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EFFICACY OF BARLEY MALT IN IMPROVING THE UTILIZATION OF BROILER DIETS

BY

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Abstract: *The objective of this study was to evaluate the effect of barley malt in improving the utilization of broiler diets. In this study, a total number of 240 unsexed one day old Ross broiler chicks were distributed randomly and divided equally into eight experimental groups nearly equal in average live weight. Each group was represented by 30 birds in three replicate pens of 10 chicks each and kept under similar management conditions. A 4 x 2 factorial design was used in this experiment using 4 levels of barley malt (0, 2.5, 5.0 and 7.5% of the diet, in expense of the corn) in each of two diets. The first diet contained the strain catalog recommendation of energy (RE), while the second diet contained low energy level (LE). All diets were formulated to meet other nutrient requirements of the chicks according to the strain catalog recommendation.*

The chemical analysis of barley malt showed that it had a good nutritive value. On air dry basis, it contained 4.16% moisture, 95.84% DM, 94.1% OM, 8.19% CP, 2.65% EE, 4.12% CF, 79.14% NFE and 3899 kcal/kg ME. It is rich in minerals (ppm), especially: Total P (3100), K (2500) and Fe (1500). Barley malt, in comparison to the corn it contained more amounts of all essential amino acids, except leucine and histidine which were the first limiting amino acid (0.67), and the second limiting amino acid (0.91), respectively. Both BW and BWG were improved (P≤0.05) for LE diets when compared to RE diets up to 28 days of age, Regardless of dietary energy, the improving effect of barley malt was between 10-28 days of age due to the level of 7.5% barley malt (7.81% increase in BWG as compared to 0% barley malt), the effect decreased after 28 days of age. Addition of barley malt to the LE diets increased FI when compared with those at same levels in RE diets, while FC values were improved when barley malt was added either to RE or LE diets, during the total period. The European Production Efficiency Index (EPEI) values of LE diets supplemented with barley malt, especially at 7.5% were better than the control of RE diet. Carcass characteristics and immune organs (spleen, bursa and thymus) values were

not adversely affected by the treatments. Addition of barley malt decreased abdominal fat pad (AFP) values gradually, especially when added to LE diets. There was no clear trend in digestibility coefficients values due treatments, except for EE and NFE which were increased numerically due to addition of barley malt, the best values were for 7.5% barley malt when added to LE diets. Results indicated that LE diets lowered total feed cost/kg BW and improved net revenue and economic efficiency compared to RE diets. Barley malt lowered total feed cost/kg BW, improved net revenue and economic efficiency compared to the control (without malt). Addition of barley malt to LE diets at all levels; especially at 7.5% lowered total feed cost/kg BW, improved net revenue and economic efficiency compared to the control of RE diets.

It is concluded that addition of barley malt at 7.5% of the diet resulted in the best broiler performance, meat quality and economic efficiency and it is suggested to carry out further studies using higher levels.

INTRODUCTION

Barley malt is a product of barley germination, used mainly in beer manufacturing. In the manufacture of malt, barley grains are first steeped to water content 43-45%, then germinated for 4-7 days during which enzymes are activated which break down the cell structure, solubilize proteins and hydrolyse starch (**Hickenbottom, 1996).** The product is different than barley grains which have low nutritional value for poultry because of the absence of an intestinal enzyme for efficient depolymerization of (1,3-1,4)-beta -glucan, the major polysaccharide of the endosperm cell walls. This leads to high viscosity in the intestine, limited nutrient uptake, decreased growth rate, and unhygienic sticky droppings adhering to chickens and floors of the production cages (**Wettstein *et al.* 2000).**

Barley-malt has been found to have many useful functions. The previous studies showed that the extract of barley-malt is one of normal techniques used as a carbon source for yeasts (single-cell protein) production (**Schulz and Oslage, 1976)**. **Fujino and Nagawa (1989)** found that barley malt warm-water extract resulted in higher frequency of occurrence of mouse intestinal bifidobacteria than in control. Malt extract was more positive than that of barley extract in improving the viability of lactic acid bacterium *Lactobacillus plantarum* as probiotic under gastrointestinal tract conditions **(Haruhito *et al.*, 2006)**. **Maillard *et al.* (1996)** reported an antioxidant activity of barley (mainly due to polyphenols), which increases during malting. Some other studies showed that barley malt contains some enzymes, such as β-amylase (**Mohan *et al.*,**

2005) and phytase (**Nermin *et al.*, 2006)** which may improve the utilization of low energy diets**.** Therefore this study aimed to evaluate barley malt as a natural growth promoter in broiler diets with low or recommended energy content, where almost there are no available data on evaluation of barley malt in broiler diets.

