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EFFECT OF MAXIGRAIN SUPPLEMENT ON GROWTH PERFORMANCE, ECONOMIC INDICES AND HAEMATOLOGICAL PARAMETERS OF HEAT-STRESS BROILERS FED THREE DIETARY FIBRE SOURCES

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ORIGINAL ARTICLE

ABSTRACT: *The study determined effects of Maxigrain supplementation to 3 dietary fibres on growth performance, economic indices, tibia ash of broilers raised under daily heat stress (42^{0}centigrade) of 4 hours. A total of 162 day old broiler chicks of Arbor Acres strain were divided into 6 treatments with 3 replicates per treatment of 27 birds. The fibrous ingredients were wheat offal, rice bran and corn bran. These were included in broiler starter and finisher diets at 3% and 20% respectively. Feed and water were supplied ad libitum. Birds in groups T1 (wheat offal), T3 (rice bran), T5 (corn bran) were fed unsupplemented diets. Diets in T2 (wheat offal), T4 (rice bran) and T6 (corn bran) were supplemented with Maxigrain® at 100mg/kg. The results showed Maxigrain addition to corn bran–and rice bran–diets significantly (P<0.05) improved feed conversion of heat stress birds. Heat stress chickens fed rice bran Maxigrain diet had better final liveweight and improved compressive strength than those fed enzyme wheat offal diet (final liveweight of 1758.9 versus 1566.67 g per bird and compressive strength of 4.75 versus 3.04 Newton percm^2). Heat stress broilers fed rice bran enzyme supplemented diet had the best feed conversion, strongest compressive strength and achieved the highest profit (P<0.05). Birds consumed less of Maxigrain diets. However, the enzyme failed to improve final liveweight of heat stress chickens fed wheat bran diet.*

Key words: *Heat stress, enzyme, fibres, tibia, compressive strength, broilers*

INTRODUCTION

Feed ingredients of plant origin and their by- products contain a number of components that are resistant to monogastric digestive enzymes because of lack of and/ or insufficiently of endogenous enzyme secretions (Ravindran et al., 1999). These components lower the utilization of other dietary nutrients leading to performance reduction. The incorporation of feedstuffs containing antinutritive factors may adversely affect the performance of poultry. The nutritional strategy used to address the antinutritive feedstuffs involved the use of feed enzymes that offer immense potential to overcome the problems. Degradation of non-starch polysaccharide (NSP) through the use of enzymes is the underlying mechanism to improve bird performance by releasing trapped nutrients within the cell and lowering digesta viscosity to enhance nutrient digestion and subsequent absorption (Classen and Bedford 1991, Bedford and Schulze 1998). Maxigrain® has been identified to optimize the use of non-conventional feed ingredients by improving weight gain and feed conversion ratio in broilers, improve litter quality and egg production as well as shell quality. It also reduces levels of dicalcium phosphate incorporation in the feed substantially (Polchem Innovative Solution, 2013). Rearing of broiler in the tropical environment usually expose birds to heat stress.

Stress is used to describe the use of non-specific responses or defense mechanism of the body when confronted with abnormal or extreme demand (Sahin et al., 2009). High ambient temperature (that induces heat stress) is of great concern in all types of poultry operations. It compromises performance and productivity through reduced feed intake and decreasing nutrient utilization, body weight (BW), growth rate, egg production, egg quality, hatchability, carcass characteristics and other important traits governing the prosperity of the industry are adversely affected by severe heat stress (Geraert et al., 1996). Heat loss in poultry is limited due to feathering and the absence of sweat glands. This leads to physiological changes that are accompanied by a change in hormonal status and a reduction in feed intake to reduce metabolic heat production (Teeter et al., 1985). Broiler not only eats less at high temperature, it also gain less per unit of intake, especially at temperature above 30^{0}C (Daghir, 2009). Considerable attention is given to nutritional manipulation to manage heat stress in poultry. These include dietary

