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EFFECTOFREPLACINGMAIZEWITHMALTEDBARLEYGRAINONEGGQUALITYANDLAYINGHENSPERFORMANCEOFWHITELEGHORN

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Haftu kebede [α], Mengistu Urge [σ] & Kefelegn Kebede [ρ]

Abstract- The effect of various levels of malted barley grain (MBG) on the laying performance and egg quality of white leghorn pullets was investigated. A total of 180 white leghorn pullets were randomly assigned to four dietary treatments consisting of 0%, 10%, 20% and 30% barley as a replacement for maize. There were 45 birds per treatment and three replicates of 15 birds and the experiment was laid in a completely randomized design. The evaluated traits were egg production, egg weight, egg mass, feed consumption, feed conversion ratio, shell thickness, yolk weight, shell weight, yolk index, yolk diameter, yolk height, albumen height, yolk color and Haugh unit. The result showed significant increase in feed consumption, yolk color, albumen weight and shell thickness ($P<0.01$) and body weight gain and sample egg weight ($P<0.05$), but it had no significant effects on other traits measured. Therefore, since MBG did not negatively affected laying performance and product quality, it can be replaced for maize grain as a source of energy up to 30%.

Keywords: egg quality, laying hens, malted barley grain, performance.

I. Introduction

Poultry industry is a predominant source of animal protein in both developed and developing countries. Adenjimi *et al*. (2011) noted that the expansion of the poultry industry depends largely on the availability of good quality feed in sufficient quantity and at prices affordable to both producers and consumers. The production of ethanol from maize is increasing currently and expected to increase in the future as a result of rising cost of fossil oil and the environmental pollution issues IFAD (2008). Increased demands for domestically produced liquid fuel is increasing competition between animal feed and fuel production uses of maize. As a result, the recent rise in demand and consequent increase in the cost of maize has spurred interest in replacing it in poultry diets with locally grown other energy grains Mehri *et al*. (2009). Although there are quite many literatures in the utilization of barley by poultry, there is a scarcity of complete information on feeding malted barley (water treated barley) to domestic chicken. Accordingly, this study was designed to investigate the effects of feeding different levels of malted barley grain on egg quality and laying performance of white leghorn layers and to compare the profitability of replacing maize with different levels of malted barley grain.

II. Materials and Methods

The experiment was conducted at Haramaya University poultry farm. The study area is located, at a distance of 515Km from Addis Ababa capital city. The average annual temperature and rainfall ranges from 8 - 24°C and 650 to 800 mm. respectively Mishra *et al.* (2004).

III. Malted Barley Processing

Barley was mixed with water in the ratio of 1kg to 2 litters in a barrel, stirred/soaked gently and the container was tightly sealed and left for 24 h. Then water was removed after the barrel is covered with sieve and the moist barley left in the same container to germinate for 72 h. The grain were thinly spread on plastic sheet and dried under shade at room temperature for 72 h to prevent the seed internal enzymes activity. The grains were then ground into a leaf meal using a hammer mill of mesh size of 3mm.

IV. Experimental Diets

Four experimental diets at isocaloric and equiprotein composition were formulated, such that Diet 1 which served as the control had no malted barley (0%), Diet 2 had 10% malted barley, Diet 3: 20% and Diet 4: 30%; the ingredient composition of the experimental diets are shown in Table 2.

V. Experimental Animals/ Experimental Design

One hundred eighty white leghorn pullets used in the study were obtained from Haramaya university Farms. The birds were randomly allocated to four dietary treatment groups such that each treatment had three replicates comprising 15 pullets per replicate and 45 pullets per treatment in a CRD design. The pullets in each replicate were housed in a pen with 2 x 4m size. During the eight week period of the study, the birds were subjected to similar managerial and sanitary conditions

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and equal quantities of feed and water were provided daily, such that the only source of variation was the levels of Malted barley in the diets.