MATERIALS AND METHODS

The present study was performed at El–kanater El–khairia poultry research station, Animal Production Research Institute. The chemical analysis was conducted at laboratories of Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt. Barley malt was obtained from Al-Ahram Manufacturing and Filling Beverage Company, Tharwat St., Bin El-Saraiat, Giza, Egypt in air dried form. In this study, a total number of 240 unsexed one day old Ross broiler chicks were distributed randomly and divided equally into eight experimental groups nearly equal in average live weight. Each group was represented by 30 birds in three replicate pens of 10 chicks each and kept under similar management conditions. A 4 x 2 factorial design was used in this experiment using 4 levels of malt (0, 2.5, 5.0 and 7.5% of the diet, in expense of the corn) in each of two diets. The first diet contained the strain catalog recommendation of energy, while the second diet contained low energy level. First experimental diet contained 23% CP and 3100 kcal ME /Kg during the first stage (0-10 days of age), 21% CP and 3200 kcal ME /Kg during the second stage (10-28 days of age) and 19% CP and 3270 kcal ME /Kg during the third stage (28-42 days of age), while the second experimental diet contained 23% CP and 2900 kcal ME /Kg during the first stage (0-10 days of age), 21% CP and 3000 kcal ME /Kg during the second stage (10-28 days of age) and 19% CP and 3070 kcal ME /Kg during the third stage (28-42 days of age). All diets were formulated to meet other nutrient requirements of the chicks according to the strain catalog recommendation. Artificial light was used beside the normal day light to provide 24-hour / day photoperiod. Feed and water were provided *ad libitum.* Dietary composition and calculated analyses of the diets are shown in Table 1, 2 and 3.

Feed consumption and body weight of the birds were measured, while, body weight gain, feed conversion ratio (g feed / g gain), and economic efficiency were calculated. The digestibility coefficients of nutrients of the experimental diets were evaluated using 3 male birds from each treatment at the end of the experimental period (at 6 weeks of age). Faecal nitrogen was determined according to the method outlined by **Jakobsen *et al.* (1960)**, while the urinary organic matter fraction was calculated according to **Abou-**

Raya and Galal (1971). The proximate analyses of malt, feed and dried excreta samples were carried out according to the official methods **(AOAC, 1990)**. Amino acids were determined in barley malt sample according to **(OJEC, 19-9-98)** in the Central Laboratory for Food & Feed (CLFF)**,** Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. Its mineral contents were determined in analytical laboratory of General Organization Agriculture Equalization Fund (GOAEF), where (Mn, Mg, Zn, Cu, Fe, Ca) were determined using Atomic Absorption (GBC 932/933) Operation manual with AAS software for windows 95, (Na and K) were determined using Flame Photometer Jenway (PFP7) and (P) was determined using Spectronic 21D. Three male birds were chosen randomly from each treatment, at the end of the experiment, for slaughter test, and carcass weights were determined and presented as a percentage of live body weight.

Data from all the response variables were subjected to factorial (4x2) analysis of variance **(SAS, 2000)**. Variables having a significant F-test ($P \leq 0.05$) were compared using Duncan's Multiple Range Test **(Duncan, 1955)**.

Model:

$X_{ij} = \mu + T_i + F_j + (TF)_{ij} + E_{ij}$

Where : X_{ij} = Any observation.

μ =Overall mean.

T_i = Malt levels (i=1, 2, 3 and 4).

F_j = Energy levels (j=1 and 2).

$(TF)_{ij}$= Interaction between malt levels and energy levels

E_{ij}= Experimental error

RESULTS AND DISCUSSION

Chemical composition of malt:

The chemical analysis of malt (Table 4) showed that it contained, on air dry basis, 4.16% moisture, 95.84% dry matter (DM), 94.1% organic matter (OM), 8.19% crude protein (CP), 2.65% ether extract (EE), 4.12% crude fiber (CF), 1.74% ash, 79.14% nitrogen free extract (NFE), 3899 kcal/kg metabolizable energy (ME), 71.85% NDF, 21.82% ADF, 11.09% cellulose, 50.03% hemicellulose, 10.73% ADL. It contained the following minerals (ppm): 3100 total P, 2500 K, 1500 Fe, 1375 Na, 875 Mg, 250 Cu, 67.5 Zn, 25 Ca and 20 Mn.

Table 5 illustrated that barley malt, in comparison to the corn, contained more amounts of all essential amino acids, except leucine and histidine which were the first limiting amino acid (0.67), and the second limiting amino acid (0.91).

The values of this study were not very far from those of **El-Boushy (1994)** who revealed higher protein content (12.4% vs. 8.19%) lower EE (2.10% vs. 2.65%), higher ash (2.90% vs. 1.74%), higher CF (6.00% vs. 4.12%) and lower NFE (68.90% vs.79.14), on air dry basis (7.70 vs. 4.16% moisture).

