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Performance, Egg Quality, Haematological Indices and Cost-Benefit Analysis of Laying Hens fed Palm Kernel Meal and Varying Levels of Rice Bran Diets Supplemented with Maxigrain®

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ABSTRACT [ENGLISH/ANGLAIS]

The effects of Maxigrain®(MAXI) addition to rice bran (20%RB & 40%RB)- and palm kernel meal (40%PKM)- diets were investigated in a study of 8 weeks on laying performance, egg quality and haematological parameters of hens. Each of these 3 diets was supplemented with MAXI Maxigrain® while their unsupplemented diets served as controls. The enzyme was included in the diet at 100mg/kg. The results revealed that MAXI significantly improved feed conversion (FC) of hens fed 40% RB and 40% PKM diets whereas it failed to improve the FC of hens fed 20% RB diet. Laying hens fed 20% RB diet had highest hen day production (HDP) and maximum profit. Furthermore, hens fed 40% RB diet had the poorest HDP. Meanwhile MAXI supplementation to 40% RB-and 40% PKM-diets produced little profits. Maxigrain® significantly ($P<0.0$) improved Haugh unit of hens fed RB and PKM. This revealed that MAXI supplementation improved the egg quality of hens fed RB and PKM diets. The packed cell volume (PCV), red blood cells (RBCs), haemoglobin (Hb), white blood cells (WBCs) and platelets of hens fed MAXI supplemented diets were superior to those fed unsupplemented diets. In conclusion, the study showed specified effects of Maxigrain® supplementation to 40% PKM diet, 20%- and 40%- RB diets on the performance and profitability. Laying hens fed 20% RB diet produced the highest HDP and maximum profits.

Keywords: Hen day production, Laying hens, Maxigrain®, palm kernel meal, profit, rice bran

RÉSUMÉ [FRANÇAIS/FRENCH]

Les effets de Maxigrain® (MAXI) plus de son de riz (20% RB RB% & 40) - et de repas de palmiste (40% PKM) - les régimes ont été étudiés dans une étude de 8 semaines sur les performances de ponte, la qualité des œufs et des paramètres hématologiques des poules. Chacun de ces 3 régimes a été complétée par MAXI Maxigrain®, tandis que leurs régimes n'ayant pas reçu de servi de témoins. L'enzyme a été inclus dans le régime alimentaire à 100mg/kg. Les résultats ont révélé que MAXI considérablement amélioré la conversion des aliments (FC) des poules nourries RB 40% et 40% des régimes PKM alors qu'il a échoué à améliorer la FC de poules nourris avec le régime RB 20%. Poules pondeuses nourris avec le régime de 20% RB était le plus élevé de production quotidienne de poule (HDP) et un profit maximum. En outre, poules nourries à 40% alimentation RB qui ont le moins HDP. Pendant ce temps la supplémentation MAXI à 40% RB-et 40% des régimes PKM produit petits profits. Maxigrain® de façon significative ($P < 0,0$) amélioration de l'unité Haugh, de poules nourries avec RB et PKM. Cette étude a révélé que la supplémentation en MAXI améliorée la qualité des œufs de poules nourries RB et les régimes PKM. Le volume globulaire (PCV), les globules rouges (hématies), l'hémoglobine (Hb), des globules blancs (WBC) et des plaquettes de régimes poules nourries MAXI supplémenté étaient supérieures à celles nourris avec des aliments n'ayant pas reçu de. En conclusion, l'étude a montré les effets prévus de Maxigrain® supplémentation de la diète PKM 40%, 20% - et 40% - les régimes RB sur la performance et la rentabilité. Poules pondeuses nourris avec le régime de 20% RB produit le plus HDP et le maximum de profits.

Mots-clés: Journée de production poule, poules pondeuses, Maxigrain®, farine de palmiste, le bénéfice, son de riz

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INTRODUCTION

Rice bran (RB) is a major by-product from the rice milling process. It contains high amount of phytate and non-starch polysaccharide (NSP), which are two major antinutritive factors that limit the use of RB in poultry

diets [1]. He also reported that 35% RB in the diets was not detrimental to laying hens performance and supplementation of phytase (Natuphos® BASF) significantly increased overall egg production. Other studies have recommended lower RB inclusion without

detrimental effect on performance such as dietary inclusion of RB in broiler diet at 10% [2], 15% [3], 10-20% [4] while for laying hens, 7.5% [5] and 10% [6]. Although Oladunjoye and Ojebiyi [2] also recommended 20% RB supplemented with Roxazyme G2G® for broilers. The economic indices of Roxazyme G2G® supplementation to RB diet were however not properly evaluated [4]. Also Broilers fed a diet with 40% rice bran had higher pancreas and intestine weights than control [4]. This suggests the presence of antinutritive factors and that enzyme supplementation to 40% RB diet is necessary.