VI. Data Collection

Egg production, egg weight and feed consumption were recorded daily for each replicate. Eggs collected three times a day from each pen at 10:00 am and in the afternoon at 2:00 and 6:00 pm were weighed in group immediately after collection for each replication and average egg weight was computed by dividing the total egg weight to the total number of eggs. After mean weight has been determined, the egg mass per pen on daily bases was calculated according to North (1984). The amount of DM consumed was determined as the difference between the DM offered and refused. Feed conversion ratio was determined per replicate by calculating the weight of feed, on DM basis, consumed per egg mass. Egg quality was assessed in terms of egg weight, albumen height and quality, shell thickness, yolk color, yolk index and Haugh Unit Score (HUS). For the measurements, 15 eggs per treatment/week (5 per replication) were taken randomly and the average was computed for each quality parameters once every week. The sample eggs were individually weighed, marked and broken on flat tray and the height of the thick albumen of each egg was measured with a tripod micrometer and the average Huagh Unit value for each replicates was calculated by using the formula given by Stadelman and Cotterill (1986). The egg shell thickness was measured at three sites, at equator, from the blunt and pointed end using a micrometer gauge. The average of the three measurements was taken as thickness of each egg Ajuwon *et al*. (2002). Yolk color was measured using Roche color fan. To compare the profitability of replacement of malted barley grain for maize grain the partial budget analysis developed by Upton (1979) was used.

Table 1 : Chemical composition of feed ingredients used to formulate experimental ration

	Ingredients				
Chemical components	Malted barley grain	Nouge seed cake	Soybean Meal	Maize grain	Wheat short
Dry mater (%)	90.8	93.7	94.4	90.9	90.7
Crud protein (% DM)	11.5	31	38	8.8	15.4
Ether extract (% DM)	2.1	5.1	8.2	5.1	5.1
Ash (% DM)	3.7	7.8	7.6	4	4.84
Crud fiber (% DM)	6.2	17.9	5.9	4.9	8.1
Calcium (% DM)	0.1	0.7	0.3	0.02	0.1
Phosphorus (% DM)	0.3	0.3	0.7	0.3	0.4
ME (kcal/kg)	3366.7	2339.1	3563.7	3630.6	3312.3

a) *Chemical Analysis*

Representative samples were taken from each of the feed ingredients and analyzed before formulating the actual dietary treatments. The results of the analysis were used to formulate the ration. Samples were also taken from each experimental diet at each mixing and bulked over the experimental period and sub sample was taken for chemical analysis. Thus, the total samples analyzed were 5 feed ingredients and 4 treatment rations (Table 1and 2), respectively. The samples were analyzed for dry matter (DM), ether extract (EE), crude fiber (CF) and ash according to AOAC (1990). Nitrogen (N) content was determined by Kjeldahl procedure and crude protein (CP) was calculated as Nx6.25. The total metabolizable energy content was estimated by using the formula of Wiseman (1987) as: ME (Kcal/kg DM) = 3951 + 54.4 EE – 88.7 CF – 40.8 Ash. Chemical analyses of feeds were done in Animal Nutrition and Soil Laboratories of Haramaya University.

b) *Statistical Analysis*

The data collected for egg production and egg quality parameters during the period of the study was subjected to analysis of variance using SAS (2005, version 9.13). The following model was used for data analysis. $Yij = \mu + Ti + eij$ Where: Yij = represents the j^{th} observation (experimental unit) taken under treatment i, μ = over all mean, Ti = feed effect and e_{ij} = random error

Logistic regression analysis was used for data recorded on yolk colour (1/2…/5). The general logistic regression model used is given below:

$$\text{Model: ln}\left\{\frac{\pi}{1-\pi}\right\} = \beta_0 + \beta_1 * (X)$$

Test H_0: No treatment effect (i.e., $\beta_1 = 0$) vs. H_A: Significant treatment effect ($\beta_1 \neq 0$).
Where, π = probability, β = slope and x = treatment.

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VII. Results and Discussion

Table 2 : Ingredients used in formulating the experimental rations and calculated chemical analyses of the layer rations

Ingredients (kg)	Treatments			
	T1	T2	T3	T4
Maize	48.0	38.0	28.0	18.0
Malted barley	0.0	10.0	20.0	30.0
Wheat short	14.0	14.0	15.0	15.0
Noug seed cake	18.8	18.8	18.8	18.8
Soybean meal	11.0	11.0	10.0	10.0
Lime stone	7.0	7.0	7.0	7.0
Salt	0.5	0.5	0.5	0.5
Vitamin premix	0.7	0.7	0.7	0.7
Total	100	100	100	100
Chemical composition				
Dry mater (%)	92.4	92.4	92.3	92.3
Crud protein (% DM)	16.5	16.8	16.8	16.9
Ether extract (% DM)	5.1	5.0	4.9	4.8
Ash (% DM)	10.7	11.8	10.0	10.4
Crud fiber (% DM)	9.4	9.5	10.4	10.4
Phosphorus (% DM)	0.4	0.4	0.4	0.5
Calcium (% DM)	3.1	3.1	3.2	3.2
ME (kcal/kg)	2959.4	2898.8	2887.1	2861.3

