EFFECT OF SELECTED SUPPLEMENTAL FEED ADDITIVES ON PRODUCTION PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF LAYING CHICKENS FED MOULDY DIETS

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Abstract
An experiment was conducted to investigate the effect of dietary supplemental Retinol, tocopherol, multi-vitamin and a commercial binder on the production performance and egg quality characteristics of laying chickens fed mouldy diets. One hundred and eighty laying birds were used for the eight-week study. The experimental birds were completely randomized into six treatments in three replicates lots of 10 birds each. The control group was fed Aflasafe maize-based diet while birds in treatments 2 to 6 were fed mouldy maize-based diets without supplement, with retinol, tocopherol, multi-vitamin or a commercial binder supplements respectively. Results of aflatoxin and vitamin determination showed a substantial depreciation in both retinol and tocopherol contents of the mouldy maize to the tune of 48% and 37% loss respectively. Similarly the aflatoxin content rose from near zero in aflasafe maize grains to 267µg in mouldy maize. In terms of performance, the control group had the best body weight gains, hen-day production and conversion efficiency. This was followed by the vitamin supplemented groups which were similar ($P>0.05$) to control. Egg quality differs ($P<0.05$) only in terms of shell thickness and yolk colour. The commercial binder tends to have superior values ($P>0.05$) over vitamin supplements in shell thickness and compare more closely with the control while a significantly low values ($P<0.05$) were obtained for birds on mouldy non- supplemented diet. Supplementation of vitamins A, E or continuous use of vitalyte on birds fed mouldy diets at the tested levels in this study may be encouraged in layers' production because mould contamination is ubiquitous and practically difficult to eliminate completely in poultry feed.

Key words: aflasafe maize, mouldy maize, retinol, tocopherol, commercial binder.

Introduction

Moulds are filamentous fungi found ubiquitously in many feedstuffs including roughages and concentrates (Whitlow and Hagler, 2004). Growth of mould on grains under field conditions or during storage occurs at moisture levels above 16%, relative humidity above 70% and temperatures above freezing (Shamsudeen *et al.*, 2013). This affect the nutritional quality of grains in several ways. First, decrease the nutritional value of the commodity as moulds consume fats, protein and carbohydrates present in the grains. Moulds reduce feed values by at least 10% (Whitlow, 2007). Secondly, some species of mould are able to produce highly toxic compounds called mycotoxins (Marquardt,1996). Mycotoxins are biologically active, toxic metabolites produced by toxigenic fungi mainly belonging to *Aspergillus, Fusarium* and *Penicillium* species, which invade crops in the field and may grow on foods during storage under favourable conditions of temperature and humidity (Shamsudeen *et al.*, 2013). Mycotoxins are toxic to humans and animals and this explains the major concern of food and feed industries in preventing them from entering the food chain. At the global level, it is considered that 25% of the world crop production is contaminated by mycotoxins, which may be a risk factor affecting human and animal health (*Weaver et al., 2013*).

The economic impact of mycotoxins includes increased mortality, increased veterinary care costs, reduced livestock production and total disposal of contaminated foods and feeds (*Goossens et al., 2012*). However, the major problem associated with animal feed contaminated with mycotoxins is not acute disease episodes, but rather the ingestion of low level of toxins which may cause an array of metabolic, physiologic, and immunologic disturbances (*Greinier et al., 2013*).

Use of binders, physical and chemical methods, biological anti-oxidants to reduce the toxic effects of mycotoins has been proposed in many studies with varying results and attended challenges. It is envisaged that the use of retinol and tocopherol with their antioxidant properties could ameliorate the effect of mould contamination in diets of laying chickens. Thus the main objective of this study is to determine the effect of supplementing retinol or tocopherol on the production performance and egg quality characteristics of laying chickens fed mouldy diets.

Materials and Methods

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. Two batches of maize were obtained. First batch was aflasafe maize grains used for control diets and second batch was maize grains with physical evidence of mouldiness obtained from open markets in Ile-Ife and its environs. Samples of the maize were taken from the bulk and then tested in the laboratory for proximate and aflatoxins analyses. The selected additives were obtained at the retailed outlet and added at the dosages indicated in Table 1 below. There were six dietary treatments, a control diet with aflasafe maize grains and other five diets with mouldy maize grains with different supplemental additives as indicated in Table 1. One hundred and eighty laying chickens of 52 weeks of age were used for the study. They were randomly divided into the six treatments and each treatment had three replicates of ten birds per replicate. The birds were housed in a battery cage system and were allocated to experimental diets at random; feed and water were given *ad libitum for 8 weeks of the trial.*

Data Collection

Feed intake and hen-day production were determined weekly. At the end of the experiment, feed conversion ratio/ kg egg mass, feed conversion ratio/dozen eggs and body weight gains were calculated. Egg quality parameters measured include shell thickness using a micrometer screw gauge, yolk colour using a yolk colour fan, albumen weight, yolk weight, shell weight and egg weight using a sensitive scale.