Palm kernel meal (PKM) contains a number of non-starch polysaccharides (NSPs) which are mostly indigestible [7]. Of the total NSPs in PKM 78 % is mannan, 3 % is arabinoxylans, 3% is glucoroxylans which have been found to be water-insoluble and 12 % is cellulose [8]. Efforts to hydrolyse the NSPs in PKM are fermentation and enzyme supplementation. Muanhkeow and Chinajariyawong [7] reported that fermentation of PKM with *Aspergillus wentii* TISTR 3075 slightly reduce apparent and nitrogen-corrected metabolizable energy (AME, AMEn) as well as true and nitrogen-corrected metabolizable energy (TME, TMEn). They suggested that fermentation by *A. wentii* TISTR 3075 reduced the energy source in PKM. This particular method has negative effect in nutrient content of the fermented PKM. Soltan [9] reported that palm kernel cake inclusion up to 20% with enzyme preparation (EniBioCell® product containing amylase, protease, glucanase, lipase, xylanase and cellulase) for broiler chicks resulted in a comparable weight gain and feed efficiency compared to control corn-soybean meal based diet. Most studies on the utilization of rice bran and palm kernel meal using microbial enzyme preparations have not reported on the economic implication and haematological response of the experimental animals. However, Esuga *et al.* [10] reported that feed cost/kg weight gain of broilers was significantly lower than the control and all PKM diets with Maxigrain® supplementation compared to all PKM diets without Maxigrain®. Hence, the study investigated effects of adding Maxigrain® to RB- (20% & 40%) and 40% PKM-diets on performance, egg quality, haematological parameters and economic indices of laying hens.

MATERIALS AND METHODS

Site of experiment

The study was carried out at Layer House, Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomosho, Nigeria.

Management of experimental hens

A total of 192 twenty-five-week old Black Harco strain were randomly distributed to 6 dietary treatment groups. Each treatment group contained 32 hens of four replicates. Feed and water were provided *ad-libitum*. Normal routine management practices and vaccination were also carried out during the study. Data were collected on laying performance, egg quality and economic implication of the study. The study lasted eight weeks.

Cost-benefit analysis of the study

This was carried out based on the value of current exchange of naira to a dollar (#160 to \$1).

Chemical analysis

Blood samples (8 samples per treatment) were collected into EDTA bottles for estimation of haematological parameters using the methods of Ghai [11]. The crude protein of the experimental diets was determined using the method of AOAC [12].

Formulation of diets and maxigrain® composition

Six experimental diets were formulated as shown in Table 1. Rice bran was incorporated into diets T1, T2, at 20%, and T3 and T4 at 40%. Palm kernel meal was included in diets T5 and T6 at 40%. Maxigrain® enzyme was added to diets in T2, T4 and T6 while T1, T3 and T5 were unsupplemented groups. All the diets contained 3.63% ±0.02 Calcium, however those in T2, T4 and T6 were deficient in available phosphorus by 16.5%. This was done to test the efficacy of the phytase activity present in MAXI in order to release phosphorus from phytate phosphorus complex present in RB- and PKM-diets. Each gram of Maxigrain® contained 10,000 IU cellulase, 200 IU β-glucanase, 10,000 IU xylanase and 2500 FTU phytase.

Statistical analysis

Data collected were analyzed by factorial analysis of variance using General Linear Model of SAS [13] under completely randomized design. The factors were fibre (type and concentration) and Maxigrain® concentration (0, 100mg/kg). Significant means were separated using Duncan option of the same software. A probability of 5% was considered significant.

