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Effects of Feeding Locally Grown Whole Barley on Broiler Performance

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ABSTRACT

The experiment was carried out using one hundred and eighty insexed 1 day old (ISA) broiler chicks to evaluate their response to diet with different levels of barley. The diet was made to replace maize with barley at 0%, 25% 50%, 75% and 100% corresponding to rates of incorporation in the feed of 0; 16.2, 32.4, 48.6 and 64.8 % to form treatment diets, T_1 (control), T_2, T_3, and T_4 and T_5, respectively. This feed of identical formulations, was distributed *ad libitum*. Treatments were replicated three times with 14 birds per replicate. The experiment lasted for eight weeks. The results showed that the inclusion of barley up to 50% level of the diet showed similar or even better performance to the control diet. However, compared to the other levels, feeding whole barley at 100% level of the diet slowed growth rate at all ages throughout the trial. Consequently, the use of local barley as a sole grain in the ration is not practical.
KEYWORDS: Barley, Broiler, Feed intake, Weight gain, Feed efficiency.

INTRODUCTION

Globally poultry meat production is expected to increase from 98.7 million tons in 2015 to 127.6 million tons by 2020 [1]. However, higher feed cost remain the principal problem for most developed and developing countries. Feeds constitute 60-80% of the total inputs in poultry production [2]. Alternative feed energy sources for cereal grains especially maize have been investigated by many research workers. Barley ranks third in Algeria in terms of growing area and production [3] with an average production of 1.3 million tonnes annually [4].

The low nutritional value of barley for poultry is because of the absence of an intestinal enzyme for efficient depolymerization of (1,3–1,4) beta-glucan [5]. This non starch polysaccharide (NSP) creates a viscous environment in the intestinal tract of broilers, which in turn inhibits digestion and absorption of nutrients [6,7].

However, the energy content of barley can vary widely [8]. Levels of β-glucan are influenced by both genetic and environmental factors [9]. Although, the anti-nutritional effects of NSPs are known content, there is relatively limited data available on appropriate dietary levels of locally available barley in broiler diets. What is the minimum level of dietary barley which result in adverse effects or the maximum dietary level that will support normal performances?

Therefore, the intention of this trial was to estimate the possible use of relatively cheaper locally available by-products by proportionately reducing the expensive concentrate feeds and this by evaluating the performance of broilers fed to eight weeks on a mixture of local barley at various levels.

MATERIAL AND METHODS

Experimental design

Animals and diets

Two hundred and ten insexed one day old (ISA) broiler chicks were used for the experiment. The birds were reared in deep litter floor pens. All vaccinations were given before and during the experiment. Birds were alloted into five dietary treatments with three replications having 14 birds in each replication (4.6 bird/m^2) by using complete randomized design. Five experimental diets were formulated in wich maize or barley or both were the main source of energy. Barley was used to replace maize in the diet by 0%, 25%, 50%, 75% and 100%. Diet (T_1) was the maize based only (control), diet (T_2) consist of 75% maize 25% barley, diet (T_3) 50% maize 50% barley, diet (T_4) 25% maize 75% barley and diet (T_5) barley based only.

The composition of experimental (%) diets is presented in table 1. On the 14th day, a total of 30 animals (2 from each pen) were used in order to determine the nitrogen retention on day 42 (data were not shown). The other animals (180 birds) were led to the ground during 8 weeks and were provided *ad libitum* access to feed twice a day (08:00 a.m. and 19:00 p.m). Drinking water was provided at all time. Observations for deaths were conducted every day.

[1] # *Deceased on September 14, 2016*

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Experimental conditions

The applied temperatures by phase, and the relative humidity were those recommended by [10]. The light program was started at 1 day of age for 23 h light: 1 h dark. A programs of the vaccination against Newcastle disease (Pestos HB), Gumboro disease (Gumboral CT), and coccidiose (Cocsal CT) was applied.

Analysis

Measures and takings on animals

The amount of feed offered to the birds and the remaining were weighed and recorded daily. Mortality was registred as it occurred and all animals were weighed immediately after death. Average weight gain, Average feed intake and feed efficiency were determined when the birds were 14, 42 and 56 days of age. Feed intake was adjusted for all mortalities, and their weight was included in the calculation of feed conversion ratio.

Chemical composition

Samples of maize, barley and the test diets were analysed for dry matter (DM), crude ash (CA), crude proteine (CP), crude fat (CF) and crude fiber (CFB) (Tables 1 and 2). DM was determined by drying samples at 105 °C for 24 h to constant weight. Ash content was determined by ashing at 550°C in a muffle furnace for 16 hrs [11]. The Kjeldahl method (ISO 5983-1, 2005) was used to determine CP (6.25 x N). CF were determined using Soxhlet apparatus. CFB were determined by the Weende method outlined by [12]. Results are expressed in % of DM. Metabolizable energy was calculated according to the Sibbald method [13].

