Determination of the Nutritional Requirements of the Baladi Chickens: 1. Effect of Arginine Inclusion (in Excess of the Leghorn Requirement) on Performance of the Saudi Baladi Chickens

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Abstract:

Arginine is known to enhance the release of lutenizing hormone (LH) that is responsible for induction of ovulation in farm animals. Feeding arginine in excess of layers' requirement may enhance egg production in weak producers.

In an attempt to enhance the egg production of Baladi layers by feeding arginine in excess of leghorn requirements and to assess Baladi performance when arginine accompanied with high lysine level. Two experiments were conducted; one involved four levels of arginine and a control. In the second experiment, the same treatments were used, but Lysine level was raised by 0.5 % in the basal diet. Results of the investigation revealed; raising the arginine level to 1.5 % improved egg production (59.22 %) and feed conversion (4.88 kg/kg) compared to the other treatments. However, negative linear response was observed in feed intake and specific gravity of the eggs when arginine increased from 1 - 2.5 %, and from 0 – 2.0 %, respectively. Increasing level of lysine to 1.2 % in diet, improved egg production (67.86 %) and feed conversion (2.943 kg/kg) of the group fed 1.5 % arginine. No significant effect was found on egg components, except yolk weight, in the 2.5 % arginine fed groups.

It was concluded that arginine and lysine requirement of the Baladi chicken could be around 1.5 % and 1.2 % respectively.

Key Words : Arginine, lysine, performance, Saudi Baladi chickens

Introduction:

Production of Baladi chickens is far behind that of foreign breeds (Al-Aqil, 1998) . A considerable amount of work has been carried out to improve the production in this breed. Najib (1994) showed that average hen-day production for Baladi layers may increase up to 44 % when 18 % protein level was used in the ration, while using 16 % deteriorate the production to 37 %. Later, Al-Yousef and Najib (1997) demonstrated that as level of protein increased from 13 to 17 % in Baladi diet, hen-day egg production was increased from 41 % to 48 %. These data have clearly demonstrated that increasing protein level resulted in an increased rate of production which probably indicate that Baladi bird has the potentiality to improve it's production by manipulating protein intake and it's components, the amino acids.

Arginine, an essential amino acid for chicken, is known for it's role in the protein metabolism (Scott *et. al*., 1982) . Recently, Takahashi *et. al.* (1994) reported that arginine, as part of the hormone arginine vasotocin, (neurohypophysial hormone) plays an important role in the initial contraction of hen's uterus through an increased binding to it's receptor. The process of oviposion in hen involves the contraction of the uterus and the oviduct, sending the egg to the vagina and expelling the egg out through the cloaca (Sykes, 1953). It was also used intravenously in prepubrtal does and ewes to enhance the release of luteinizing hormone (LH), which is a pituitary hormone responsible for the induction of ovulation in farm Animals (Recabarren *et. al*., 1996 and Basiouni *et. al.,* 1999). If this true for large animals, then feeding arginine in excess of the requirement to layers hypothesized to enhance the release of folicle stimulating hormone (FSH) and luteinizing hormone (LH) which may stimulate egg production.

These studies were carried out to investigate the effect of increasing levels of arginine and lysine , beyond the NRC requirement of the leghorn layer on production parameters of Saudi Baladi layers.

Materials and Methods:

Two hundred Baladi day-old chicks were brought from a local source to grower house and kept under gas hoover for 4 weeks. During this period, temperature was maintained at 32 ˚C during the first week and lowered by

3˚C each following week. During the rest of the growing period, the temperature remained within the comfortable zone (24 – 27 ˚C). Lighting cycle was maintained for 9 hours daily using artificial lights, if necessary. These procedures were done according to North (1994). Debeaking procedure was done twice during these periods, at week 9 and 16. The birds were also vaccinated according to the vaccination program of this area. During the period from hatching to 5 % production , the pullets were fed commercial starter and grower diets. These diets are presented in table 1.

Table (1)
The chemical constituents of the starter and grower diets

Nutrients	starter	grower		pre-lay
	0 – 4 wk	5 – 11	12 - 17 wk	18 wk–5 % Production
Crude Protein, %	19	18	16	18
Metabolizable Energy (ME), Kcal/Kg	2900.0	2850.0	2800.0	2800.0
Ca, %	1.0	1.0	1.0	2.5
P (available), %	0.45	0.45	0.44	0.44

On week 19, 100 pullets were moved to cages in a house where cooling device was installed. In this house, the birds were fed the dietary treatments.