Growth Performance:

Tables 6 and 7 show the effect of the different treatments on body weight (BW), where IBW refers to initial body weight, body weight gain (BWG), feed intake (FI), feed conversion (FC) and European Production Efficiency Index (EPEI).

The results (Table 6) indicated that both BW and BWG were improved ($P \leq 0.05$) for LE diets when compared to RE diets up to 28 days of age, thereafter there were no significant differences between low energy (LE) diet and recommended energy (RE). Regardless of dietary energy, the improving effect of barley malt was between 10-28 days of age due to the level of 7.5% barley malt (7.81% increase in BWG as compared to 0% barley malt), the effect decreased after 28 days of age.

Table 7 indicates that the amounts of feed consumed were almost similar for both RE and LE diets until 28 days of age, thereafter the birds fed LE diets consumed more feed ($P \leq 0.05$) than those fed RE diets. Addition of barley malt after 28 days of age decreased ($P \leq 0.05$) FI as compared with 0% barley malt. The addition of barley malt to the LE diets increased FI when compared with those at same levels in RE diets (3054 g vs. 3415 g for 2.5% barley malt in RE diets and 2.5% barley malt in LE diets). Feed conversion ratio values were better ($P \leq 0.05$) for LE diets than RE diets during the first 28 days of age. Addition of barley malt to the LE diets improved FC values at all levels as compared with those in RE diets. After 28 days of age and during the total period RE diets and the diets containing barley malt gave better FC values than LE diets or 0% barley malt.

The values of European Production Efficiency Index (EPEI) showed a clear trend, where RE diets gave better values than LE diets. Addition of barley malt increased EPEI values as compared with 0% barley malt, the best value was for 7.5% barley malt, regardless of diet energy. The best treatment (315.99) was for 7.5% barley malt added to RE diet, followed by 7.5 barley malt (289.86) added to LE diet vs. (276.48) for the control of RE diet. The EPEI values of all LE diets supplemented with barley malt at 2.5, 5.0 and 7.5% were better than the control of RE diet (285.68, 284.45 and 289.86 vs. 276.48, respectively).

The improving effect of barley malt on the broiler performance was supported by **Vipond *et al.*(1995)** who indicated that malt distillers grains proved efficacious as a component of animal finishing diets. **Von *et al.* (2003)** found an excellent growth and normal survival of broilers tested on barley diets supplemented with malt. They added that using malt containing thermotolerant (1,3-1,4)-beta-glucanase provides an environmentally friendly alternative to enzyme additives as it uses photosynthetic energy for production of the enzyme in the grain and thus avoids use of non-renewable energy for fermentation.

Carcass Characteristics

The carcass characteristics and immune organs (spleen, bursa and thymus) values were not adversely affected by the treatments (Table 8). The values (as percentage of the live body weight) were ranged between 72.06-75.11, 2.12-2.71, 2.27-2.49, 0.51-0.60, 0.54-1.08, 5.89-7.16, 0.06-0.08, 0.13-0.20, 0.15-0.25 and 0.39-0.68% for carcass, liver, gizzard, heart, abdominal fat pad (AFP), intestine (Intes), gall bladder (GB), spleen, bursa and thymus, respectively. There was a clear trend in AFP values, where LE diets gave less AFP value than RE diets, addition of barley malt decreased AFP values gradually, especially when added to LE diets. The least values (0.82 and 0.54%) were for 5.0 and 7.5% barley malt when added to LE diets vs. (0.98%) for the control of RE diets.

The low value of abdominal fat pad due to barley malt may be supported by **Wilson** *et al.* **(2004)** who demonstrated that consumption of oats or barley lowered serum cholesterol concentrations, where they increased significantly fecal excretion of cholesterol. They explained that the substance present in the soluble fiber fraction of both cereal grains to which this effect has been attributed is ß-glucan.

Nutrients Utilization

There were no significant differences or clear trend between the values of the digestibility coefficients as affected by different treatments (Table 9), except for NFE which were increased numerically due to decreased energy level and or addition of barley malt. The best values were for 7.5% barley malt when added to LE diets.

The enzyme content of barley malt may have a role in improving the utilization of the nutrients, where barley malt flour can be used as a source of β-amylase (**Mohan *et al.*, 2005**) and phytase and it was able to remove the antinutritional effects of phytic acid in wheat flour (**Nermin *et al.*, 2006). Junmei *et al.* (2004)** stated that approximately 80% of β-glucan present in barley grains was degraded after malting and that β-glucanase activity increased after

malting. **Ann *et al.* (2005)** reported that malting processes of barley decreased both phytate and β-glucan, while increased iron availability.