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fortification with vitamins, minerals, fat and amino acids. Heat stress affects drastically the enzyme-kinetics (Yang and Wang, 2006), and consequently the rate of metabolic pathways (Schlesinger et al., 1997). Increased mineral excretion is one of the important consequences of heat stress in chicks. Belay and Teeter (1996) reported lower retention rates for phosphorus, potassium, sodium, magnesium, sulphur, magnesium, copper and zinc in broilers raised at high cycling ambient temperatures. The following hypothetical questions were stated to address the effects of heat stress in relation to utilization of dietary fibres and the use of feed enzyme to solve the problem of fibre utilization during high environmental temperature. To what extent will heat stress have on the capacity of broilers to properly handle dietary fibres and what effect will these fibres have on tibia bone characteristics under daily high environmental temperature? Will enzyme supplementation to dietary fibres for broilers exposed to daily high environmental temperature achieve better performance and improve tibia bone than those fed without the enzyme? Hence, this study investigated effects of Maxigrain® supplementation to 3 dietary fibre sources on growth performance, economic production indices, tibia ash and other tibia characteristics of broilers raised under heat stress of 4 hours daily.

MATERIALS AND METHODS

Experimental condition

The experiment was carried out with birds exposed to an environmental temperature of 42^0 centigrade for a period of 4 hours daily (12.00noon-4.00pm). Two automatic adjustable thermostat electric fan heaters with 2000W 220 voltage output (Ningbo Aipai Electric Company Limited Zhejiang, China) were hanged on the walls of the poultry pens (at 100cm from the floor of the pens). These electric heaters were used to achieve uniform distribution of 42^0C for the birds.

Experimental design

A 2 by 3 factorial arrangement under completely randomized design (CRD) was adopted for the study. The 2 factors were fibre sources (wheat offal, rice bran and corn bran) and Maxigrain® supplementation (at 0, 100mg/Kg) to examine interaction effects of the factors on the measured parameters of broilers.

Management of experimental birds

The management practices included thoroughly disinfection of the pens and allowed the pens to rest for 2 weeks. The equipments were cleaned. The foot-dip disinfectant was prepared at the entrance of the pen. A total of 162 day old broiler chicks of Arbor Acres strain were randomly distributed to 6 dietary groups. Each treatment contained 3 replicates of 27 birds. Other normal management practices were also observed during the study such as proper vaccination and medication. Starter diets were fed to the birds for first phase of growth (0-4 weeks) and finisher diets for the last phase of their growth (5^{th} -7^{th} week). The birds were fed experimental diets and given water *ad libitum* throughout the study period of 7weeks under high ambient temperature of 42^0C for 4hours daily (12.00-4.00pm).

Formulation of experimental diets

There were 6 experimental diets containing 3 fibres which were wheat offal (WO), rice bran (RB) and corn bran (CB). These fibrous ingredients were included in the broiler starter and finisher diets at 3% and 20% respectively (Table I). Treatment groups of T1 (WO), T3 (RB), and T5 (CB) were diets without enzymes. The experimental diets of T2 (WO), T4 (RB) and T6 (CB) were supplemented with Maxigrain® at 100mg/kg.

Cost analysis

Economic efficiency of growth was estimated using profit as a proportion of feed cost.

Maxigrain® composition

Each gram of Maxigrain® contained 10,000 IU cellulase, 200 IU beta-glucanase, 10,000 IU xylanase and 2500 FTU phytase. Maxigrain® is manufactured by Polchem Hygiene Laboratories, India.

Chemical analysis and structural measurement of tibia

Six samples of tibia bones per treatment were used for each of ash, physical and structural measurements. The collected tibia bones were autoclaved using the procedure described by Hall *et al.* (2003). Ash content of the tibia were estimated by ashing the samples at 550°C for 5 h. The tibia bones were subjected to direct axial loads using Essay Universal Machine. The loads (Newton) caused structural compression in the bones. The physical measurements of tibia bones were carried out with the aid of measuring tape: diameter, length and breadth of the bones. The area of the bones was a multiplication of length and breadth of the bones. The compressive strength of tibia was determined using load (Newton) divided by the area of the bone which was expressed as Newton/cm^2. The ash and structural measurements of tibia bones were carried out at the Laboratory of Department of Animal Production and Health, as well as Photogrametry⁄Geodetic⁄Structural Engineering Laboratory of Civil Engineering Department respectively, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

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Statistical analysis

All data collected were analyzed using factorial analysis of variance under completely randomized design (SAS, 1999). Significant means were separated using Duncan option of the same software. A probability of 5 percent considered significant.

