were preserved and taken to the laboratory for determination of aflatoxin residues in the meat samples.

Data analysis

All data obtained were subjected to analysis of variance using statistical analysis system (SAS, 2000), software package and means were separated using Duncan multiple range test of the same software.

RESULTS

Performance characteristics of broiler birds fed diets infected with aflatoxin and inclusion of different toxin binders

Table 2 showed that there was significant difference ($P < 0.05$) in all the parameters measured at for the starter phase. Treatment 4 (infected diet + Binder C) had the highest value (35.12%) of average daily weight gain while treatment 3 (infected diet + binder B) had the least value (21.85%) of average daily weight gain at starter phase. Average daily feed intake at starter phase, revealed that there was significant difference ($P < 0.05$) among the treatments. The values obtained from T₁–T₆ were 96.12g, 96.49g, 98.21g, 97.98g, 99.93g, and 78.96g respectively. There was significant difference ($P < 0.05$) among the treatments on the birds at finisher phase. Treatment 5 (infected diet+Binder D) had the highest ADWG (50.39g) even than treatment 6 (the negative control) (42.86g). The result obtained from finisher phase showed a significant ($P < 0.05$) difference both in the ADWG and ADFI. Treatment 5 had the highest ($P < 0.05$) value of ADFI (173.57g) while the least ($P < 0.05$) value (149.64g) was obtained from the negative control. Highest ADWG (50.39g) was recorded from the birds fed infected diet +

binder D which was even significantly ($P < 0.05$) higher than the negative control but statistically ($P > 0.05$) similar to others birds on infected diet. There was no significant difference ($P > 0.05$) in terms of feed efficiency ratio at the finisher phase. However, treatments 5 had highest numerical value of 0.290 and treatment 1 having the least value of 0.264.

All the parameters measured under nutrient utilization were significantly ($P < 0.05$) different (Table 3). Highest Dry Matter Digestibility (DMD) (84.84%) was obtained from infected diet with binder B. infected diet with binder C also had a better value compared to the negative control (74.45%) which was statistically ($P > 0.05$) similar to infected diet with binder D (76.65%) but better than infected diet with binder A and positive control diet (69.38 and 66.79 respectively). Highest crude protein digestibility (CPD) 83.05% was obtained from treatment 3 (infected diet + binder B). T₄ (infected diet + binder C) recorded a better value (77.15%) compared to the negative control diet (73.11%) which was statistically ($P > 0.05$) similar to T₅ (infected diet+binder D) (72.90%) but still better than infected diet+binder A and positive control diet. The least value (59.83%) was however obtained from treatment 2 (infected diet+binder A). On Ether Extract Digestibility (EED), infected diet+binder B had the highest value while the least value was obtained from infected diet+binder A (87.12% and 63.41% respectively). Also, T₄ (infected diet + binder C) had higher EED value compared to the negative control which was statistically ($P > 0.05$) similar to positive control diet (76.85%) and higher than infected diet with binder D (74.95%). Highest Crude Fibre Digestibility (CFD) was obtained from T₃, followed by T₄ which recorded a value of 74.99%. The CFD value obtained from T₅ (66.80%) was statistically ($P > 0.05$) higher than the negative control (63.58%) which was also found to be better ($P < 0.05$) than T₂ and positive control diet (59.55% and 57.28% respectively). Ash digestibility also followed the same trend as in crude fibre digestibility. The values obtained showed significant difference ($P < 0.05$) in all treatments.

Table 2: Performance characteristics of broiler chicken fed infected diet with aflatoxin and inclusion of different toxin binders

Parameters	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
FER	0.29 ^c	0.33 ^b	0.23 ^c	0.36 ^{ab}	0.33 ^b	0.39 ^a	0.01
Finisher							
ADWG (g)	43.29 ^{ab}	47.21 ^{ab}	45.51 ^{ab}	42.54 ^b	50.39 ^a	42.86 ^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
FER	0.264	0.285	0.277	0.279	0.290	0.286	0.01
Cost/KG meat produced	343.00	318.05	318.05	318.05	307.36	310.13	11.34