a) *Production Characteristics and Feed Intake*

The result showed that replacing maize with malted barley grain had no significant effect ($P > 0.05$) on egg production, egg mass, feed conversion ratio and egg weight, but there was significant difference on feed consumption and body weight (Table 3). The present result agree with that of Fafiolu *et al.* (2006) who reported increase in average final body weight of experimental birds with increasing levels of malted sorghum sprouts (MSP) up to 30% in the ration of layers. Similarly, Mohammed *et al*. (2010) noted significant increase in feed consumption due to substitution of yellow maize with enzyme supplemented barley grain in laying hen diets. Apparently, production was largest for T4 (53.8 %) followed by those of T3 (51.3 %), T2 (48.3 %) and T1 (46.5 %) without significant ($p > 0.05$) difference among treatments. Furthermore, Mahdavi *et al*. (2005) showed no significant difference in egg production as barley is supplemented with probiotic substituted maize diets. The present result disagree with Mohammed *et al*. (2010) who reported that egg production, egg weight and egg mass increased when maize replaced with enzyme supplemented barley.

The dry matter intake of birds fed T2 diet (10% MBG + 38% MG) were similar with the group fed diet without MBG (T1, control), but birds fed T3 diet (20% MBG + 28% MG), and T4 (30% MBG + 18% MG) resulted in a significantly ($P<0.01$) higher dry matter intake than T1 and T2 groups. The results demonstrated that inclusion of malted barley grain improved daily dry matter intake of birds, which could be attributed to the relatively higher crude protein content of malted barley grain. The findings of this study were in agreement with that of Ebadi *et al*. (2005) who reported a significant increment in feed take as a result of replacement of maize with sorghum grain in layers diet. Similarly, Mohammed *et al*. (2010) noted significant increase in feed consumption due to substitution of yellow maize with enzyme supplemented barley grain up to 50 % in laying hen diets.

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Table 3 : Effects of different levels of malted barley grain as a substitute for maize on production characteristics of white leghorn laying hens

Parameter	Treatment				SEM	SL
	T_1	T_2	T_3	T_4		
DMI (g/hen/d)	90.6^b	90.8^b	91.9^a	92.2^a	0.24	**
Initial BW (g)	1010.5	1034.2	1039.2	1060.9	8.98	NS
Final BW (g)	1049.6^b	1077.7^{ab}	1091.9^{ab}	1120.3^a	9.92	*
Body wt. change	39.1^b	43.4^b	52.8^{ab}	59.4^a	3.00	*
BW gain(g/head)	0.4^b	0.5^b	0.6^{ab}	0.7^a	0.03	*
Total egg/bird	41.8	43.5	46.5	48.4	1.06	NS
HDEP (%)	46.5	48.3	51.6	53.8	1.18	NS
Egg weight	47.8	49.1	48.0	48.3	0.21	NS
EM (g)	22.2	23.7	24.7	26.1	0.58	NS
FCR	5.2	4.8	4.7	4.4	0.12	NS

*[a,b]Means with in a row with different superscripts are significantly different, *=Significant at (P< 0.05), **=Significant at (P<0.01), NS=Non- significant (P>0.05), SL = significant level, SEM = standard error of mean, DMI = dry matter intake, g = gram, BW = body weight, HDEP = hen day egg production, FCR = feed conversion ratio, EM = daily egg mass, MBG = malted barley grain, T1 = 0% MBG +100% maize, T2 = 10% MBG + 90% maize, T3 = 20% MBG + 80% maize, T4 = 30% MBG + 70% maize.*

b) *Egg mass and Feed Conversion Ratio*

There was no significant (P>0.05) difference in feed conversion ratio and egg mass between the treatments. However, egg mass (P=0.091) and feed conversion ratio (P=0.08) tended to increase with increasing level of MBG as a substitution for maize grain up to 30% (Table 3). The present result agree with Mahdavi *et al*. (2005) who reported absence of significant (P>0.05) difference in egg mass as barley supplemented with probiotic substituted maize up to 100%. This result disagree with the finding of Mohammed *et al*. (2010) who reported that egg mass increased when enzyme supplemented barley replaced up to 50 % of yellow corn. The present result also disagree with the finding of Mahdavi *et al*. (2005) who noted that feed conversion ratio decreased as barley supplemented with probiotic substituted corn beyond 50%.