RESULTS

Feed intake and feed conversion of heat stress broiler starters were significantly (P<0.05) influenced by the main effects of dietary fibre sources and levels of Maxigrain® supplementation (Table II). Maxigrain® supplementation decreased the feed intake and improved feed conversion of broiler starters exposed to daily 4 hours of heat stress. Interaction of the dietary fibre source and Maxigrain® significantly (P<0.05) improved final live weight and weight gain of heat stress broiler starters fed rice bran at 3% in the diet. However, heat stress broiler starters fed wheat offal and corn bran Maxigrain® supplemented diets resulted in lower final liveweight and weight gain than their counterparts fed wheat offal and corn bran unsupplemented diets.

Dietary treatment significantly (P<0.05) influenced final live weight and feed conversion of the 49th day old broiler finishers exposed to daily 4 hours of heat stress (Table III). Heat stressed broiler chickens fed rice bran Maxigrain® diet had the best final live weight and most efficient feed conversion. Broiler chickens fed corn bran Maxigrain® diet had slightly improved final live weight than those fed unsupplemneted CB diet. Chickens fed wheat offal diet supplemented with enzyme had the least final live weight among the treatment groups. Furthermore, Maxigrain® addition to the rice bran– and corn bran- diets significantly (P<0.05) improved the feed conversion of the birds at finisher phase. However, chickens fed unsupplemented- and enzyme- wheat offal diets had statistically similar feed conversion.

Heat stress broiler chickens fed wheat offal- and rice bran- diets without enzyme had significantly (P<0.05) lower compressive strength than those that were fed Maxigrain® supplemented wheat offal and rice bran diets (Table IV). Furthermore, heat stress broiler chickens fed enzyme supplemented wheat offal diet had significantly (P<0.05) lower diameter, area and load of tibia than their counterparts fed unsupplemented wheat offal diets. Diets did not significantly (P>0.05) influence tibia ash content of heat stress broiler chickens.

Highest and lowest feed costs (₦/kg weight gain) were observed in heat stressed broilers fed unsupplemented corn bran diet and those fed enzyme rice bran diet respectively (Table V). Maxigrain® significantly (P<0.05) lowered feed cost (₦/kg weight gain) for broilers fed these dietary fibres. Furthermore, Maxigrain® supplementation to rice bran diet achieved maximum profit and produced the best economic efficiency of growth for heat stress broiler chickens.

DISCUSSION

Addition of Maxigrain® may be responsible for lower feed intake experienced by heat stress broilers and the resultant improved final liveweight of broiler finishers. Maxigrain® could have improved the utilization of dietary fibres and other energy giving nutrients thereby lowering the amount of feed consumed by broilers fed enzyme supplemented diets than those fed unsupplemented diets. This agrees with the report of Sekoni et al. (2008) that Maxigrain® supplementation increases the retention of many vital nutrients and metabolizable energy. The effect of multiple–enzymes preparation (Maxigrain®) to improve the overall performance of broilers fed these dietary fibres was feasible even during heat stress in this study. Similar account was given by Yu and Chung, (2004) who reported that broilers responded to enzyme supplementation with greater magnitude in the hot season than in the cool season. This was also supported by Sekoni et al. (2008) that Maxigrain® supplementation significantly improved the dietary fibre retention under normal environmental condition. Esuga *et al.* (2008) recorded higher broiler weight gain in an experiment designed to evaluate enzyme (Maxigrain®) supplementation to graded levels of palm kernel meal. Addition of Maxigrain® to wheat offal- and corn bran- diets did not improve the final liveweight, weight gain, compressive strength and other tibia characteristics of heat stress broilers. This implied that the enzymatic profile in Maxigrain® preparation could not hydrolyse the non-starch polysaccharide (NSP) of wheat offal diet so as to make nutrients and minerals more available for the birds. In addition, exposure of broilers to heat stress may have hindered the capacity of these birds to secrete adequate endogenous secretion to utilize the nutrients in corn bran diet. Ademola et al. (2012) reported that Roxazyme G® corn bran diet produced the best feed conversion and maximum profit among those fed either Maxigrain® or Roxazyme G® supplemented diets containing each of corn bran, wheat offal and brewery dry grain. They also showed that both enzymes failed to improve the performance and profits of hens fed wheat offal diet under normal environmental condition.

