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Effects of wheat offal replacement of maize with or without enzyme addition on laying performance and egg quality characteristics

[1*]Ogunleye J.B., [1]Uzor, G.O., and [2]Iyayi, E.A.

[1]Institute of Animal Science, Chinese Academy of Agricultural Science, Beijing, China. [2]Department of Animal Science, University of Ibadan, Ibadan, Oyo state, Nigeria.

Corresponding Author: *bukoladelola@yahoo.com ***Phone No.:*** +8613127667376

Target audience: Poultry farmers that are into rearing of laying hens and poultry nutritionist

Abstract

The objective of this experiment was to evaluate the effects of wheat offal (WO) replacement of maize with or without enzyme addition on laying performance and egg quality characteristics. Eight weeks feeding trial was conducted using thirty six black harco hens out of fifty that was purchased for the experiment. The thirty six laying hens was randomly allocated to three dietary treatments. Wheat offal was used to replace maize at 0 and 40 percent replacement level with or without enzyme addition. Diet one served as the control. Diet two was 40% WO replacement of maize with enzyme. Diet three was 40% WO replacement of maize without enzyme. The experiment was completely randomized design. Results showed that only feed and egg shell thickness from diet two reflected significant (P<0.05) difference on both laying performance and egg quality characteristics of laying hens. This showed that enzymes addition to laying hens diet with 40% WO replacement of maize can be recommended to poultry farmers that are into commercial egg production whose target is shell thickness to reduce egg loss due to low shell thickness.

Key words: layers, enzymes, wheat offal, eggs

Description of Problem

Efficiency in feeding has been the major concern of raising poultry birds. In Nigeria, poultry feed is based primarily on maize and soybean meal as energy and protein source (1). During scarcity periods, the above mentioned feed ingredients are usually expensive. This factor has constituted a problem to production and sustainability of poultry industry in Nigeria. Agro-industrial by-products (AIBP) are cheap and abundant in Nigeria and they represent ready feedstuffs for feed formulation in animal production (2). AIBP such as grain offals (maize or wheat), husks, de-grained cobs and legume hulms are noted for high fiber content which is a major problem against their efficient use in monogastric animal nutrition (3,4). In recent years, replacement of maize with feed ingredients that are less competitive between man and livestock and also readily available for animal feed formulation have become the focus of many poultry nutritionist in Nigeria.

Wheat offal is one of such feedstuffs that have been found to suitably replace maize at certain inclusion rates in poultry diets. Wheat offal is obtained from the wheat grains through the abrasive action of a blade-bearing rotating drum inside the machine. The offal comes out through a sieve with rectangular slits of 1 x 10mm, while the polished grain comes out through another opening in the machine (5). Presently, wheat offal does not serve as staple food for human consumption, hence considered suitable feedstuff for monogastric animals. However, wheat offal is a high fibrous feed material containing non-starch polysaccharides (NSP) which cannot be digested by endogenous digestive enzymes located along the gastrointestinal tract of poultry birds. Enzyme supplementation of wheat offal causes the breakdown of its cell wall with the release of oligosaccharides resulting into improvement in nutrient digestibility and gut health (6). Wheat offal has been reported to favorably replace maize when supplemented with enzymes. (7) reported that inclusion of wheat offal at graded levels to replace maize with enzyme supplementation resulted into decreased feed intake and increased nutrient digestibility of broiler chickens. (1) stated that enzyme supplemented wheat offal significantly ($P<0.05$) enhance body weight gain, reduced feed intake and improved feed conversion ratio (FCR) in broilers. Ronozyme ® WX is a preparation of endo-1, 4-beta xylanase produced by a genetically modified strain of *Aspergillus oryzae*. The composition of the enzyme includes the fermentation product, sodium sulfate (52.7%), calcium carbonate (15%), kaolin (9%), dextrin and sucrose (8%), cellulose (6%), and vegetable oil (7%) (8). Published data on the use of enzyme supplemented for poultry are very much in circulation. However, to our knowledge and data available to us, little works have been done on the use of ronozyme ® wx as addition to wheat offal in replacement of maize for laying hens. Therefore, the objective of this present study is to evaluate the effects of wheat offal replacement of maize with or without enzyme addition on laying performance and egg quality characteristics of laying hens.

Materials and Methods

This experiment was carried out at the Teaching and Research Farm, University of Ibadan, Nigeria. The enzymes used for this experiment was supplied by DSM Nutritional, Switzerland. Wheat offal was sourced for from a reputable feed mill in Ibadan. Fifty black harco hens were purchased from a commercial farm at fourteen weeks of age, fed with commercial layers diet for a period of four weeks till 50% hen-day production rate was recorded among the birds. At 19th week of age, thirty six black harco hens were randomly selected and allocated into three dietary treatments. The birds were arranged in a Completely Randomised Design. Each dietary treatment was divided into six replicates comprising of two birds per replicate. Two weeks was used as adaptability period to the experimental birds and to ascertain that only experimental diets remain in the gastrointestinal tracts of the birds which were solely responsible for onward performance and egg laying ability of the birds. Diet 1 served as the control with Maize representing 50% of the control diet. In diet 2, maize was replaced with wheat offal at 40%, giving wheat offal 20% inclusion rate of the whole experimental diet 2 with addition of enzyme. Diet 3 followed the same trend with diet 2, except that no enzyme was added. The experiment commenced when the birds attained 22nd week of age and lasted for a period of eight weeks. Feed and water were offered *ad libitum*. Birds were observed daily for optimum health performance and no bird was culled and no mortality was recorded throughout the experimental period.