Four levels of arginine, 1, 1.5, 2 and 2.5 % of the diet and a control (0% added arginine) were used in experiment (1). The amounts of supplemented arginine were estimated to cover the differences between the level of arginine found in the basal diet (0.89 %) and the proposed levels of arginine (1, 1.5. 2 and 2.5 %). In the second experiment, the same treatments were used plus adding 0.5 % lysine to the basal diet (control) to bring up the level of lysine to 1.27 %.

Composition of the experimental diets is presented in table (2). The amino acids profile of the basal diet was as follows; aspartic acid, 1.39 % ;

therionine, 0.58 % ; serine, 0.68 % ; glutamic acid, 2.78 % ; glycine, 0.63%; alanine, 0.78 % ; valine, 0.68 % ; methionine, 0.28 ; isoleucine, 0.60 % ; leucine, 1.32 %; tyrosine, 0.50 % ; phenylalanine, 0.78 % ; histidine, 0.43 % ; lysine, 0.77 and arginine, 0.89 %.

Each of the treatments was replicated 5 times in experiment 1, and 3 times in experiment 2. Birds were distributed randomly among cages, each containing 4 pullets in both experiments.

Birds were weighed individually at the beginning of the experiment and then periodically on a bi-weekly basis. Each two weeks were considered as a period in experiment 1, and each week was considered as a period in experiment 2. Eggs were collected daily however, calculation of hen-day production was based on two weeks collection of eggs in experiment 1 and one week collection in experiment 2.

Egg weight, albumen height and specific gravity of the eggs were performed on three days collection at the end of each period. Feed was given ad-libitum to the birds as needed. Feed left was measured to determine feed intake. The duration of experiment 1 was 24 weeks while experiment 2 started after the termination of experiment 1 and lasted for 4 weeks.

Data were analyzed as pooled means of the periods. They were subjected to analysis of variance using the GLM procedure of SAS® (SAS institute, 1986). Differences among the means were detected using Duncan Multiple Range Test and the orthogonal comparison contrast as described in Steel and Toori (1980). The statistical model used was :

$$\mathbf{Y_{ij} = \mu + t_i + e_{ij}}$$

Where;

Y_{ij} is the measurement of j^{th} pen on the I^{th} treatment

μ is the overall mean

t_i is the effect of i^{th} treatment , i , 1,……5

e_{ij} is the random error associated with the i^{th} pen assumed normally distributed with zero mean and variance $\sigma^2 I$

Table(2)

Feed ingredients and composition of the experimental diets.

INGREDIENTS %	DIETARY TREATMENTS				
	0 % (CONTROL)	**1 %**	**1.5 %**	**2.0 %**	**2.5 %**
YELOW CORN	61.90	60.0	58.00	58.30	57.66
SBM, 44	26.31	26.20	26.20	26.70	26.80
WHEAT BRAN	1.0	2.5	3.5	2.00	2.00
LIMESTONE	8.38	8.34	8.33	8.42	8.30
MVMIX*	0.20	0.20	0.20	0.20	0.20
DICAL PHOS.	1.0	1.0	0.95	1.01	0.98
SALT	0.40	0.40	0.40	0.40	0.40
CORN OIL	0.80	1.3	1.85	1.84	2.03
ANTIOXIDANT	0.01	0.01	0.01	0.01	0.01
ADDED ARGININE	0.00	0.1	0.60	1.1	1.60
TOTAL	100	100	100	100	100
CALCULATED COMPOSITION					
PROTEIN, %	17.00	17.00	17.00	17.00	17.00
ME, Kcal/Kg	2750	2750	2750	2750	2750
CALICIUM, %	3.51	3.50	3.50	3.52	3.50
AVAILABLE PHOSPHORUS, %	0.30	0.30	0.30	0.30	0.30
RIBOFLAVIN, mg/kg	1.43	1.47	1.50	1.45	1.45
NIACIN, mg/kg	24.35	26.63	28.03	22.44	25.32
PANTOTHENIC ACID, mg/kg	7.00	7.36	7.10	7.22	7.21
CHOLINE, mg/kg	1131	1133	1134	1131	1130
METH+CYST., %	0.57	0.57	0.56	0.56	0.56
LYSINE, %	0.77	0.76	0.76	0.78	0.79
ARGININE, %	0.89	0.99	1.49	1.99	2.49
LINOLEIC A.,%	1.48	1.48	1.44	1.42	1.41