Biochemical assessment of tibia bone ash did not show significant effect, however, physical and structural measurements revealed that tibia compressive strength and other tibia characteristics were significantly enhanced by Maxigrain® supplementation to rice bran diet. Addition of Maxigrain® to rice bran diet resulted in the maximum profit which is likely connected with the ease with which broilers were able to utilize rice bran. These results were in accordance with the findings of Kaczmarek et al. (2007) who reported a significant interaction between temperature of drying maize and enzyme supplementation on body weight gain in the growing and total periods. These results demonstrated that it was possible to positively affect the performance of birds fed dietary fibres exposed to heat stress by supplementing the diets with the appropriate fibre degrading enzyme. However, profit obtained from heat stress broiler chickens fed corn bran supplemented diet did not respond well to enzyme supplementation.

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Table 1 - Ingredient composition of starter and finisher diets

Parameters	Starter diets						Finisher diets					
	T1	T2	T3	T4	T5	T6	T1	T2	T3	T4	T5	T6
Maize	59.54	59.54	59.25	59.25	58.97	58.97	54.25	54.25	50.38	50.38	48.77	48.77
Soybean meal	30.71	30.71	31.00	31.00	31.28	31.28	20.00	20.00	23.87	23.87	25.48	25.48
Wheat offal	3.00	3.00	-	-	-	-	20.00	20.00	-	-	-	-
Rice bran	-	-	3.00	3.00	-	-	-	-	20.00	20.00	-	-
Corn bran	-	-	-	-	3.00	3.00	-	-	-	-	20.00	20.00
Fixed ingredients*	6.75	6.75	6.75	6.75	6.75	6.75	5.75	5.75	5.75	5.75	5.75	5.75
Maxigrain®	-	+	-	+	-	+	-	+	-	+	-	+
Calculated Analysis												
Energy	3000.34	3000.34	3033.24	3033.24	3028.40	3028.40	2840.44	2840.44	3006.60	3006.60	2895.78	2895.78
Crude Protein (%)	21.06	21.06	21.00	21.00	21.00	21.00	17.81	17.81	18.00	18.00	19.00	19.00
Calcium (%)	1.50	1.50	1.50	1.50	1.50	1.50	1.28	1.28	1.26	1.26	1.28	1.28
Available P. (%)	0.63	0.63	0.71	0.71	0.63	0.63	0.60	0.60	0.64	0.64	0.58	0.58
Methionine (%)	0.44	0.44	0.34	0.34	0.35	0.35	0.30	0.30	0.32	0.32	0.31	0.31
Lysine (%)	1.15	1.15	1.15	1.15	1.16	1.16	0.97	0.97	1.00	1.00	0.98	0.98
Crude fibre (%)	3.43	3.43	3.59	3.59	3.66	3.66	4.11	4.11	4.98	4.98	5.05	5.05

*Vitamin mineral premix supplied the following vitamins and trace elements per kg diet: Vit. A 12500IU,Vit. D_3 2500IU, Vit. E 40mg, Vit. K_3 3mg, Vit. B_1 3mg, Vit.B_2 5.5mg, Niacin 5.5mg, Calcium Pantothenate 11.5mg, Vit B_6 5mg, Vt B_{12} 0.025mg, Folic Acid 1mg, Biotin 0.08mg, Mn 120mg, Choline Chloride 500mg, Fe 100mg, Zn 80mg, Cu 8.5mg, I 1.5mg, Co 0.3mg, Se 0.48mg and Antioxidant 120mg. Fixed ingredients (FIs) for starter diet contained 2.65% fish meal, 1.5% oyster shell, 0.25% salt, and FIs for finisher diet contained 2.1% fish meal, 1% oyster shell, 0.3% salt. Both diets also contained 0.25% vitamin premix, 0.1% meth. and 2% bone meal. - = unsupplemented group + = MAXI supplemented group

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Table 2 - Growth performance of heat-stress broiler chicks fed 3 fibre sources and Maxigrain® (1-28 days, g/bird)

Parameters	T1 Wheat offal -	T2 +	T3 Rice bran -	T4 +	T5 Corn bran -	T6 +	SEM	Fibre	Maxi	Int.
Final live wt	905.56	893.33	875.56	1000.01	955.57	888.33	31.6	NS	NS	S
Init live wt	58.81	58.81	58.81	58.81	58.81	58.81	0.07	NS	NS	NS
Weight Gain	846.75	834.52	816.74	941.20	896.76	829.52	31.6	NS	NS	NS
Feed Intake	1616.67^{c}	1254.70^{d}	1609.50^{c}	1276.50^{d}	2365.00^{a}	1921.23^{b}	53.60	S	S	NS
Feed conversion	1.92^{c}	1.50^{d}	1.97^{b}	1.36^{d}	2.66^{a}	2.31^{c}	2.74	S	S	NS

^{abcd} Means along the same row with different superscripts are significantly different. (P<0.05), FS+= fibre sources, + and – mean Maxigrain® supplemented and Unsupplemented diets respectively, S= significant, NS= not significant.