^{abc}Means on the same row with different superscripts were significantly (<0.05) different; ADWG: Average daily weight gain, ADFI: Average daily feed intake, FER: Feed efficiency ratio; SEM: Standard Error Mean; T₁- positive control; T₂- infected diet + binder A; T₃- infected diet + binder B; T₄- infected diet + binder C; T₅ - infected diet + binder D; T₆- negative control diet

Table 3: Nutrient digestibility of broilers fed infected diet with or without toxin binder

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	SEM(±)
DMD (%)	66.79 ^c	69.38 ^d	84.84 ^a	82.13 ^b	76.65 ^c	75.45 ^c	1.11
CPD (%)	61.86 ^d	59.83 ^d	83.05 ^a	77.15 ^b	72.90 ^c	73.11 ^c	1.41
EED (%)	76.85 ^{cd}	63.41 ^e	87.12 ^a	83.90 ^b	74.95 ^d	78.13 ^c	1.30
CFD (%)	57.28 ^e	59.55 ^e	84.15 ^a	74.99 ^b	66.80 ^c	63.58 ^d	1.60
ASHD (%)	40.93 ^c	49.20 ^d	73.43 ^a	65.99 ^b	57.18 ^c	51.04 ^d	1.88

^{abcde}Means on the same row with different superscripts were significantly (<0.05) different; DMD: Dry Matter Digestibility; CPD: Crude Protein Digestibility; EED: Ether Extract Digestibility; CFD: Crude Fibre Disgestibility; ASHD: Ash Digestibility; T₁- positive control; T₂- infected diet + binder A; T₃- infected diet + binder B; T₄- infected diet + binder C; T₅ - infected diet + binder D; T₆- negative control diet

Table 4: Carcass characteristics of the broiler birds fed infected diets fortified with various toxin binders

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	SEM (±)
Carcass Wt	1300.33 ^{ab}	1282.33 ^{ab}	1152.67 ^b	1465.67 ^a	1417.33 ^a	1470.67 ^a	50.66
Head	3.61 ^b	4.54 ^b	6.06 ^a	4.21 ^b	4.03 ^b	3.75 ^b	0.29
Neck	7.38 ^{ab}	7.10 ^{ab}	7.96 ^a	7.20 ^b	6.72 ^b	6.48 ^b	0.19
Wing	11.56	11.62	11.94	11.88	12.21	11.07	0.25
Shank	5.82 ^b	6.69 ^b	8.48 ^a	6.16 ^b	6.30 ^b	6.14 ^b	0.29
Dstick	14.77 ^c	15.13 ^{bc}	16.02 ^b	15.33 ^{bc}	14.64 ^c	17.43 ^a	0.31
Thigh	17.60 ^{ab}	16.58 ^b	18.01 ^{ab}	17.29 ^{ab}	18.66 ^a	16.14 ^b	0.38
Breast	28.31	29.01	26.94	28.96	28.70	27.27	0.42
Back	16.90	17.86	18.09	17.65	17.35	17.52	0.29
Abd. Fat	3.21 ^a	1.72 ^b	1.97 ^b	1.47 ^b	1.89 ^b	1.81 ^b	0.22

^{abc}Means on the same row with different superscripts were significantly (<0.05) different; Dstick- Drumstick; Abd. Fat- Abdominal fat; T₁- positive control; T₂- infected diet + binder A; T₃- infected diet + binder B; T₄- infected diet + binder C; T₅ - infected diet + binder D; T₆- negative control diet

Table 5: Result of Laboratory Analysis of Meat of the Experimental Bird Fed Aflatoxin infected diets with Different Toxin Binder

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	SEM (±)
Aflatoxin fed (ppb)	278	278	278	278	278	-	-
Aflatoxin residue in meat (ppb)	3.13	1.48	2.52	2.50	1.81	0.96	0.125

*United Food and Drug Administration (UFDA) safe level = 20ppb (CAST, 2003); T₁- positive control; T₂- infected diet + binder A; T₃- infected diet + binder B; T₄- infected diet + binder C; T₅ - infected diet + binder D; T₆- negative control diet