Statistical analysis

The data on weight gain, feed intake and feed efficiency were subjected to analysis of variance (ANOVA). Means of treatments were compared by Newman-Keuls multiple range test. Statistical significance was set at $P < 0,05$. Statistical analysis was carried out using SPSS version 20.0 [14].

RESULTS

Mortality rates were 4.5%, 7.7%, 12.2%, 9.5% and 16.6 % for T_1, T_2, T_3, T_4 and T_5 respectively. Mortality did not appear to be affected by dietary treatments ($P > 0.05$). Performance response of the broilers fed diets with different barley levels during the starter (1 to 14 d), grower (15 to 42 d) and finisher (43 to 56 d) phases are summarized in Tables 3, 4 and 5.

Feed intake data (Table 3) shows that the birds in the five diets consumed essentially the same amount of feed between 1 to 14 days ($P > 0.05$). In the growing period, there was, however, significant effect resulting from diet on the feed consumption ($P < 0.01$). It is the same over the finishing period in which the average feed intake was significantly higher ($P < 0.01$) for the experimantal diets (except T_5) compared to the control. In addition, at the end of the experiment, birds on control, T_2 and T_3 have similar cumulative feed intake values wich are significantly superior ($P < 0.01$) than those obtained by chicks receiving diet contained barley at 75% and 100%.

The average initial body weight of the birds ranged from 34.13 to 36.55 g (Table. 4). Results from this experiment showed that weight gain was significantly ($P < 0.01$) affected by the treatment diets throughout the experimental period. Weight gain appeared to decline significantly ($P < 0.01$) with increased barley in the diet over the starting (1 to 14 d) and growing (15 to 42 d) periods. However, during the finishing period, weight gain appeared to improve when barley was used in the diet at 25%, 50% and 75%. The control diet resulted to weight gain similar to that of diet without maize ($P > 0.05$). At the end of the experimental period, the best weight gain was obtained on birds consuming the control diet, which was not statistically different from that obtained on T_2 and T_3 treatments ($P > 0.05$). The lowest weight gain values were obtained when barley was used at 75% and 100% of the diet.

The order of values of feed conversion ratio (Table 5) showed an increase with increasing levels of barley in the diets. The feed efficiency was significantly ($P < 0.001$) altered in birds fed with barley at 50%, 75% and 100% levels compared to the control diet over the starter phase. However, during the grower phase, this parameter was slightly but not significantly altered in birds fed with barley except for those on T_5 diet. In the finisher period, there was no differences ($P > 0.05$) in terms of feed efficiency between the five diets.

At the end of the trial (1 to 56 d), the feed conversion ratio varied from 1.38 to 2.21. The control diet supported significantly ($P < 0.01$) better feed efficiency than all experimental diets, whereas birds fed the diet T_5 were the least efficient ($P < 0.01$). Moreover, no differences ($P > 0.05$) in terms of feed conversion ratio were observed between birds fed control, T_2, T_3 and T_4 diets.

Table 1. Determined chemical composition of maize and whole barley (% DM).

%	Maize	Barley
Dry matter	88.6	90.9
Ash	1.98	2.25
Crude proteins *(N x 6.25)*	7.91	10.4
Crude fiber	3.39	4.01
Crude fat	2.50	2.31
ME (kcal/kg)	3705.5	3629.2

Table 2. Ingredients and chemical composition (on dry matter basis) of the experimental diets fed to broilers from 0 to 8 weeks of age.

Item	Treatment				
	T_1(Control)	T_2	T_3	T_4	T_5
Ingredients composition					
Maize %	64.70	48.5	32.40	16.20	0.00
Barley %	0.00	16.20	32.40	48.50	64.70
Soybean meal %	32.00	32.00	32.00	32.00	32.00
Methionine %	0.10	0.10	0.10	0.10	0.10
NaCl %	0.30	0.30	0.30	0.30	0.30
Dicalcium phosphate %	1.00	1.00	1.00	1.00	1.00
Calcium carbonate %	1.30	1.30	1.30	1.30	1.30
CMV %	0.60	0.60	0.60	0.60	0.60
Total	100.00	100.00	100.00	100	100
Chemical composition					
Dry matter %	88.93	88.85	89.31	89.37	89.25
Organic Matter %	93.00	93.00	92.60	92.30	92.10
Crude protein %	20.28	20.86	21.54	21.94	23.13
Crude fibre %	3.61	3.96	4.32	4.98	5.42
C/P	173.33	165.57	155.32	152.88	142.37
Crude fat %	3.41	3.28	2.75	2.40	1.98
Crude ash %	6.98	7.01	7.38	7.64	7.95
ME, Kcal/Kg (calculated)	3515.2	3453.8	3345.7	3354.2	3293.2

Table 3. Effects of different dietary inclusion levels of whole barley on feed consumption (g) of experimental broilers.