*Multivitamins and minerals premix provided the following per kilogram of diet: vit. A, 12000 IU; vit. D_3 , 6000 ICU; vit. E, 8 mg; choline chloride, 20 mg; vit. K, 1.6 mg; vit. B_6, 0.8 mg; niacin, 20 mg; pantothenic acid, 8 mg; folic acid, 0.8 mg; biotin, 0.08 mg; vit. C, 80 mg; ethoxyquin, 56 mg; Cu, 12 mg; I, 0.8 mg Fe, 40 mg; Mn, 80 mg Zn, 48 mg; Co, 0.04 mg; Se, 0.16 mg.

Results and Discussion:

Experiment 1.

The results of this study are presented in table 3. Data of this study provided evidence that inclusion of arginine in the Baladi layer diets in quantities exceeded that of the leghorn requirement (0.75 %) (NRC, 1994) had a significant effect on feed intake (P<0.001), hen-day egg production (P<0.001), feed conversion (P<0.001), egg weight (P<0.001), and specific gravity (P<0.01). Test of linearity has also shown a significant linear trend of feed intake and specific gravity (P<0.001 and P<0.01, respectively).

The treatment levels of arginine significantly (P<0.001) affected feeding pattern of the Baladi birds. It was clear that daily feed intake of the birds were linearly decreased proportional to the increasing levels of arginine from one to 2.5 % (Table 3). There is no doubt that this effect was due to the treatments. The biggest drop in feed intake was in birds fed arginine exceeding 1.5 % (Table 3) which probably indicates that higher levels of Arginine may impair the palatability of the feed. This change in feed pattern was reflected on the performance of the birds, under these treatments (2.0 % and 2.5 %).

Level of arginine had a significant effect on egg production. Although, the response of egg production to the treatment levels was inharmonious and somehow inexplicable such in case of 1 % arginine level, there seems to be a trend that increasing level of arginine beyond 1.5 % would deteriorate the production rate of the bird. The best production rate was found in birds, fed 1.5 % arginine. However, that was not statistically different from that of the control. This result is surprising since feed intake of the bird fed 1.5 % arginine was not the highest. It is conceivable however, that level of arginine might have made the difference. There is very limited findings to support or contradict this result.

The lowest production rate was found in birds, fed 2 % arginine. No doubt this was due to the lowest feed intake the birds experienced under this treatment which could be due to palatability. The loss of linearity (P>0.05) in egg production response could be due to the inconsistency of the response.

Feed conversion was slightly improved in the birds fed 2 % arginine (4.649 kg/kg) and that did not statistically differ from those fed, 1.5 %

(4.855 kg/kg). High production rate (55.76 %) , lower feed intake (102.3 g/h/d) and larger egg size (41.99 gm) were the reasons for the improvement of feed conversion in birds fed 2 % arginine while the significantly higher production rate (59.22 %) was solely the reason for the improvement of feed conversion in birds fed 1.5 % arginine. Calculation of feed conversion is dependent on number of eggs produced during certain period of time, feed intake during the same period and average egg weight (North, 1984).

Response of egg weight to the treatment levels was highly significant ($P<0.001$) (Table 3). Furthermore there was an insignificant linear trend in the response of egg weight to the treatments ($P>0.05$) (Table 3). The largest egg weight was found in birds fed 2 % arginine and that was significantly different from all other treatments including the control. However, in general, egg weight of the birds under investigation was smaller than their counterpart the white leghorn. These birds had never been in any genetic improvement program. Unpublished data from this institute on three generations of Baladi birds during the years from 1991 to 1995 showed that average egg production was ranged from 37 to 52 % and egg weight from 43 to 45 gm.

Livability estimate of the birds fed different levels of arginine showed a close figures in all treatments (Table 3) which indicate that level of arginine had no effect on the survival rate of the birds.