Economic Efficiency

The economic efficiency of the different formulated diets as affected by different treatments is shown in Table 10. Results indicated that LE diets lowered total feed cost/kg BW and improved net revenue and economic efficiency compared to RE diets. Barley malt lowered total feed cost/kg BW, improved net revenue and economic efficiency compared to the control (without malt). The best values were for 7.5% barley malt regardless of diet energy. Addition of barley malt to LE diets at all levels lowered total feed cost/kg BW, improved net revenue and economic efficiency compared to the control of RE diets. The least feed cost/kg BW (2.26) and the highest relative economic efficiency (127) were for 7.5% barley malt when added to LE diet compared to the control of RE diets (2.61 and 100, respectively).

Table (1): Composition and calculated analysis of the starter diets

Ingredients (%)	Recommended Energy				Low Energy			
	Malt levels				Malt levels			
	(0%)	2.5%	5.0%	7.5%	(0%)	2.5%	5.0%	7.5%
Yellow corn	48.57	46.07	44.09	41.80	48.57	46.58	44.09	42.40
Soybean meal (38%)	33.99	33.99	33.99	33.99	39.55	39.55	39.55	39.50
Corn gluten meal (60%)	9.16	9.16	9.16	9.16	6.00	6.00	6.00	5.75
Malt	--	2.50	5.00	7.50	--	2.50	5.00	7.50
Corn oil	4.21	4.21	3.71	3.50	2.00	1.50	1.50	1.00
Di calcium phosphate	1.66	1.66	1.64	1.64	1.60	1.59	1.58	1.57
Lime stone	1.42	1.42	1.42	1.42	1.41	1.41	1.41	1.41
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix1	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine Hcl	0.18	0.18	0.18	0.17	0.05	0.05	0.05	0.04
DL-Methionine	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.23
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis:								
Crude protein %	23	23	23	23	23	23	23	23
Metabolizable energy (Kcal ME /Kg diet)	3100	3100	3100	3100	2900	2900	2900	2900
Available P %	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Calcium %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lysine %	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Methionine %	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Methionine + Cystine %	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08

1. Each 3 kg of Vit. & Min. Mixture contains: Vit. A, 12000,000 IU; Vit. D_3, 2000,000 IU; Vit. E, 10,000 mg; Vit. k_3, 2000 mg; Vit. B_1, 1000 mg; Vit. B_2, 5000 mg; Vit. B_6, 1500 mg; Vit. B_{12}, 10 mg; Pantothenic acid, 10,000 mg; Niacin, 30,000 mg; Folic acid, 1000 mg; Biotin, 50 mg; Choline chloride, 300,000 mg; Manganese, 60,000 mg; Zinc, 50,000 mg; Copper, 10,000 mg; Iron, 30,000; Iodine, 1000 mg; Selenium, 100 mg; Cobalt, 100 mg; Ca CO3 to 3,000 gm.

Table (2): Composition and calculated analysis of the grower diets

Ingredients (%)	Recommended Energy				Low Energy			
	Malt levels				Malt levels			
	(0%)	2.5%	5.0%	7.5%	(0%)	2.5%	5.0%	7.5%
Yellow corn	50.11	48.11	46.00	44.00	53.18	50.94	48.54	46.30
Soybean meal (38%)	33.75	33.75	33.00	33.00	35.75	35.75	36.30	36.30
Corn gluten meal (60%)	6.00	6.00	6.49	6.40	4.61	4.56	4.06	4.05
Malt	--	2.50	5.00	7.50	--	2.50	5.00	7.50
Corn oil	6.37	5.92	5.80	5.39	2.82	2.62	2.50	2.25
Di calcium phosphate	1.67	1.66	1.66	1.66	1.65	1.64	1.61	1.61
Lime stone	1.20	1.16	1.15	1.15	1.14	1.15	1.16	1.16
NaCl	0.30	0.30	0.30	.0.30	0.30	0.30	0.30	0.30
Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine Hcl	0.09	0.09	0.10	0.10	0.04	0.03	0.02	0.02
DL-Methionine	0.21	0.21	0.20	0.20	0.21	0.21	0.21	0.21
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis:								
Crude protein %	21	21	21	21	21	21	21	21
Metabolizable energy (Kcal ME /Kg diet)	3200	3200	3200	3200	3000	3000	3000	3000
Available P %	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Calcium %	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Lysine %	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Methionine %	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Methionine + Cystine %	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

1. Each 3 kg of Vit. & Min. Mixture contains: Vit. A, 12000,000 IU; Vit. D_3, 2000,000 IU; Vit. E, 10,000 mg; Vit. k_3, 2000 mg; Vit. B_1, 1000 mg; Vit. B_2, 5000 mg; Vit. B_6, 1500 mg; Vit. B_{12}, 10 mg; Pantothenic acid, 10,000 mg; Niacin, 30,000 mg; Folic acid, 1000 mg; Biotin, 50 mg; Choline chloride, 300,000 mg; Manganese, 60,000 mg; Zinc, 50,000 mg; Copper, 10,000 mg; Iron, 30,000; Iodine, 1000 mg; Selenium, 100 mg; Cobalt, 100 mg; Ca CO3 to 3,000 gm.