Carcass Characteristics of the Experimental Birds fed infected diets fortified with different toxin binders

Table 4 showed the result of proportion of cut parts under carcass characteristics of broiler birds fed infected diets with or without toxin binders. Significant (P<0.05) differences were recorded in the proportion of parts such as head, neck, thigh, drumstick and shank. The significant differences did not have a definite trend as it can be observed in the table. Another vital information was that the proportions of major primal or high price cuts (breast, wing and back) were not significantly (P>0.05) different among the infected diet with or without toxin binder and the negative control diet. Treatment 6 (negative control diet) had the highest (P<0.05) value of carcass weight (1470.67g) and treatment 3 (infected diet + binder B) had the least value (1152.67g) of carcass weight. There was no significant difference (P>0.05) among head weight

proportion except treatment 3 with the highest (P<0.05) value (6.06%). No significant difference (P>0.05) between treatments 1, 2, 4, 5 and 6, and likewise treatments 1, 2 and 3 in term of their carcass weight and neck proportion. There was significant difference (P<0.05) among drumstick and thigh proportion with highest value of 17.43% and 18.66% in treatment 6 (negative control diet) and treatment 5 (infected diet + binder D) for drumstick weight and thigh weight respectively. No significant difference (P>0.05) among the abdominal fat proportion for all treatments except treatment 1 (positive control) which had highest statistical value (3.21%) of abdominal fat.

Laboratory analysis for residual aflatoxin in experimental birds fed infected diets

The laboratory result obtained from the meat sample of experimental birds showed that there were significant

differences ($P < 0.05$) among the treatments (Table 5). Treatment 1 (positive control) had the highest value (3.13ppb) of aflatoxin residue while the least value (1.81ppb) of aflatoxin residue in meat was obtained from treatment 6 (negative control diet). Treatment 3 (infected diet + binder B) and treatment 4 (infected diet with binder C) were statistically ($P > 0.05$) similar. Treatment 2 (infected diet + binder A) had the least residual value (1.48ppb) of aflatoxin among infected diets incorporated with toxin binders. However, treatment 6 (negative control diet) recorded the lowest aflatoxin residual value (0.96ppb).

DISCUSSION

Performance characteristics of broilers fed infected diet with inclusion of different toxin binders

The high feed consumption rate observed in all the infected dietary treatments with or without binder at starter phase could be the effect of aflatoxin on the nutrient availability in the diets. It was reported that diet is been fed, and when there is energy loss in feed, the birds tend to consume more to meet up with the energy requirement (Verma *et al.*, 2007). Thus, low consumption rate with highest feed efficiency ratio in treatment 6 (control diet) was concluded to be as result of absence of aflatoxin as it was reported by Tedesco *et al.* (2004).

At finisher phase, the birds fed infected diets with different toxin binder had a significantly ($P < 0.05$) higher feed intake and efficiency than treatment 1 (positive control) and treatment 6 (negative control diet), this clearly indicated the beneficial effects of toxin adsorbent when incorporated into aflatoxin contaminated diets of poultry bird (Miazzo *et al.*, 2000). Birds in treatment 1 (positive control) recorded high feed consumption which was in agreement with the result obtained by Tessari *et al.* (2006), and the low feed efficiency and weight gain are also in agreement with that of Dersjant-Li *et al.* (2003) which revealed that the impact of high concentration of aflatoxin in poultry diets, leading to growth rate reduction, high feed intake and reduced feed efficiency due to the aflatoxin contamination.

On cost implication of each of the diet, activated charcoal proved to be more economical (₦307.36) as it has been observed in feed efficiency ratio.

Nutrient utilization of broilers fed infected diet with inclusion of different toxin binders.

The observed result for Dry Matter Digestibility (DMD) showed that treatment 1 (66.79%) was greatly affected which may be due to the presence of toxin in the diet compared to treatment 6 (uninfected diet) (75.45%). The infected diets that were incorporated with binders had better values than treatment 1 with treatment 3 recording a better digestibility value even than the negative control diet (treatment 6) this fall in line as it was reported that presence of aflatoxin in diets reduces Dry Matter Digestibility and energy utilization in birds (Nelson *et al.*, 1982).