c) *Egg Quality Traits*

Replacing maize with malted barley grain had no significant effect (P>0.05) on Yolk weight, Shell weight, Yolk index, Yolk diameter, Haugh unit, Yolk height and Albumen height. However, there was a significant effect on sample egg weight, Yolk color, Albumen weight and Shell thickness (Table 4). These results agree with previous research conducted by Fafiolu *et al.* (2006) who reported that there was no significant difference in yolk weight and Haugh unit by feeding malted sorghum sprout (MSP) up to 30%. Similarly Ebadi *et al*. (2005) reported no significant effect of replacement of maze with sorghum grain up to 25% on Haugh unit. Moreover, Mahdavi *et al*. (2005) reported absence of significant (P>0.05) difference in Haugh unit when barley supplemented with probiotic substituted for corn up to 100%. The yolk index values of the eggs from the various treatment groups ranged from 0.43–0.44, which is within the accepted range of 0.33 – 0.50 for fresh eggs Ihekoronye and Ngoddy, (1985). These results disagree with previous research conducted by Ebadi *et al*. (2005) who reported significant increase in Yolk index as a result of replacement of maize with sorghum grain up to 25% in layers diet.

d) *Albumen, Yolk and Shell Weight*

There was no significant (P>0.05) differences in shell and yolk weight between the treatments. However, Albumen weight was significantly (P<0.01) higher in T3 (20% MBG + 28% MG) and T4 (30% MBG +18% MG) than birds fed diet T2 (10% MBG +38% MG) and the diet without MBG (T1, control; Table 4). These results agree with previous research conducted by Fafiolu *et al.* (2006), who noted no significant (P>0.05) difference in yolk weight and albumen weight by feeding malted sorghum sprout (MSP) up to 30%. The present results disagree with Ebadi *et al*. (2005) who reported that there was no significant (P>0.05) difference in albumen weight, but significant increase in yolk and shell weight as a result of replacement of maize with sorghum grain up to 25% was observed.

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Table 4 : Various levels of malted barley grain as a substitute for maize on egg quality treats

Parameters	Treatments				SEM	SL
	T_1	T_2	T_3	T_4		
Sample egg wt. (g)	49.0^{c}	49.4^{bc}	50.4^{ab}	50.8^{a}	0.28	*
Albumen weight (g)	28.3^{c}	28.5^{bc}	29.5^{ab}	29.7^{a}	0.20	**
Yolk weight (g)	14.4	14.3	14.8	14.7	0.10	NS
Shell weight (g)	5.7	5.7	5.9	5.9	0.05	NS
Yolk index	0.43	0.44	0.44	0.44	0.002	NS
Yolk diameter (cm)	3.7	3.6	3.6	3.6	0.01	NS
Yolk color	1.58^{c}	2.02^{b}	2.26^{a}	2.24^{a}	0.092	**
Haugh unit	91.0	93.7	93.0	91.3	0.698	NS
Shell thickness	0.32^{c}	0.32^{bc}	0.34^{ab}	0.35^{a}	0.004	**
Yolk height	15.8	15.7	15.7	15.9	0.04	NS
Albumen height	7.8	8.4	8.3	7.9	0.13	NS

*$^{a, b \& c}$ = Means with in a row with different superscripts are significantly different,**=Significant at (P< 0.01), * =Significant at (P< 0.05), NS=Non- significant, SL = significant level, g = gram, cm = cent meter, SEM = standard error of mean, T = treatment,T_1 = 0% MBG +100% maize, T_2 = 10% MBG + 90% maize, T_3 = 20% MBG + 80% maize, T_4 = 30% MBG + 70% maize, MBG = malted barley grain*

e) Yolk Color

The mean and logistic regression results for yolk color showed significant difference (pr >chisq <0.0001 at α = 0.05) with Wald chi Sq value of 66.3209 among the treatments (Table 4 and 5, respectively). The odd ratio value of T1 vs. T4 shows that T1 has 0.146 times the odds of receiving a lower score than T4 (Table 7). This shows that malted barley grain induced slightly higher yolk color values in eggs than the white maize used. Malted barley sprouts may have certain pigment that confers such status on egg yolk. The result of the study is comparable with Fafiolu *et al*. (2006) who noted a slightly higher yolk color with increased level of malted sorghum grain up to 30% in substitution for maize. The Roche color fan reading recorded during the experiment ranges from 1 (pale yellow) to 5, with majority of the egg having 1 and 2 values on the yolk color point (Table 6).