Period	Diets					SEM	*P*
	T_1 (control)	T_2	T_3	T_4	T_5		
Starter 1 to14 d	378.2^{a}	366.3^{ab}	365.9^{ab}	361.3^{ab}	334.4^{b}	13.5	0.080
Grower 15 to 42 d	2799.5^{a}	2835.0^{a}	2555.3^{b}	2269.1^{b}	2214.1^{b}	110.1	0.001
Finisher 43 to 56 d	1697.1^{c}	1939.9^{ab}	1978.7^{a}	1913.0^{ab}	1791.0^{bc}	56.7	0.003
Overall 1 to 56 d	4874.8^{b}	5141.2^{a}	4860.0^{b}	4542.5^{c}	4339.4^{c}	113.2	0.001

$^{a\text{-}c}$ Values with different letters differ significantly, according to Newman-Keuls 's multiple range test (P<0.05). SEM : Standard error of mean

Table 4. Effects of different dietary inclusion levels of whole barley on weight gain (g) of experimental broilers.

Period	Diets					SEM	*P*
	T_1 (control)	T_2	T_3	T_4	T_5		
Beginning weight	36.55^{a}	35.37^{ab}	34.13^{b}	34.68^{b}	34.82^{b}	0.65	0.005
Starter 1 to14 d	290.4^{a}	256.2^{b}	238.6^{c}	225.6^{d}	197.3^{e}	6.24	0.001
Grower 15 to 42 d	1589.7^{a}	1442.7^{b}	1410.0^{b}	1253.9^{c}	1006.4^{d}	45.3	0.001
Finisher 43 to 56 d	785.3^{b}	917.9^{a}	890.7^{a}	871.8^{a}	762.3^{b}	30.8	0.001
Overall 1 to 56 d	2665.4^{a}	2616.8^{a}	2539.2^{a}	2351.3^{b}	1966.0^{c}	78.7	0.001
Final weight, 56 d	2702.1^{a}	2652.2^{a}	2573.3^{a}	2386.0^{b}	2000.8^{c}	78.8	0.001

a-e Values with different letters differ significantly, according to Newman-Keuls 's multiple range test (P<0.05). SEM : Standard error of mean.

Table 5. Effects of different dietary inclusion levels of whole barley on feed /gain ratio (g/g) of experimental broilers.

Period	Diets					SEM	*P*
	T1 (control)	T2	T3	T4	T5		
Starter 1 to14 d	1.30[c]	1.43[bc]	1.53[ab]	1.60[ab]	1.69[a]	0.07	0.001
Grower 15 to 42 d	1.76[b]	1.96[b]	1.81[b]	1.80[b]	2.20[a]	0.08	0.005
Finisher 43 to 56 d	2.16	2.11	2.22	2.19	2.35	0.1	0.220
Overall 1 to 56 d	1.83[c]	1.96[b]	1.91[b]	1.93[b]	2.21[a]	0.03	0.001

[a-c] Values with different letters differ significantly, according to Newman-Keuls 's multiple range test ($P<0.05$). SEM : Standard error of mean.

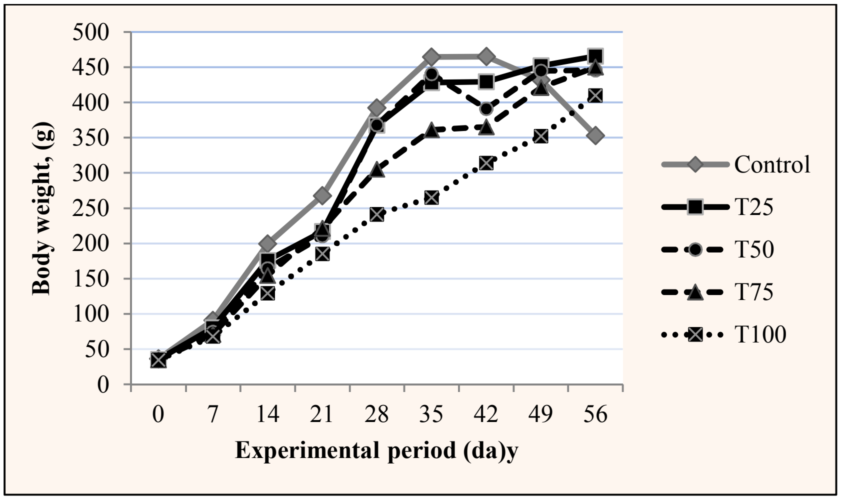

Fig 1. Body weight gain of experimental broilers.