RESULTS AND DISCUSSION

The laying performance and cost-benefit analysis of supplementing rice bran- and palm kernel meal – diets with or without Maxigrain® are shown in Table 2. Laying

hens fed 20% RB and 40% PKM had higher HDP than those fed 40% RB. Hens fed high fibre diets (40% RB and 40% PKM) responded well to MAXI than those fed 20% RB. There was significant improvement in feed conversion of laying hens fed 40% RB and 40% PKM whereas the enzyme failed to significantly improve feed conversion of hens fed 20% RB. This corroborated the finding of Banerjee [14] who reported that no benefit may be expected from the use of enzyme preparation (as feed additives) unless feed composed of high amounts of barley, wheat, sunflower, rice bran or oat grains when fed to chickens. Furthermore, Maxigrain® contained mainly cellulases and xylanases that could assist in hydrolysing the cellulose and arabinoxylan of RB and PKM probably at high dietary fibre concentration. [15] reported that Oil-

extracted rice bran contained over 700 gram of NSPs of which arabinose and xylose are predominant [15]. Sekoni et al. [16] had earlier reported that Maxigrain® treated PKM had increased retention of vital nutrients and metabolizable energy of broiler chicks. Also they suggested that Maxigrain® may have acted on cellulose, glucuronoxylans and arabinoxylans of PKM, thereby reducing crude fibre and increasing the metabolizable energy. However, Farrell and Martin [17] reported that 2 enzyme preparations did not benefit the performance of broiler chicks, ducklings and ducks fed RB diets. It has been suggested that the variation in response to RB may be caused by differences in processing methods or by varietal or environmental differences during growth [18].

Table 1: This table shows ingredient composition of experimental diets

Ingredients	Rice Bran				40% PKM	
	20% RB		40% RB		T5(UN)	T6(S)
	T1(UN)	T2(S)	T3(UN)	T4(S)		
Maize	33.03	33.03	14.96	14.96	37.06	37.06
Soybean meal	18.82	18.82	16.89	16.89	9.79	9.79
Wheat offal	15.00	15.00	15.00	15.00	-	-
Rice bran	20.00	20.00	40.00	40.00	-	-
Palm kernel meal (PKM)	-	-	-	-	40.00	40.00
Bone meal	2.50	2.00	2.50	2.00	2.50	2.00
Oyster shell	7.00	7.50	7.00	7.50	7.00	7.50
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin premix ⁺	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
Maxigrain®	-	+	-	+	-	+
Cal. Energy (kcalME/kg)	2581.19	2581.19	2480.06	2480.06	2492.77	2492.77
Determ. CP (%)	16.40	16.40	16.40	16.40	16.40	16.40
Available Phosphorus (%)	0.46	0.39	0.47	0.39	0.47	0.39
Calcium (%)	3.62	3.61	3.62	3.61	3.66	3.66
Crude fibre (%)	5.66	5.66	7.67	7.67	6.21	6.21
Methionine (%)	0.46	0.46	0.46	0.46	0.48	0.48
Lysine (%)	0.98	0.98	0.98	0.98	0.76	0.76

⁺Vitamin premix supplied the following vitamins and trace minerals per kg of feed: Vit.A. 6250IU; Vit.D₃ 1250IU; Vit.E. 14.38mg; Vit.K₃ 1.25mg; Vit.B₁ 1.88mg; Vit.B₂ 3.75mg; Niacin 31.25mg; Calcium pantothenate 6.25mg; Vit. B₆ 3.13mg; Vit B₁₂ 0.02mg; Choline chloride 250mg; Folic acid 0.63mg; Biotin 0.03mg; Mn 75mg; Fe 62.5mg; Zn 50mg; Cu 5.31mg; I 0.94mg; Co 0.19mg; Se 0.08mg and Antioxidant 75mg.

Interactive effect of Maxigrain® and fibre source/level significantly affected feed costs (Pp<0.031 and p<0.011) and income (p<0.010). Hens fed unsupplemented 20% RB diet had maximum income. Hens fed enzyme supplemented 40% RB had more income than their counterparts fed unsupplemented 40%RB diet. Dietary treatment tended to significantly influence feed cost per

kg egg (p<0.056) and egg weight (p<0.058) of the experimental hens. Eggs of laying hens fed 40% RB supplemented with Maxigrain® were the heaviest. Moreover, these hens (40%RB) have significantly heavier eggs than their counterparts fed unsupplemented 40%RB diets. Hens fed 20% RB with Maxigrain® had the best feed conversion and minimum feed cost per kg egg.