Table (3): Composition and calculated analysis of the finisher diets

Ingredients (%)	Recommended Energy				Low Energy			
	Malt levels				Malt levels			
	(0%)	2.5%	5.0%	7.5%	(0%)	2.5%	5.0%	7.5%
Yellow corn	55.45	52.95	50.86	48.36	59.10	56.61	54.42	52.22
Soybean meal (38%)	30.23	30.69	30.69	30.94	31.23	31.23	31.90	31.42
Corn gluten meal (60%)	4.46	4.00	4.00	3.76	3.45	3.45	2.75	3.07
Malt	--	2.50	5.00	7.50	--	2.50	5.00	7.50
Corn oil	6.62	6.62	6.21	6.21	3.00	3.00	2.75	2.60
Di calcium phosphate	1.18	1.17	1.17	1.17	1.17	1.17	1.14	1.14
Lime stone	1.18	1.19	1.19	1.19	1.18	1.18	1.19	1.19
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine Hcl	0.07	0.06	0.06	0.05	0.05	0.04	0.03	0.04
DL-Methionine	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis:								
Crude protein %	19	19	19	19	19	19	19	19
Metabolizable energy (Kcal ME /Kg diet)	3270	3270	3270	3270	3070	3070	3070	3070
Available P %	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Calcium %	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Lysine %	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Methionine %	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Methionine + Cystine %	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93

1. Each 3 kg of Vit. & Min. Mixture contains: Vit. A, 12000,000 IU; Vit. D_3, 2000,000 IU; Vit. E, 10,000 mg; Vit. k_3, 2000 mg; Vit. B_1, 1000 mg; Vit. B_2, 5000 mg; Vit. B_6, 1500 mg; Vit. B_{12}, 10 mg; Pantothenic acid, 10,000 mg; Niacin, 30,000 mg; Folic acid, 1000 mg; Biotin, 50 mg; Choline chloride, 300,000 mg; Manganese, 60,000 mg; Zinc, 50,000 mg; Copper, 10,000 mg; Iron, 30,000; Iodine, 1000 mg; Selenium, 100 mg; Cobalt, 100 mg; Ca CO3 to 3,000 gm.

Table (4): Chemical composition of Malt

Items		On air dry basis (as fed)	On dry matter basis
Moisture,	%	4.16	--
Dry matter (DM),	%	95.84	100
Organic matter (OM),	%	94.1	98.18
Crude protein (CP),	%	8.19	8.55
Ether extract (EE),	%	2.65	2.77
Crude fiber (CF),	%	4.12	4.30
Ash,	%	1.74	1.82
Nitrogen free extract (NFE),	%	79.14	82.56
Calculated ME (kcal/kg)[6]		3899	4068
Fiber fraction			
NDF[1]	%	71.85	74.97
ADF[2]	%	21.82	22.77
Hemi cellulose[3]	%	50.03	52.20
Cellulose[4]	%	11.09	11.57
ADL[5]	%	10.73	11.20
Total P	ppm	3100	3235
K	ppm	2500	2609
Fe	ppm	1500	1565
Na	ppm	1375	1435
Mg	ppm	875	913
Cu	ppm	250	261
Zn	ppm	67.5	70
Ca	ppm	25	26
Mn	ppm	20	21

NDF[1] (Neutral detergent fiber) = cellulose + hemicellulose + lignin
ADF[2] (Acid detergent fiber) = cellulose + ADL[5] (lignin)
Hemicellulose[3] = NDF-ADF Cellulose[4] = ADF-ADL
ME[6] = 53 + 38 (% CP + 2.25 x % EE + 1.1 x NFE), **Scott *et al.* (1976)**

Table (5): Amino acids composition of barley malt as compared to corn

Amino acid (%)	Malt (a)	Yellow corn (b)[1]	(a / b)[2]
Arginine	0.49	0.38	1.29
Histidine	0.21	0.23	0.91
Isoleucine	0.33	0.29	1.14
Leucine	0.67	1.00	0.67
Lysine	0.37	0.26	1.42
Methionine	0.31	0.18	1.72
Phenylalanine	0.43	0.38	1.13
Threonine	0.31	0.29	1.07
Valine	0.53	0.40	1.33
Asparatic	0.68	--	
Serine	0.28	0.37	
Glutamic	2.04	--	
Proline	1.03	--	
Glysine	0.37	0.33	
Alanine	0.43	--	
Cystein	0.23	0.18	

