Evaluation of diet formulation based on digestible amino acids and true metabolizable energy on broiler breeder performance

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A study was conducted to determine the effects of the formulation of diets based on digestible amino acids of feeds and nitrogen corrected apparent metabolizable energy on the performance of Arian broiler breeder from 50 to 64 weeks old. Four treatments with six replicates (7 females with a male) were applied, using a completely randomized experimental design and a 2 × 2 factorial arrangement. Four experimental diets were formulated based on two factors: first, two levels of Apparent and True Metabolizable Energy corrected for Nitrogen (AMEn and TMEn) and second, two levels of Total (TAA) and Digestible Amino Acids (DAA) of feeds. Feeding broiler breeders AMEn diet significantly increased egg weight, while the egg mass, fertility and hatchability were significantly different, which were affected by diets formulation based on energy ($P<0.05$). Diet formulated with DAA significantly improved egg weight, Haugh unit and fertility ($P<0.01$). Treatment 2 (AMEn+TAA) was significantly highest in egg weight, (68.97 g); egg mass, (43.1 g/hen/day); albumen height, (7.96 mm); Haugh unit, (86.32); fertility, (81.51 %); hatchability, (64.69 %); chicken weight, 50.27 (g) and amount of chickens per hen, (34.3) ($P<0.05$). This experiment showed that diet formulation based on AMEn + DAA for broiler breeder significantly increased performance.

Key words: *broiler breeders, energy, amino acids, chicken.*

Energy and amino acids are the most important factors in the diet of broiler breeder hens. Any changes in the daily nutrients intake of broiler breeder hens must be based on their requirements. Apart from the requirements for essential amino acids, protein requirements will be related to the total needs for nitrogen and to any adverse effects of protein excess. The minimum total nitrogen requirement of broiler breeders, like any other poultry, has not been critically determined (Fisher 1987 and 1998).

The yolk and albumen in the egg supply the developing embryo with nutrients, water and minerals for normal growth. Yolk is an important nutritional component of the avian egg because it contributes in 75% of the Joules and provides all the lipids, and thus the energy, for the developing embryo (Noble *et al.* 1996), as well as being an important protein source (Deeming 2002).

Nutrition of broiler breeder hens can influence on egg quality and is, therefore, extremely important for the embryo development and for the successful hatching of a high quality chick. Current recommendation for diet formulation for broiler breeder hens are expressed as daily nutrient intakes based on Apparent Metabolism Energy (AME) rather than True Metabolism Energy (TME) of feeds (Ross Manual 2007).

Absorption and retention rate of amino acids depends on two factors. The first factor is digestibility (protein hydrolysis and absorption) and the second is the rate of amino acids retention. All amino acids are not available in the food for maintenance and production. Part of amino acids is not digestible and can vary among different feeds. So to adjust poultry diets with digestible amino acids of foods is much better and easier to meet the real requirements of birds for maintenance and production (Leeson and Summers 2000).

The objective of this experiment was to evaluate type of broiler breeder formulation diets on performance. Diets based on two types of energy (AMEn, TMEn) and two types of amino acids of feeds (total and digestible).

Materials and Methods

To determine the effects of diet formulation on the Arian broiler breeder performance, 168 hens and 24 males was used (50 to 64 week). A completely randomized experimental design with a 2 × 2 factorial arrangement was used, with four treatments and sex replications per treatment. The first factor included two types of Apparent and True Metabolizable Energy corrected for nitrogen (AMEn and TMEn) of feeds, the second factor included two levels of Total Amino Acids (TAA) and Digestible Amino Acids of feeds (DAA). At 50 weeks of age, broiler breeders were weighed, and allocated to treatment groups based on the mean body weight (g), female (3550 ± 25) and male (4390 ± 30).

The pattern of total and digestible amino acids and also nitrogen corrected apparent and true metabolizable energy were determined for foods (Yaghobfar and Boidaji 2002 and Yaghobfar and Zahedifar 2003). The adjustments of diets were based on the requirements of Arian broiler breeder (Arian Breeder Management Guide, 2002). Table 1 shows the composition and calculated contents of the diets. Foods provided was mashed and milled with a 3 mm screen to obtain a similar particle size in all diets. Both, males and female broiler breeders received the same diets at 8:00 am. Diets provided 410 Kcal of metabolizable energy and 21/2 g of protein on a day. Eggs were collected at 52, 56, 60 and 64 weeks old. A random sample of eggs production per day from each replicate (24 total eggs/day) was collected to determine egg characteristics. An amount of 168 eggs were used for measuring egg characteristics in a week (7 eggs for every replicated).