Experimental design and Statistical analysis

The experiment was conducted as a completely randomized design. Data collected was subjected to one-way analysis of variance using the general linear model of SAS. Means among variables was separated using the Duncan Multiple Range Test.

Results and Discussion

Chemical Composition of Mouldy and Aflasafe Maize grains

Table 2 shows some of chemical composition of test ingredients. Fungi and mould growth in feedstuffs is associated with the utilization of nutrients from the host, causing a reduction in the nutritional content of the feedstuff. However, results of vitamin determination showed a substantial depreciation in both retinol and tocopherol contents of the mouldy maize to the tune of 48% and 37% loss respectively. This further affirmed claims that mould contamination reduced feed values (Bell, 2003). Similarly the aflatoxin content rose from near zero in aflasafe maize grains to 267µg in mouldy maize. The current action level (the concentration above which a commodity is condemned) of total aflatoxin in food is 20 µg/kg (Muzaffer *et al.*, 2003; WHO, 2006). Concentration above this level results in depressed feed intake, reduced body weight gains; drop in egg production, clinical diseases and mortality. The total aflatoxin detected in the mouldy maize used in this experiment was above the action level recommended and thus may be responsible for the depressed performance in recorded in this experiment.

Performance and Egg quality characteristics of laying birds fed mouldy diets with or without supplemental additives

The results of performance characteristics are shown in Table 3. Results reveal that consumption of mouldy diets reduced feed intake in laying chickens ($P \leq 0.01$). The decreased feed intake in the mouldy diets may be attributed to the higher concentration of aflatoxin in the mouldy feed. Earlier reports had shown that the first sign of aflatoxin poisoning in animal feed is a decreased feed intake (Devegowda, 1998). Supplementation with vitamins improved the feed intake in birds across the treatments and was not significantly different from the control while the non-supplemented group had the lowest feed intake. The results on bodyweight gains reflected a similar trend to that of feed intake in that the laying chickens fed the control diet had higher bodyweight gains than those fed on mouldy diet without any vitamin supplementation. There were no significant differences (P>0.05) in bodyweight gains of layers supplemented with vitamins compared to the control diet indicating a positive role of the vitamins supplementation in improving body weight gains. A decrease in body weight of birds during experimental aflatoxicosis had been reported (Bintvihok and Kositcharoenkul 2006). In terms of egg production, birds on control gave better hen day production followed by birds on vitamin supplementation. However, birds on mouldy diets without additive have a depressed (P>0.05) egg production similar to those on commercial binder. Presence of aflatoxins has been reported to cause a drop in egg production (Patil *et al.*, 2014). Although, layers in the Control group had superior feed conversion ratio/kg egg mass, they were not different from groups on dietary vitamin supplementation. Birds on mouldy diet without additive and those on commercial binder had lower (P>0.05) conversion efficiency. Lower levels of aflatoxin contamination has been associated with considerable decrease in feed

intake and feed conversion ratio (Shi *et al.*, 2006) while Bains (2007) had reported that under practical conditions, supplementation of vitamins could alleviate clinical sign of aflatoxicosis in the flock as a way of restoring performance traits.

In terms of egg qualities, there were no significant differences ($P>0.05$) in the egg weights, yolk weight and albumen weight across the treatments. However, significant differences ($P<0.05$) in mean values were observed for shell thickness, yolk colour and shell weight. The use of the selected additives in this study improved the shell thickness and yolk coloration of the experimental birds over birds on mouldy diet without supplementation. The use of commercial binder had slight superior value over their vitamin supplemented counterpart. Yegani *et al.* (2006) in his report had indicated that the feeding of aflatoxin contaminated grains decreased eggshell thickness. While binder has proven to be an effective adsorbent of some mycotoxins (Avantaggiato *et al.*, 2004; Devreese *et al.*, 2012), its unspecific binding is the major drawback in its use as a feed additive. It has been found to diminish nutrient absorption, such as vitamins and minerals, and consequently impairs the nutritional value of feed (Avantaggiato *et al.*, 2004).