Table 5 : Results of logistic regression of yolk color in white leghorn chicken fed diet containing different levels of malted barley grain as a substitute for maize

	Wald		
Parameter	DF	Chi-Square	Pr >ChiSq
Yolk color	3	66.3209	<.0001

f) Egg Shell Thickness

The mean egg shell thickness, as a measure of egg shell quality, resulting from feeding the four treatment rations is shown in Table 4. The results showed that there was significant (P<0.01) difference among treatments in egg shell thickness. Increased egg shell thickness observed in this experiment may be related to the increase in β-glucans digestibility. Similarly, Rimsten (2003) reported that activating enzyme phytase during germinating increase Ca and P digestibility. Moghaddam *et al.* (2009) reported that Ca and P digestibility improved by 4.5% and 4%, respectively when malted barley grain was replaced with barley in broilers feed. This result disagree with results of previous studies conducted by Ebadi *et al*. (2005) who reported a significant decrease in shell thickness as a result of replacement of maize with sorghum grain in layers. Mahdavi *et al*. (2005) reported absence of significant difference in shell thickness between treatments when different levels of barley supplemented with probiotic substituted maize up to 100%. The results of this study implied that feeding layers with diets containing different proportions of malted barley grain and maize would improve the egg shell quality of chicken.

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Table 6 : Yolk color points of egg samples from different experimental diets

Treatments	Roche color fan number					
	1	2	3	4	5	Total
T1	60	53	5	2	0	120
T2	29	63	25	3	0	120
T3	14	70	28	7	1	120
T4	15	65	36	4	0	120
Total	118	251	94	16	1	480

T1= T1 = 0% MBG +48% maize, T2 = 10% MBG + 38% maize, T3 = 20% MBG + 28% maize, T4 = 30% MBG + 18% maize,

The economic return in terms of partial budget from egg sale, commercial feed costs and other cost are presented in table 8. The highest value for marginal rate of return was recorded in 20% inclusion (T_3). According to partial budget analysis, hen fed T_4 returned a higher total net income, followed by T3, T2 and T1. Although T4 has higher total return and superior egg sale to feed cost ration, it has lower profit margin than hen fed the 20% (T3) malted barley grain (MBG) inclusion. This means, the income obtained from 30% MBG (T_4) inclusion returned less per unit of expenditure, suggesting T3 to be the treatment of choice in terms of profit. Therefore, substitution of maize with malted barley is profitable because of the increased egg production, although cost of barley is higher than maize. Thus, barley can be substituted for maize up to 30% economically without affecting body weight, egg quality and laying hens performance.

Table 7 : Analysis of Maximum Likelihood Estimates of Yolk Color of white leghorn chicken fed diet containing different levels of malted barley grain as a substitute for maize

Parameter		DF	Estimate	S. E	Wald Chi-Sq	Pr > ChiSq	Exp(Est)
Intercept	5	1	-5.7555	1.0102	32.4599	<.0001	0.003
Intercept	4	1	-2.8810	0.2834	103.3588	<.0001	0.056
Intercept	3	1	-0.7152	0.1804	15.7152	<.0001	0.489
Intercept	2	1	1.9107	0.2053	86.6240	<.0001	6.758
TRT	T_1vsT_4	1	-1.9255	0.2651	52.7487	<.0001	0.146
TRT	T_2 vsT_4	1	-0.6301	0.2517	6.2648	0.0123	0.533
TRT	T_3 vsT_4	1	-0.0378	0.2476	0.0233	0.8788	0.963
TRT	T_1vsT_2	1	-1.2954	0.2571	25.3818	<.0001	0.2738
TRT	T_1vsT_3	1	-1.8877	0.2646	50.8774	<.0001	0.1514
TRT	T_2vsT_3	1	-0.5923	0.2517	5.5403	0.0186	0.5530

DF= Degree of Freedom; SE = Standard Error

VIII. Conclusion

The result of the present study indicated that malted barley can replace maize economically up to 30% without adversely affecting egg laying performance and quality parameters.

IX. Acknowledgements

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