Table 3 - Growth Performance of heat-stress broiler finishers fed 3 fibre sources and Maxigrain® (29-49 day, g/bird)

Parameters	T1 Wheat offal -	T2 +	T3 Rice bran -	T4 +	T5 Corn bran -	T6 +	SEM	Fibre	Maxi	Int.
FLW	1606.67^{bc}	1566.67^{c}	1553.33^{c}	1758.90^{a}	1638.90^{b}	1717.77^{ab}	42.26	NS	S	S
ILW	905.56	893.33	875.56	1000.01	955.57	888.33	31.60	NS	NS	S
WG	701.11	673.33	677.78	758.89	683.33	829.43	40.19	NS	NS	NS
FI	2733.60	2053.30	2745.60	2333.30	2977.80	2845.60	224.64	NS	NS	NS
FCR	3.86^{abc}	3.05^{c}	4.08^{ab}	3.07^{c}	4.39^{a}	3.44^{bc}	0.28	NS	S	NS

^{abcd} Means along the same row with different superscripts are significantly different. (P<0.05), + and – mean Maxigrain® supplemented and Unsupplemented diets respectively. FLW= final live weight, ILW= initial live weight, WG= weight, FI= feed intake, FCR= feed conversion ratio.

Table 4 - Tibia characteristics, compressive strength and ash content of heat-stress broiler chickens fed 3 fibre sources and Maxigrain®

Parameters	T1 Wheat offal -	T2 +	T3 Rice bran -	T4 +	T5 Corn bran -	T6 +	SEM	Fibre	Maxi	Int.
Diameter (cm)	0.63^{a}	0.59^{d}	0.61^{cd}	0.62^{bc}	0.62^{ab}	0.61^{bc}	0.004	NS	S	S
Area (cm^2)	13.69^{a}	9.69^{b}	11.30^{ab}	8.16^{b}	9.38^{b}	9.30^{b}	0.99	NS	S	NS
Load (Newton, N)	36.00^{a}	29.20^{b}	31.50^{ab}	33.67^{ab}	35.00^{a}	36.00^{a}	1.47	NS	NS	S
Compressive strength (N/cm^2)	2.70^{b}	3.04^{b}	3.04^{b}	4.75^{a}	3.79^{ab}	3.63^{ab}	0.37	S	S	S
Tibia ash (%)	42.72	42.84	42.63	44.13	43.06	43.94	1.57	NS	NS	NS

^{abc} Means along the same row with different superscripts are significantly different. (P<0.05), S= significance, NS= not significant

Table 5 - Cost and profit of heat stress broiler chickens fed 3 fibre sources and Maxigrain®

Parameters	T1 Wheat offal -	T2 +	T3 Rice bran -	T4 +	T5 Corn bran -	T6 +	SEM	Fibre	Maxi	Int.
Feed cost per Kg wt gain (#/kgWG)	405.55^{c}	354.77^{cd}	420.63^{bc}	307.18^{d}	548.34^{a}	458.03^{b}	24.66	S	S	NS
Profit (#/kgWG)	294.45^{bc}	354.23^{ab}	279.37^{bc}	392.82^{a}	151.66^{d}	241.97^{c}	24.66	S	S	NS
EEG (%)	72.83^{bc}	100.66^{ab}	68.14^{bcd}	130.81^{a}	28.09^{d}	34.17^{cd}	12.94	S	S	NS

^{abcd} Means along the same row with different superscripts are significantly different (P<0.05), S= significance, NS= not significant. Total P.= Total period

CONCLUSION

Heat stress decreased growth performance and tibia compressive strength of broiler chickens fed these dietary fibres. Maxigrain® enhanced the growth performance, tibia compressive strength and profit obtained from heat stress broilers chickens fed rice bran diet. The study clearly showed that enzyme supplementation could be used to combat heat stress in broiler chickens based on specific fibre–enzyme interaction and reduced feed intake.

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