Data collection

Data collected were hen-day production expressed in percentage and calculated as multiplication of number of eggs collected per week by 100 divided by multiplication of number of days in a week and number of birds per replicate; egg weight was recorded in grams and calculated as total number of eggs collected per week divided by number of eggs laid per week; feed intake was measured as feed remaining subtracted from feed offered;

the FCR was calculated as feed intake divided by multiplication of average egg weight and number of egg laid per week; shape index expressed in percentage was calculated as the division of egg width by egg length multiplied 100; shell thickness was determined by the use of micrometer screw gauge, egg shells were air-dried and shell membranes was removed, measurements was taken at three points upper, lower and middle ends, the means was calculated and recorded; percentage albumen index was measured as multiplication of albumen height with 100, then divided by the average of albumen length and albumen width; yolk index was expressed in percentage and determined as multiplication of yolk height with 100 divided by yolk diameter, and haugh unit was calculated using the following formula: 100 x [AH + 7.57- 1.7 x $EW^{0.37}$] where AH is Albumen height and EW is egg weight. All data obtained from the experiment were subjected to One-Way Analysis of Variance of SPSS version 23 (9). Treatment means were separated using Duncan Multiple range test of the same software. Level of significance was declared at $P<0.05$.

Results and Discussion

Chicken eggs are one of the most nutritious foods for humans, and they can help provide the recommended daily allowance of nutrient for human of all ages (10). Several studies with enzymes supplemented diets have yielded varied results depending on the NSP component of the diet in question (11). On the results of the performance of laying hens from this current study shown on Table 2, only feed intake of birds fed enzymatic diet showed significant ($P<0.05$) difference. The feed intake of the enzyme supplemented diet was reduced with a value of 116.64 g/bird/day. Parameters such as hen-day production, egg weight, and FCR did not show significant ($P>0.05$) difference among the three dietary treatments. This result agrees with the findings of (12) who reported that feed intake was notably decreased in laying hens fed wheat-based diets supplemented with enzyme. These authors attributed their observation to the influence of diet composition and type of enzyme used in their study. They also reported that ineffectiveness of enzyme supplementation on performance of hens may be due to enzyme level used. Moreover, the result on performance of laying hen fed enzyme supplemented diet showed the least egg weight, the least value for hen-day production and highest FCR. This obviously implies that type of enzyme used did not favor the performance rate of laying hens fed enzyme supplemented diet. This inference affirmed the claim of (2) who stated that the response of the laying hens fed enzyme supplemented diets in their study showed that the type of NSP degrading enzymes used is crucial to the performance of laying hens fed different sources of dietary fibre. It is certain that ronozyme ® WX used in this study did not improve the overall performance of laying hens in this study, except the decreased feed intake which possibly explains the lowest values recorded for hen-day production (78.27%) and egg weight (54.39g) and the highest value for FCR (1.43). It is important for us to state here that as at the time the experiment was conducted very little information was available to us about the usefulness and major activities of this enzyme. On egg quality characteristics, significant ($P<0.05$) difference was seen only for shell thickness of eggs laid by birds on 40% wheat offal replacement of maize with enzyme addition. An egg shell is the hard, usually white or brown or greenish blue coating that provides the eggs solid structure and shapes. The egg shell is an important structure for two reasons. Firstly, it forms an embryonic chamber for developing chick, providing mechanical protection and a controlled gas exchange medium. Secondly, it is a container for the market egg, providing protection of the contents and a unique package for a valuable food. Breakage or cracking of egg shells in market channel is a serious concern to commercial egg producers. (13) stated that failure of egg shell for any reason compromises the egg value, whether as a hatching egg or food product. The same author also emphasized that egg shell failures often have significant economic consequences on egg producers. (14) grouped factors influencing egg shell quality into internal and external factors. Among the external factors the authors mentioned was nutrition or diet composition for laying hens. The significant ($P<0.05$) difference seen on shell thickness from the result of this study could be attributed to composition of diet. The result on shell thickness from this study clear showed that enzyme used in this study had significant impact on egg shell formation of eggs laid by birds on 40% wheat offal replacement of maize with addition of enzyme. This result tallied with the findings of (15) who concluded that acceptable egg shell thickness suitable for market and hatching ranged from 0.24 to $0.42mm10^{-2}$. On shape index, although the result from this study showed that no significant ($P<0.05$) difference was observed among the three dietary treatment groups. However, birds on 40% wheat offal replacement of maize with addition of enzyme had the highest value which likely reflects the positive impact of enzymatic diet on egg shape. (16) defined egg shape index as the ratio of width to length of the egg. The same authors stated that egg shape index is an important criterion in determining egg quality. Which likely means that improvement of egg shape index certain result in improvement of egg quality and acceptance by consumers. The increase recorded for egg shape index in this study could be linked to the dietary supplementation of enzyme and type of enzyme used. Moreover, acceptance of our inference on egg shape index from this study depends on further investigation and should be taken as hypothesis for future testing.