1- NRC, 1994
2- Essential amino acids of malt / corn

Table (6): Performance of broiler chicks as affected by different treatments

Treatments			Body weight (g)				Body weight gain (g)			
No	Malt level (%)	Energy level	IBW	At 10 days	At 28 days	At 42 days	0-10 days	10-28 days	28-42 days	0-42 days
	-	RE	44.59	188	924[b]	2034	144	735[b]	1111	1990
	-	LE	44.38	205	1010[a]	2041	160	805[a]	1031	1997
	0	-	44.12	213	981[ab]	2010	169	768	1029	1966
	2.5	-	44.77	191	908[c]	1990	146	717	1082	1945
	5.0	-	44.53	183	951[bc]	2041	138	769	1090	1997
	7.5	-	44.53	199	1027[a]	2110	155	828	1083	2066
1	0	RE	44.17	197	979	2067	153	782	1088	2023
2	2.5		45.03	178	825	1931	133	647	1106	1886
3	5.0		44.63	182	887	2010	138	705	1123	1965
4	7.5		44.53	195	1004	2130	151	809	1125	2085
5	0	LE	44.07	229	983	1953	185	754	970	1908
6	2.5		44.50	204	991	2050	160	787	1059	2005
7	5.0		44.43	183	1016	2073	139	833	1057	2028
8	7.5		44.53	203	1051	2091	158	848	1040	2046

a, b ....= Means in the same column within each factor differently superscripted are significantly different ($P \leq 0.05$)

Table (7): Performance of broiler chicks as affected by different treatments

Treatments			Feed intake (g)				Feed conversion				EPEI*
No	Malt level (%)	Energy level	0-10 days	10-28 days	28-42 days	0-42 days	0-10 days	10-28 days	28-42 days	0-42 days	
	-	**RE**	225	1402	1709^{b}	3336^{b}	1.57^{a}	1.93^{a}	1.55^{b}	1.68	289.04
	-	**LE**	218	1395	1897^{a}	3511^{a}	1.39^{b}	1.74^{b}	1.87^{a}	1.76	274.33
	0.0	-	238	1280^{b}	2083^{a}	3601^{a}	1.47	1.68^{b}	2.06^{a}	1.84^{a}	256.91
	2.5	-	219	1351^{b}	1665^{b}	3234^{c}	1.49	1.92^{a}	1.56^{b}	1.66^{b}	284.50
	5.0	-	213	1516^{a}	1700^{b}	3429^{b}	1.55	1.99^{a}	1.58^{b}	1.72^{ab}	282.41
	7.5	-	218	1447^{a}	1765^{b}	3430^{b}	1.42	1.75^{b}	1.64^{b}	1.66^{b}	302.93
1	**0.0**	**RE**	241	1247	2110^{a}	3598	1.58	1.60^{b}	1.94	1.78	276.48
2	**2.5**		206	1409	1439^{e}	3054	1.53	2.19^{a}	1.31	1.62	283.32
3	**5.0**		236	1518	1593de	3347	1.72	2.16^{a}	1.43	1.71	280.36
4	**7.5**		218	1433	1695^{cd}	3345	1.44	1.77^{b}	1.51	1.61	315.99
5	**0.0**	**LE**	234	1312	2056^{a}	3603	1.36	1.76^{b}	2.18	1.89	237.34
6	**2.5**		231	1293	1890^{b}	3415	1.44	1.65^{b}	1.81	1.71	285.68
7	**5.0**		190	1515	1807^{bc}	3512	1.37	1.82^{b}	1.73	1.74	284.45
8	**7.5**		219	1460	1835^{bc}	3514	1.39	1.73^{b}	1.76	1.71	289.86

a, b ....= Means in the same column within each factor differently superscripted are significantly different (P≤0.05)

*__EPEI__ = European Production Efficiency Index =

$$\frac{\text{Live body weight (kg) x Livability (100-\%mortality)}}{\text{Production period (days) x Feed conversion ratio}} \times 100$$

Table (8): Effect of treatments on carcass characteristics and immune organs (as percent of live body weight)