At the end of the week, eggs (about 30 eggs per replicate) were put into a Maino, force-draft incubator (Model II, Maino Enrico Co., Italy). On the 18th d of incubation, eggs with apparently living embryos were transferred to hatching baskets and randomly distributed in the same trolley. All chicks were removed at 21.5 d of incubation. Both, hatchability (number of saleable chicks hatched per all eggs set×100) and fertility (number of fertile eggs set per all eggs set×100) were calculated.

Data were analyzed by 2×2 factorial arrangement (GLM procedure, An ANOVA of SAS Institute, 2001) and where significance occurred, means were compared with Duncan (1955) multiple range tests. Output data were expressed as means with SEM.

Results and Discussion

The results indicated that egg weight was significantly superior on treatment fed diets formulation based on AMEn by 67.88 than TMEn by 67.02 g ($P<0.05$). These results agree with Leeson and Summers (2000), who showed that increased energy intake had significantly positive effects on egg weight.

Bornstein *et al.* (1979), Bornstein and Lev (1982) and Attia *et al.* (1995) observed that the broiler breeder hens (21 to 61 weeks) had a significant positive correlation between energy intake (396, 423 and 450 kcal/hen/day) and fertility and hatchability. No reports describe the effects of diet formulation based

Table 1 Composition and calculated contents of the experimental diets

MEn (Feed)	Apparent		True	
Amino Acid (Feed)	Total	Digestible	Total	Digestible
	Treatment			
Item	1	2	3	4
Corn, grain	54.00	54.00	33.00	33.00
Wheat	12.00	13.00	27.00	27.00
Wheat bran	13.00	11.20	20.00	20.33
Soybean meal -48%	12.37	13.00	11.00	10.80
Oyster shells	7.00	7.00	7.00	7.00
Dical. phos.	1.00	1.00	1.00	1.00
Common salt	0.03	0.20	0.20	0.20
Vitamin premix[1]	0.25	0.25	0.30	0.30
Mineral premix[1]	0.25	0.25	0.30	0.30
DL-methionine	0.05	0.05	0.15	0.02
L-lysine HCl	0.05	0.05	0.05	0.05
Total	100.00	100.00	100.00	100.00
Calculated contents				
MEn (MJ/Kg)	11.29	11.29	11.29	11.29
Protein (%)	14.00	14.00	14.00	14.00
Ether extract (%)	2.29	2.29	2.03	2.03
Linoleic acid (%)	1.05	1.05	1.05	1.05
Calcium (%)	3.00	3.00	3.00	3.00
Avail. phosphorus (%)	0.40	0.40	0.40	0.40
Potassium (%)	0.60	0.60	0.60	0.60
Chlorine (%)	0.20	0.20	0.20	0.20
Sodium (%)	0.16	0.16	0.16	0.16
LYS (%)	0.65	0.65	0.65	0.65
MET (%)	0.30	0.30	0.30	0.30
CYS (%)	0.27	0.27	0.27	0.27

[1]This premix supplied the following per kilogram of feed: 12,000 IU of vitamin A, 2,100 IU of vitamin D3, 27.5 IU of vitamin E, 2 mg of vitamin K3, 1 mg of thiamin, 6 mg of riboflavin, 10 mg of pantothenic acid, 20 mg of niacin, 2 mg of pyridoxine, 0.8 mg of folic acid, 0.020 mg of cyanocobalamin, 0.15 mg of biotin, 200 mg of choline, 80 mg of Mn, 40 mg of Zn, 40 mg of Fe, 10 mg of Cu, 1 mg of I, and 0.5 mg of Se.

Table 2. Main effects of diets formulation based on metabolizable energy, amino acids of feedstuffs on broiler breeder performance (50 to 64 weeks)

	Egg weight (g)	Egg mass (g)	Albumen height (mm)	Haugh units	Fertility (%)	Hatchability (%)	Chicken weight (g)	No. (Chicks/hen)
				MEn (Feed)				
Apparent	67.88^{a}	38.42^{a}	7.50	83.28	72.05^{a}	61.76^{a}	49.87	31.20^{a}
True	67.02^{b}	34.70^{b}	7.54	83.68	57.20^{b}	49.70^{b}	47.40	22.40^{b}
P-Value	0.006	0.001	0.882	0.81	0.001	0.001	0.169	0.015
SEM	0.22	0.78	0.18	1.17	1.05	1.54	1.30	2.02
				Amino Acids (Feed)				
Total	67.16	35.58	7.48^{b}	80.88^{b}	56.89^{b}	52.62	47.53	25.6
Digestible	67.74	37.55	7.93^{a}	86.07^{a}	72.46^{a}	55.53	49.75	28.1
P-Value	0.062	0.076	0.00	0.00	0.028	0.854	0.328	0.409
SEM	0.218	0.78	0.183	1.175	1.053	1.548	1.3	2.019

^{ab}Means within the same column not sharing a common superscript differ significantly (P<0.05).

on MEn and amino acids of feedstuffs on fertility and hatchability.