Conclusions and Applications

1. Even though the result from this study showed a significant ($P<0.05$) decrease in feed intake of birds on 40% wheat offal replacement of maize with enzyme which could imply that the enzyme added favored nutrient utilization, however, it cannot be recommended to poultry farmers whose aim is to improve laying performance of their birds. The reason for this is the fact that decreased hen-day production, reduced egg weight and highest value for FCR recorded in this study for birds on 40% wheat offal replacement of maize with enzyme is very much likely to be connected to the enzyme added to the diet and probably type of enzyme used.
2. For poultry farmers and poultry nutritionist whose target is primarily improvement of hen-day production of laying hens, the result of this study showed that 40% wheat offal replacement of maize without enzyme will meet that need, hence, it is recommended.
3. On egg quality characteristics, the result of this study showed that 40% wheat offal replacement of maize with enzyme will be good for poultry farmers whose target is egg shell thickness improvement for reduction of egg loss and maximization of profit on egg sale.
4. Finally, on a general note, the result of our study showed that enzymatic diet for improvement of laying performance should be avoided while the same diet may be adopted for egg quality value addition.

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Table 1: Gross composition of experimental diets (g/100g)

Items	Maize : Wheat offal		
	100:0 (Diet 1)	60:40 (Diet 2)	60:40 (Diet 3)
Ingredients			
Maize	50.00	30.00	30.00
Wheat offal	0.00	20.00	20.00
Groundnut cake	8.00	8.00	8.00
Soybean meal	12.00	12.00	12.00
Rice bran	13.00	13.00	13.00
Fish meal	3.00	3.00	3.00
Bone meal	5.00	5.00	5.00
Oyster shell	8.00	8.00	8.00
Salt	0.30	0.30	0.30
DL-Methionine	0.25	0.25	0.25
L-Lysine	0.20	0.20	0.20
Premix[1] (layer)	0.25	0.25	0.25
Enzyme	0.00	0.15[+]	0.00
Total	**100.00**	**100.15**	**100.00**
Chemical composition			
Calculated composition			
ME[2] (kcal/kg)	2709.80	2397.00	2396.00
Lysine (%)	0.81	0.81	0.81
Methionine (%)	0.54	0.55	0.55
Analyzed composition			
Dry matter (%)	96.80	96.92	96.91
Crude protein (%)	19.25	19.69	20.56
Ether extract (%)	10.00	10.00	11.00
Ash (%)	24.00	22.00	21.00
Crude fiber (%)	9.00	12.00	11.00

[1]supplied per 100g of diet: Manganese: 0.08g, Iron: 0.06g, Zinc: 0.06g, Copper: 0.005g, Selenium: 0.00015g, Cobalt:0.0002g, Iodine: 0.001g, Trans-retinol: 0.0036g, Cholecalciferol: 0.0001g, Mednadione: 0.005g, α-tocopherol acetate: 0.075g, Thiamine: 0.003g, Riboflavin: 0.006g, Pyridoxine: 0.005g, Cyanocobalamin: 0.00003g, Nicotinic acid: 0.04g, Panthothenic acid: 0.01g, Folic acid: 0.00075g, D-biotin: 0.000075g, Choline chloride: 0.375g
[2]Metabolizable Energy

Table 2: Effects of wheat offal replacement of maize with or without enzyme addition on laying performance

Parameters	Diet 1	Diet 2	Diet 3	SEM	P-value
Hen-day P (%)	80.95	78.27	84.82	1.99	0.43
Egg weight (g)	57.83	54.39	55.22	1.12	0.45
Feed Intake (g)	120.76[a]	116.64[b]	120.28[a]	0.45	0.59
FCR	1.33	1.43	1.34	0.04	0.51

SEM means Standard Error of Mean; [a,b] Means in the same row with different superscripts differ significantly (P<0.05)

Table 3: Effects of wheat offal replacement of maize with or without enzyme addition on egg quality characteristics of laying hens

Parameters	Diet 1	Diet 2	Diet 3	SEM	P-value
Shape Index (%)	75.12	76.22	75.27	0.48	0.63
Albumen Index (%)	12.22	10.68	9.91	0.76	0.48
Haugh unit (%)	88.33	83.13	82.28	2.49	0.59
Shell Thickness ($mm10^{-2}$)	0.16[c]	0.24[a]	0.18[b]	0.02	0.05
Yolk Index (%)	39.94	38.01	38.84	1.07	0.78

SEM means Standard Error of Mean;
[a,b,c,] Means in the same row with different superscripts differ significantly (P<0.05)