Treatments			Items							Immune organs		
No	**Malt level (%)**	**Energy level**	**Carcass (%)**	**Liver (%)**	**Gizzard (%)**	**Heart (%)**	**AFP (%)**	**Intes (%)**	**GB (%)**	**Spleen (%)**	**Bursa (%)**	**Thymus (%)**
	-	**RE**	73.51	2.43	2.35	0.56	0.98	6.25	0.07	0.17	0.20	0.56
	-	**LE**	73.55	2.49	2.37	0.55	0.81	6.40	0.06	0.15	0.18	0.55
	0.0	-	72.16	2.38	2.49	0.53	0.94	6.88	0.06	0.14	0.18	0.47
	2.5	-	73.32	2.58	2.34	0.58	1.03	6.00	0.07	0.17	0.18	0.64
	5.0	-	74.82	2.26	2.27	0.58	0.91	6.11	0.07	0.18	0.22	0.58
	7.5	-	73.82	2.61	2.34	0.53	0.71	6.30	0.07	0.15	0.18	0.53
1	**0.0**	**RE**	72.06	2.21	2.48	0.55	0.98	6.60	0.06	0.16	0.20	0.39
2	**2.5**		73.54	2.44	2.32	0.55	1.08	5.89	0.08	0.20	0.20	0.68
3	**5.0**		75.11	2.39	2.27	0.57	0.99	5.99	0.07	0.17	0.19	0.66
4	**7.5**		73.33	2.66	2.33	0.55	0.89	6.51	0.07	0.16	0.21	0.49
5	**0.0**	**LE**	72.25	2.55	2.49	0.51	0.90	7.16	0.07	0.13	0.15	0.55
6	**2.5**		73.10	2.71	2.35	0.60	0.97	6.11	0.06	0.14	0.16	0.60
7	**5.0**		74.54	2.12	2.28	0.58	0.82	6.24	0.07	0.19	0.25	0.49
8	**7.5**		74.31	2.56	2.34	0.52	0.54	6.09	0.06	0.13	0.15	0.56

a, b ....= Means in the same column within each factor differently superscripted are significantly different ($P \leq 0.05$)

Table (9): Effect of treatments on nutrients utilization

Treatments			Items					
No	**Malt level (%)**	**Energy level**	**DM (%)**	**OM (%)**	**CP (%)**	**EE (%)**	**CF (%)**	**NFE (%)**
	-	**RE**	79.6	82.3	94.0	90.7	28.4	81.6
	-	**LE**	79.4	81.6	93.3	86.0	30.3	86.5
	0.0	-	79.8	81.8	94.2	84.8	35.0	81.7
	2.5	-	79.9	82.2	94.2	89.4	27.2	85.4
	5.0	-	76.3	79.6	93.2	87.2	32.0	83.2
	7.5	-	81.9	84.3	93.0	91.9	23.2	85.9
1	**0.0**	**RE**	81.6	84.0	94.7	89.6^{ab}	29.9	83.3
2	**2.5**		79.5	81.8	93.4	89.1^{ab}	27.0	82.1
3	**5.0**		79.4	83.1	93.8	95.4^{a}	38.3	81.0
4	**7.5**		77.8	80.2	94.0	88.8^{ab}	18.3	80.1
5	**0.0**	**LE**	78.1	79.6	93.7	80.1^{b}	40.1	80.0
6	**2.5**		80.3	82.6	94.9	89.8^{ab}	27.3	88.7
7	**5.0**		73.3	76.0	92.6	78.9^{b}	25.8	85.5
8	**7.5**		86.0	88.4	91.9	95.0^{a}	28.0	91.7

a, b ....= Means in the same column within each factor differently superscripted are significantly different ($P \leq 0.05$)

Table (10): Input / output analysis and economic efficiency as affected by different treatments

Treatments			BW (kg)	FI/chick (kg)	Feed cost/chick (LE)	Feed cost/kg BW (LE)	Total revenue (LE)[1]	Net revenue (LE)	Economic efficiency (EE)[2]	Relative EE%
No	Malt level (%)	Energy level								
	-	**RE**	2.034	3.336	4.97	2.44	12.21	7.24	1.46	100
	-	**LE**	2.041	3.511	4.77	2.34	12.25	7.48	1.57	108
	0.0	-	2.01	3.601	5.17	2.57	12.06	6.90	1.33	100
	2.5	-	1.990	3.234	4.62	2.32	11.94	7.32	1.58	119
	5.0	-	2.041	3.429	4.86	2.38	12.25	7.39	1.52	114
	7.5	-	2.110	3.430	4.83	2.29	12.66	7.83	1.62	122
1	**0.0**	**RE**	2.067	3.598	5.39	2.61	12.40	7.01	1.30	100
2	**2.5**		1.931	3.054	4.57	2.36	11.59	7.02	1.54	118
3	**5.0**		2.010	3.347	4.97	2.47	12.06	7.09	1.43	110
4	**7.5**		2.130	3.345	4.93	2.32	12.78	7.85	1.59	122
5	**0.0**	**LE**	1.953	3.603	4.94	2.53	11.72	6.78	1.37	105
6	**2.5**		2.050	3.415	4.66	2.28	12.30	7.64	1.64	126
7	**5.0**		2.073	3.512	4.75	2.29	12.44	7.69	1.62	125
8	**7.5**		2.091	3.514	4.73	2.26	12.55	7.82	1.65	127

N.B: Total price for feeds was calculated according to the price of different ingredients available in A.R.E. at experimental time

1- The price was calculated due to the local market which was 6.0 LE/kg live weight.