Conclusion

This study demonstrates that the feeding of mouldy diets may compromise the nutritional requirement of laying hens because of loss of nutrient. Mouldy feed containing aflatoxins in poultry layers also causes a reduction in production performance and some egg quality characteristics of laying birds. The finding also attests to the positive role of the selected vitamins in reducing the effects of mouldiness and aflatoxicosis in layers. Supplementation of vitamins A, E or continuous use of vitalyte on mouldy diets at the tested levels in this study should therefore be encouraged in layers' production because mould contamination is ubiquitous and practically difficult to eliminate completely in poultry feed.

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Table 1: Composition of experimental diets

Ingredients, %	Control(AMD)	MMD	MMD^{A}	MMD^{E}	MMD^{V}	MMD^{B}
Maize	40	40	40	40	40	40
Wheat offal	29	29	29	29	29	29
Fishmeal	2	2	2	2	2	2
Soybean meal	12	12	12	12	12	12
GNC	5	5	5	5	5	5
Bone meal	3	3	3	3	3	3
Limestone	7	7	7	7	7	7
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.2	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2	0.2
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Retinol(µg)	$2.7x10^3$	$2.7x10^3$	$6.0x10^3$	$2.7x10^3$	$2.7x10^3$	$2.7x10^3$
Tocopherol (µg)	$5x10^4$	$1.5x10^4$	$1.5x10^4$	$3.0x10^4$	$1.5x10^4$	$1.5x10^4$
Vitalyte	-	-	-	-	0.10	-
Comm. binder						0.20
Total	100	100	100	100	100	100
M E, kcal/kg	2727	2727	2727	2727	2727	2727
CP, %	17	17	17	17	17	17
CF, %	5.13	5.13	5.13	5.13	5.13	5.13
EE, %	6.45	6.45	6.45	6.45	6.45	6.45
Calcium, %	3.41	3.41	3.41	3.41	3.41	3.41
Phosphorus %	0.54	0.54	0.54	0.54	0.54	3.41

AMD-Aflasafe maize diet, MMD-mouldy maize diet, A-Retinol E-tocopherol, V-vitalyte, B-binder

Table 2: Some chemical composition of Mouldy and Aflasafe maize.

Components	Aflasafe Maize	Mouldy Maize	Percentage loss/gain
Total Aflatoxin(µg/Kg)	23	267.41	$1.16x10^6$
VIT.A(µg/kg)	15.38	7.89	48.69
VIT.E(µg/kg)	6.78	4.23	37.61
*ME (Kcal/kg)	3240.94	3174.27	2.05

* Value obtained by calculation using Pauzenga 1985.

Table 3: Performance and egg qu ality characteristics of laying birds fed mouldy diets with selected dietary supplemental additives

	Control(AMD)	MMD	MMD^{A}	MMD^{E}	MMD^{V}	MMD^{B}	Pooled SEM	Values
Performance characteristics								
Feed intake, g/b/d	115.56^{a}	119.27^{b}	124.47^{a}	123.31^{c}	124.52^{a}	123.62^{a}	1.89	0.001
Hen day production	80^{a}	52.53^{d}	61.25^{bc}	66.03^{b}	67.01^{b}	55.17^{cd}	0.509	0.001
FCR /kg egg mass	3.21^{c}	4.25^{a}	3.37^{bc}	3.71^{abc}	3.63^{abc}	4.04^{ab}	0.115	0.043
FCR/dozen egg	2.34^{b}	3.12^{a}	2.59^{b}	2.56^{b}	2.55^{b}	3.09^{a}	0.083	0.004
Weight gain/b(g)	80^{a}	43.33^{c}	126.67^{ab}	160^{a}	133.33^{a}	53.33^{bc}	14.97	0.009
Egg quality measurement, g								
Egg weight	60.62	60.43	59.51	58.02	58.59	63.79	0.782	0.360
Shell weight	6.28^{ab}	6.32^{ab}	6.38^{ab}	6.26^{ab}	6.79^{ab}	7.09^{a}	0.011	0.015
Albumen weight	30.00	27.06	27.94	28.65	27.17	30.11	0.585	0.547
Yolk weight	14.52	14.44	13.79	14.49	14.16	14.80	0.193	0.144
Yolk colour	2.58^{b}	2.58^{b}	3.5^{a}	4.5^{a}	3.75^{a}	2.75^{a}	0.176	0.000
Shell thickness (mm)	0.34^{a}	0.26^{c}	0.31^{b}	0.29^{b}	0.29^{b}	0.32^{b}	0.0073	0.001