Furthermore, hens fed MAXI supplemented 20% RB had the highest profit per kg egg and profit per egg tray whereas those fed unsupplemented 40% PKM had the lowest profits. This implied that 20% RB diet with Maxigrain® was the best for laying hens. Although, improved performance and slightly increased profit were observed for hens fed 40% RB supplemented with MAXI but it could not yield maximum profit. Maxigrain® also

significantly enhanced feed conversion and slightly improved profit of hens fed 40% PKM. This revealed that Maxigrain® could assist in the partial hydrolysis of NSP present in PKM. Muanhkeow and Chinajariyawong [7] reported that enzyme preparations containing mannanase, galactosidase and cellulase could best be used to hydrolyse the NSPs of PKM. This study supported this assertion.

Table 2: This table shows laying performance and economic indices of hens fed RB and PKM diets supplemented with or without Maxigrain®

Parameters	Rice Bran				40% PKM		P-value	SEM	Fibre	ENZ	Int
	20% RB		40% RB		T5(UN)	T6(S)					
	T1(UN)	T2(S)	T3(UN)	T4(S)							
Hen day prod. (%)	83.94 ^a	85.94 ^a	66.32 ^b	69.83 ^b	81.35 ^a	83.72 ^a	0.0001	1.57	***	NS	NS
Egg weight	54.03	54.82	52.66	55.32	53.37	52.86	0.058	0.66	NS	NS	NS
Feed intake (g/hen/day)	124.20	120.71	122.78	123.43	124.11	118.80	0.313	1.90	NS	NS	NS
Feed conversion (feed/egg)	2.81 ^d	2.67 ^d	3.70 ^a	3.15 ^b	3.00 ^c	2.81 ^d	0.0001	0.05	***	***	***
Feed cost (\$/kg egg)	1.01	0.86	0.94	1.00	0.49	0.89	0.056	0.03	NS	NS	**
Feed cost (\$/tray)	1.62 ^a	1.40 ^b	1.47 ^{ab}	1.65 ^a	1.49 ^{ab}	1.40 ^b	0.028	0.06	NS	NS	**
Income (\$/kg egg)	2.20 ^a	2.11 ^b	2.00 ^c	2.09 ^b	1.97 ^c	1.99 ^c	0.0001	0.03	***	NS	**
Profit (\$/kg egg)	1.20 ^{ab}	1.25 ^a	1.06 ^{bc}	1.08 ^{bc}	1.02 ^c	1.12 ^{bc}	0.023	0.05	***	NS	NS
Profit (\$/tray)	1.82 ^b	2.04 ^a	1.66 ^b	1.79 ^b	1.64 ^b	1.73 ^b	0.002	0.06	***	**	NS

Means along the same row with uncommon superscripts are significantly different (**P<0.001, ***P<0.001).

UN= Unsupplemented group, S= Supplemented group.

Table 3: This table shows egg quality of hens fed rice bran- and palm kernel meal- diets supplemented with or without Maxigrain®

Parameters	RICE BRAN				40% PKM		P-value	SEM	Fibre	Enz	Int
	20%RB		40% RB		T5(UN)	T6(S)					
	T1(UN)	T2(S)	T3(UN)	T4(S)							
Haugh unit	92.27 ^{ab}	93.70 ^a	84.81 ^c	88.73 ^{bc}	88.16 ^c	92.50 ^{ab}	0.0001	1.86	***	**	NS
Yolk weight (%)	23.80 ^a	22.24 ^b	22.17 ^b	21.82 ^b	19.85 ^c	22.77 ^{ab}	0.0001	0.47	***	NS	***
Albumen weight (%)	60.98 ^c	63.15 ^b	63.48 ^b	64.68 ^b	67.88 ^a	63.04 ^b	0.0001	0.70	***	NS	***
Shell weight (%)	15.22 ^a	14.62 ^a	14.35 ^{ab}	13.50 ^b	12.28 ^c	14.20 ^{ab}	0.0001	0.62	***	NS	***
Shell thickness (mm)	34.81 ^a	32.27 ^c	33.52 ^b	32.53 ^c	32.78 ^{bc}	32.70 ^c	0.0001	0.47	**	***	***
Yolk index	0.46	0.46	0.45	0.43	0.45	0.45	0.063	0.01	**	NS	NS

Means along the same row with uncommon superscripts are significantly different (**P>0.01, ***P<0.001); UN= Unsupplemented group, S= Supplemented group