Diets formulation based on amino acids of feed (TAAF, DAA) had significantly increased in albumen height, Haugh unit and fertility (P<0.05). The results of this experiment agree with the report of Butts and Cunningham (1972), who informed that a reduction in albumen is observed when birds receive low-protein diets, suggesting that these diets are lower in essential amino acids (EAA). This diet leads to insufficient protein synthesis to meet the needs for egg formation. Chemical composition of eggs can be influenced by dietary protein level.

The egg size and internal quality of eggs are important for hatching eggs. Fertility and hatchability are the major economical traits in broiler breeder reproductive performance. Hatchability was significant in diet formulation based on energy and amino acids of feedstuffs (table 2). Main effects of energy was significant in fertility (P<0.05). The fertility and hatchability were significantly higher on treatment fed diets formulation based on AMEn by 72.05 and 61.76% than on TMEn by 57.2 and 49.7%, respectively (P<0.05). These results are in agreement with the findings of Benton and Brake (1996), who noted that the rate of water loss from the egg during incubation was not influenced by albumen quality, but suggested that thick albumen may slow vital gas diffusion, limit nutrient availability to the embryo, and, subsequently, increase the incidence of embryonic death. Changes in hatchability of broiler breeder females have been reported to be related to many factors, such as storage time (Kirk *et al.* 1980), incubation position, incubation conditions (Kirk *et al.*1980 and Tullett and Burton 1982), and shell quality (Bennett 1992). Other researchers have found that bird age (Mather and Laughlin 1979) and egg size (Morris *et al.* 1968) also affect hatchability but this experiment showed that broiler breeder hens fed AMEn diets had a higher egg weight, fertility and hatchability. This difference was significant (P<0.05).

The interaction between energy and amino acids of feeds had significant difference on performance and egg characteristics. The diets formulation based on AMEn+DAA had best performance in egg weight, (68.97 g); egg mass, (43.1 g/hen/day); albumen height, (7.96 mm); Haugh unit (86.32); fertility, (81.51%); hatchability, (64.69 %); chicken weight, (50.27 g) and No. chickens per hen (34.3).This difference was significant (table 3).

The amount of chickens from each broiler breeder hen (50 to 64 weeks) was significantly different. Treatment 2 (AMEn+DAA) had 34.3 chicks and treatment 4 (TMEn+DAA) had 21.8 chicks. There are no reports on interactions between the effects of diet formulation based on MEn and amino acids of feeds as they influence on reproductive performance of broiler breeders.

Diet formulation based on AMEn + DAA for broiler breeder significantly increased egg weight, egg mass, albumen hieght, Haugh unit, fertility, hatchability, chicken weight and number of chickens per hen. Feeding broiler breeder digestible amino acids of feedstuffs significantly increased egg weight more than broiler breeders fed total amino acids of feeds density diets. Formulating broiler diets based on digestible amino

Table3. The interaction between diets formulation based on Metabolizable Energy and Amino Acids of Feeds on broiler breeder performance (50 to 64 weeks)

MEn	Amino acids (Feed)	Egg weight (g)	Egg mass (g)	Albumen Height (mm)	Haugh units	Fertility (%)	Hatchability (%)	Chicken weight (g)	No. (Chicks/hen)
Aparent	Total	66.79^{c}	33.74^{c}	7.03^{c}	80.74^{c}	62.59^{b}	58.84^{ab}	50.10^{ab}	28.2^{ab}
Aparent	Digestible	68.97^{a}	43.10^{a}	7.96^{a}	86.32^{a}	81.51^{a}	64.69^{a}	50.27^{a}	34.3^{a}
True	Total	67.53^{b}	37.41^{b}	7.18^{c}	81.03^{c}	51.06^{c}	46.36^{c}	45.4^{c}	23.0^{ab}
True	Digestible	66.51^{b}	31.99^{c}	7.89^{b}	85.82^{b}	63.34^{b}	53.04^{bc}	49.4^{b}	21.8^{b}
P value		0.000	0.00	0.02	0.02	0.001	0.02	0.05	0.02
SEM		0.31	1.10	0.26	1.66	2.90	2.19	1.14	2.85

^{abc}Means within the same column not sharing a common superscript differ significantly ($P<0.05$).

acids of feeds gives a better prediction of dietary protein quality and broiler breeder performance than total amino acids.

Feeding broiler breeder AMEn diets significantly increased fertility, hatchability and amount of chickens per hen.

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