Treatment 2 (infected diet + binder A) revealed low digestibility value for crude protein and was statistically ($P > 0.05$) similar to treatment 1 (infected diet without binder). Meanwhile, treatment 3 (infected diet + binder B)

had the best result. It had been reported that not all mycotoxin binders (adsorbents) have the same capacity to protect livestock against the detrimental effects of mycotoxins. Report has also shown that a number of toxin binders (adsorbents) may impair essential nutrient utilization (Chung *et al.*, 1990).

Ether Extract Digestibility, Crude Fibre Digestibility, Ash Digestibility all followed the same trend while treatment 3 (infected diet + binder B) proved to be the best binder in terms of nutrient utilization.

Carcass characteristics

Carcass characteristic was also significantly ($P < 0.05$) influenced. The treatment 6 (plain diet) recorded the highest carcass weight which was in agreement with Kermanshahi *et al.* (2007) who reported decrease carcass weight and enhancement of liver weight during aflatoxicosis as a result of fat decomposition in the liver, as well as increase in internal organ weights which may decrease relative carcass weight (Leeson *et al.*, 1995), Treatment 1 (positive control diet) had the highest abdominal fat which showed the effect of aflatoxin as fat enhancer.

However, percentage carcass values of neck, head, drumstick, breast, and thigh for birds fed aflatoxin infected diet fortified with various toxin binders varied significantly ($P < 0.05$). Breast and thigh are the most important economic primal cut in chicken worldwide, values obtained were highest in treatment 2 (infected diet + binder A) and treatment 4 (infected diet + binder C) and least in treatment 3 (infected diet + binder B) and treatment 6 (negative control diet). The values varied among the treatments meaning that the effect does not have a definite trend; it has little effect on the carcass weights and/or proportion, especially the high price cut parts.

Meat quality determination

This experiment can also be supported by the laboratory result of the meat samples obtained from experimental birds where the aflatoxin residue in meat for all the treatments fell within the range of 0.96 - 3.13 (positive control inclusive), and United Food and Drug Administration safe level was reported to be 20ppb (CAST, 2003). Also from the laboratory results three treatments (T2, T5 and T6) were found lower to the result obtained from the research conducted in Costa Rica (Mariam and Villalobos-Salazar, 2009) where residual levels expressed in the liver cell from birds consuming aflatoxin contaminated feed was found to be up to 2.5ppb. Also, it was reviewed that carryover of mycotoxin into edible tissue is relatively low and is dependent on the specific mycotoxins and animal species. Poultry species vary in their susceptibility and chicken being one of the most resistant birds (Leeson *et al.*, 1995). Also according to Leeson *et al.*, (1995), residues of aflatoxins can be found in poultry meat and its products in a low amount but results of a withdrawal trial showed that poultry could metabolize and eliminate aflatoxin from their tissue in a relatively short time period (72 to 96 hours) (Miazzo *et al.*, 2005).

Conclusion

The result showed that the use of Activated charcoal as a binder in the infected diet facilitates high feed

efficiency ratio and performance characteristics. However, nutrient utilization revealed that Bentonite/Montmorillonite (binder B) was the best adsorbent as it recorded the highest values in all the parameters, followed by binder C (Aromatic-polyphenols) and binder D (Activated charcoal). Moreso, feeding aflatoxin infected diet to broilers impair feed intake (increase cost of feeding), growth performance with little or no effect on the meat and carcass characteristics of broilers. Using various toxin binders showed a positive effect to chickens and, nearly cleared the negative effect of aflatoxin. However, the degree of effectiveness of binders is a function of the binder's active ingredient and inclusion level. Laboratory analysis revealed that birds fed aflatoxin contaminated diet can produce meat safe for human consumption.

Recommendation

Aflatoxin infected diet can be fed to poultry birds such as broiler chickens (especially when the toxin binder is available and utilized), without any deleterious effect on carcass and meat, so as to subjugate the angst of consuming meat of birds fed aflatoxin infected diets.

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