Egg quality of hens fed RB and PKM diets are shown in Table 3. Maxigrain® supplemented fed hens laid eggs with higher Haugh unit (HU) than those fed unsupplemented diets. This revealed that MAXI supplementation improved the egg quality of hens fed RB

and PKM diets. In addition, laying hens fed 20%RB supplemented with MAXI had the highest Haugh unit (HU), whereas those fed 40% RB had the lowest HU. Hens fed 20% RB had the best shell thickness, yolk and shell weights. Maxigrain® supplemented fed hens laid eggs

with lower shell thickness with a decrease of 3.6% than those fed unsupplemented diets. The activity of phytase present in Maxigrain® could not sufficiently supply the required phosphorus from the bound phytate phosphorus in RB and PKM diets. This implied that another source of phytase preparation is probably needed to release adequate phosphorus from these deficient phosphorus diets.

Haematological parameters of laying hens fed RB and PKM diets supplemented with or without MAXI are shown in Table 4. Laying hens fed 20% RB MAXI diet had

the richest PCV, Hb and RBCs whereas hens fed 40% RB diets had the poorest of these parameters. The addition of MAXI to RB diets significantly improved PCV, Hb, RBCs, WBCs and platelets of the hens. The significant synergistic effects of the enzyme and fibre source were demonstrated in parameters like PCV, Hb, RBCs, WBCs, platelets and MCV. Laying hens fed enzyme supplemented diets had better WBCs and RBCs. This showed that these hens have enhanced immune-competence to handle physiological stress.

Table 4: This table shows haematological parameters of laying hens fed rice bran and palm kernel meal diets supplemented with or without Maxigrain®

Parameters	RICE BRAN				PKM		P-value	SEM	Fibre	Enz	Int
	20% RB		40% RB		T5(UN)	T6(S)					
	T1(UN)	T2(S)	T3(UN)	T4(S)							
Packed cell volume (%)	16.75 ^c	21.75 ^a	14.50 ^d	19.00 ^b	21.25 ^a	19.25 ^b	0.0001	0.68	***	***	***
Haemoglobin (g/dl)	5.50 ^c	7.05 ^a	4.75 ^d	6.20 ^b	6.28 ^b	5.98 ^{bc}	0.0001	0.23	***	***	***
RBCs (x10 ⁶ /mm ³)	6.01 ^b	6.96 ^a	5.08 ^c	6.45 ^{ab}	6.40 ^{ab}	6.36 ^{ab}	0.0002	0.25	**	***	**
WBCs (x10 ³ /mm ³)	11.20 ^{bc}	12.25 ^a	10.60 ^c	11.90 ^{ab}	12.10 ^a	11.93 ^{ab}	0.0003	0.26	**	***	**
Platelets	10.50 ^b	13.75 ^a	9.00 ^c	13.25 ^a	12.50 ^a	12.75 ^a	0.0001	0.51	**	***	***
MCV (fl)	33.25	34.50	35.00	34.25	35.00	33.50	0.081	0.59	NS	NS	*
MCH (Pg)	10.50	11.00	11.25	11.00	11.00	10.75	0.275	0.22	NS	NS	NS
MCHC (g/dl)	32.50 ^a	31.75 ^b	32.25 ^a	32.00 ^{ab}	32.00 ^{ab}	32.00 ^{ab}	0.036	0.12	NS	**	NS
Lymphocytes (%)	75.75 ^a	78.25 ^a	57.25 ^c	67.50 ^b	80.25 ^a	65.50 ^b	0.0001	1.57	***	***	NS
Neutrophils (%)	24.00 ^c	21.2 ^{cd}	42.25 ^a	31.25 ^b	18.75 ^d	33.75 ^b	0.0001	1.53	***	NS	***
Monocytes (%)	1.00	1.00	1.00	1.00	1.33	1.00	0.170	0.08	NS	NS	NS

Means along the same row with uncommon superscripts are significantly different (P>0.05); UN= Unsupplemented group, S= Supplemented group

CONCLUSION

It is concluded that the study revealed that Maxigrain® benefited the performance and profitability of hens fed 40% RB and 40% PKM. However, little profits were obtained from these hens. Supplementation of the enzyme to 20% RB diet produced the highest hen day production and maximum profits. Haematological response of hens fed 20% RB diet was also better than those fed 40% RB- and 40% PKM-diets. Egg quality of hens fed Maxigrain® diets was significantly improved.

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CONFLICT OF INTEREST

No conflict of interests was declared by authors

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