DISCUSSION

During 8 weeks, the percentage mortality was not affected ($P > 0.05$) when feeding birds with hulled barley based diet supplemented with different levels in comparison to the control group. Similar findings were reported by [15]. In this investigation inclusion of hulled barley brought interesting results when compared with a commercial corn-soybean meal. However, compared to the other levels, feeding whole barley at 100% level of the diet slowed growth rate at all ages throughout the trial. Consequently, the use of barley as a sole grain in the ration is not practical. This is in agreement with finding of [16]. Barley is utilized to best advantage in poultry diets when consideration is given to the class of bird being fed and the desired level of [17].

In terms of feed efficiency, the birds appeared to adjust to whole barley as they grew older. The finding that barley diet had a negative effect on feed efficiency over the starter phase agrees with previous research by [18]. During the first weeks after hatch, the chicken's digestive system undergoes changes and becomes more capable of efficiently digesting many of the ingredients included in the diet [19]. On the contrary, the negative effect of hulled barley inclusion in the diets after 2 weeks of age was not proved in the study of [20]. Similarly, [15] reported that when barley was used at levels of 12 and 25% of the diet, the body wheight of broilers decreased by 2-4% compared with control groups. There is, however, disagreement as to the time at which the digestive system becomes competent in its ability to digest and absorb various nutrients [21].

By increasing the soluble NSP concentration in diets, the viscosity of digesta increases and nutrient absorption and diffusion rate of digestive enzymes decreases, resulting in loss of energy and lower feed utilization [22, 23, 24]. In fact, due to the constant microflora population in adult birds, the harmful effects of NSP are reduced [25].

On the other hand, addition of barley up to 50% level of the diet resulted in equal or even better performance when compared to the control diet. These results tend to support previous finding of [21] who reported that body weight gain, feed conversion, and livability of broilers fed grower and finisher diets containing barley up to 30% of the diet did not differ from those of broilers reared on the maize-based control diets. Similarly, [26] used whole barley at a rate of 700 g/kg in the diet and observed no effect on performance in broilers. In another study, it has been revealed that a level of up to 40% can sustain similar performances to that of the conventional control diet including 10% barley [27]. Although hull-less barley contains less indigestible fiber than hulled cultivars, it also contains higher levels of β- glucans [28]. [29] found that at the 60% inclusion level, hulled barley was significantly superior to hulless barley for most parameters, including body weight, fat absorption and starch absorption.

The superiority of corn diets to hight barley diets is probably due to hight metabolizable energy concentration in the corn diets, a difference of about 161 and 222 kcal/kg occured in the calculated ME between the control and the diet containing 75% and 100% barley, respectively. In the present study, the ME value (3629.2 kcal/kg) and the protein content (10.4%) of locally grown barley were much higher than the values obtained in other studies [20]. These differences may be due to genetic make-up [30], conditions of cultivation, variations among cultivars [28] and vegetation period [31]. [32] reported low correlations between broiler performance and apparent ME values. It can therfore be assumed that other factors such as sex, genotype and feed form can affect the growth rate of broilers.

The use of exogenous feed enzymes in poultry diets is becoming a norm to overcome the adverse effects of antinutritional factors [33]. A large number of studies have confirmed that enzyme addition to barley-based diets increases their ME content and improves feed consumption and growth performance when fed to broilers [34, 35,36,8]. Enzyme supplementation of chicken cereals based diets has resulted in improved starch and nitrogen digestability as well as improved absorption of starch, amino acids and lipids [37]. Furthermore, prolonged storage of the grains tends to reduce the ß-glucan content of barley [38]. [32] reported that the apparent ME value of some grains improves after 3-4 months of normal storage and feed conversion efficiency of birds fed these grains also improves. However, the reasons for differences between stored and new season grains have not been well understood [39]. In addition, in recent years, there has been considerable interest in the use of heat treatment to increase the nutritional values of feed [40]. In any case, it is critical to provide a more accurate estimate of barley energy available to the animal.

CONCLUSION

The data from these experiments revealed that barley used in this study can be fed up to 50% even up to 75% of the grower and finisher diet without negative effect on performance of broilers grown to 56 days of age. The inclusion of high levels of locally availaible barley is a useful way to valorise the large surplus harvested. These findings have an important economical advantage because the cost of barley is generally lower than that of specific broiler diets.

AUTHOR CONTRIBUTIONS: LD, MD and MH carried out the main research works, results interpretation and discussion from MH and MD. LD performed the statistical analysis, tables and figures and drafted the manuscript.

CONFLICTS OF INTEREST:

The authors declare no conflict of interest.

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