2- EE = (Net revenue / chick (LE)) / (Total feed cost / chick (LE))

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الملخص العربي

كفاءة مولت الشعير في تحسين الاستفادة من علائق بداري التسمين

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استهدفت هذه الدراسة تقييم كفاءة مولت الشعير لتحسين الاستفادة من علائق بداري التسمين المحتوية علي طاقة منخفضة . تم في هذه الدراسة استخدام عدد 240 كتكوت روص غير مجنس عمر يوم وزعت عشوائيا إلي8 مجاميع متساوية في العدد و متوسط وزن الجسم. احتوت كل مجموعة علي 3 مكررات بكل منها 10 كتاكيت ربيت تحت ظروف متماثلة. أضيف مولت الشعير بأربعة مستويات (صفر، 2.5، 5.0 ، 7.5% من العليقة بدلا من الذرة الصفراء) إلى كل من عليقتى التجربة. احتوت العليقة الأولى و التي اعتبرت عليقة المقارنة على احتياجات السلالة من الطاقة بينما كانت العليقة الثانية منخفضة في محتواها الطاقة وتم تكوين العلائق لتغطي احتياجات السلالة من باقي العناصر الغذائية.

أوضحت نتائج هذه الدراسة القيمة الغذائية للشعير المنقوع حيث احتوي (علي أساس المادة الجافة هوائيا) علي 4.16% رطوبة ، 95.84% مادة جافة، 94.1% مادة عضوية، 8.19% بروتين خام، 2.65% دهن خام، 4.12% ألياف خام، 79.14% مستخلص خالي الازوت، 3899 كيلو كالورى / كجم مولت طاقة ممثلة. كما أنه غني في الأملاح المعدنية (جزء في المليون)، الفوسفور الكلي (3100)، البوتاسيوم (2500)، الحديد (1500). بمقارنته بالذرة الصفراء وجد أنه يحتوي علي كميات أكبر من جميع الأحماض الامينية الأساسية فيما عدا الليوسين و الهستيدين حيث كان الليوسين هو الحامض الاميني المحدد الأول (0.67) و الهستيدين كان الحامض الاميني المحدد الثاني (0.91). تحسنت قيم وزن الجسم و الزيادة في وزن الجسم معنويا في حالة التغذية علي العلائق المنخفضة في الطاقة عن تلك المحتوية علي احتياجات السلالة من الطاقة حني 28 يوم من العمر. و كانت أفضل القيم في الفترة مابين 10–28 يوم من العمر عند مستوى إضافة 7.5%.

إضافة مولت الشعير إلي العلائق المنخفضة في الطاقة أدي إلي زيادة العلف المأكول عند مقارنته بنفس مستوي الإضافة إلي العلائق المحتوية علي احتياجات السلالة من الطاقة. تم تحسين

معدل التحويل الغذائي عند إضافة مولت الشعير سواء إلي العلائق المنخفضة في الطاقة أو العلائق المحتوية علي احتياجات السلالة خلال فترة التجربة الكلية.

أفضل قيم دليل الكفاءة الإنتاجية كانت لمجاميع الطيور المغذاة علي علائق منخفضة في الطاقة و المضاف إليها مولت الشعير خاصة عند مستوي 7.5% مقارنة بالطيور المغذاة علي علائق الكنترول المحتوية علي احتياجات السلالة من الطاقة.

لم يكن هناك تأثيرات عكسية للمعاملات علي صفات الذبيحة و أعضاء المناعة (الطحال، غدة البرسا، الغدة الثيموسية). إلا أن إضافة مولت الشعير إلي العلائق خاصة المنخفضة في الطاقة أدي إلي انخفاض تدريجي في قيم دهن البطن. إضافة مولت الشعير بمستوي 7.5% إلي العلائق منخفضة الطاقة أدي إلي ارتفاع قيم هضم كل من مستخلص الاثير و المستخلص الخالي من الازوت. خفضت العلائق المحتوية علي الطاقة المنخفضة تكلفة كجم وزن جسم و حسنت صافي الدخل و الكفاءة الاقتصادية بالمقارنة بالعلائق المحتوية علي احتياجات السلالة كما أن إضافة مولت الشعير إلي العلائق أدي إلي خفض تكلفة كجم وزن جسم و حسن صافي الدخل و الكفاءة الاقتصادية بالمقارنة بالكنترول (بدون مولت الشعير).

في ضوء هذه الدراسة نستنتج أن إضافة مولت الشعير بمستوي 7.5% إلي العلائق أعطي أفضل أداء إنتاجي لبداري التسمين، جودة لحم، كفاءة اقتصادية و عليه يمكن اقتراح إجراء دراسات مستقبلية علي استخدام مستويات أعلي من مولت الشعير في علائق بداري التسمين.