Specific gravity of the eggs was highly affected by the treatment level ($P<0.01$) also showing strong linearity ($P<0.01$) in response to the treatments. It is obvious that with exception of 2.5 % level which probably caused the quadratic effect ($P<0.01$), there was a decline in specific gravity values as levels of arginine increased from 0 to 2 % (Table 3). These values, even, with the lowest specific gravity (1.091) are still better than most values seen in eggs of their counterpart, the White Leghorn, fed untreated diet (Najib *et al*., 1994 and Najib, 1994). Therefore, this result would not impose any problem to the Baladi birds since their higher specific gravity could be attributed to the genetically small eggs they produce. It was hypothesized that the hen is capable of generating a uniform daily quantity of egg shell materials throughout her life and as egg get progressively large, the shell material must be spread over a large area, and thus become thinner.

The effect of treatments on Haugh unit was not showing any sign of significance, neither was any linearity or quadratic response (table 3). Height of Albumen of the Baladi eggs was comparable to those reported with other batches of Baladi birds raised here in this institute. However, these figures were much lower than those given by the white leghorn (Unpublished Data).

Table (3)

Effect of adding excess arginine in the Baladi layer's diet[1]

Source of Variation	GBD	HD	FC	EW	LIV	SPG	HU
TRT Level, %[2]	**	**	**	**	NS	*	NS
0	112.2[a]	56.97[a]	5.118[b]	40.75[b]	99.63[a]	1.094[a]	88.89[a]
1	112.3[a]	51.70[b]	5.652[a]	40.66[b]	99.48[a]	1.093[ab]	88.53[a]
1.5	110.2[a]	59.22[a]	4.855[bc]	40.55[b]	99.51[a]	1.092[bc]	88.66[a]
2	102.3[b]	55.76[ab]	4.649[c]	41.99[a]	99.74[a]	1.091[c]	89.01[a]
2.5	101.4[b]	51.65[b]	5.299[ab]	39.62[b]	100.0[a]	1.092[bc]	88.90[a]
P	0.0001	0.0005	0.0001	0.0006	0.572	0.0017	0.8853
± SEM	0.910	0.680	0.070	0.175	0.110	0.0002	0.164
Linear	0.0006	0.5034	0.3704	0.0535	0.3244	0.0041	0.8908
Quad.	0.8075	0.3458	0.0725	0.0020	0.3887	0.0074	0.7802

[1]Means within columns having different superscripts, are significantly different, $P<0.05$

[2] Level of arginine in the diets; TRT, treatment; GBD, gram/bird/day feed intake; HD, % hen-day production; FC, kg/feed/kg eggs, feed conversion; EW, gram egg weight; LIV, % livability; SPG, specific gravity of the eggs; HU, haugh unit.

Experiment 2:

Due to the fact that amino acid antagonism is existed between arginine and lysine as reported by D'Mello and Lewii (1970), therefore, a short term experiment was conducted to determine if adding lysine in extra amount above that already in the ration would further improve the production of the Baladi birds. 1.27 % lysine in the diet was fed to the birds at 45 weeks of age. The result of this experiment is presented in table 4.

It is obvious that addition of lysine to the diet already fortified with extra arginine has numerically (not significantly) improved the production rate in all the treatments, except the 2.5 % arginine treatment which was already at the bottom line in experiment 1 as shown in table 3. The highest increase (67.86 %) was observed in birds fed 1.5 % arginine as those were also the best producers under the same treatment in Experiment 1 (table 3). This higher production rate in experiment 2 was partially the reason for better egg mass and feed conversion in birds fed 1.5 % arginine.

Egg production of the control birds reflected the normal production rate of Baladi birds at this age (unpublished data).

The lack of the significance among the means of the production parameters (HD, EW, EM, FC and FI), in spite of the clear numerical differences, could be due to the smaller error degrees of freedom (15) which were occurred as a result of smaller number of observation (20), since the experiment lasted only 4 weeks.

The response of hen-day production to the treatments showed a weak linearity but a strong quadratic effect.

Egg components were also determined in this study. No clear response to the treatments was exhibited, except for few points, worth mentioning.

Yolk index, which is the function of yolk height and diameter, was the highest in birds fed 2 % and the lowest was in birds fed 1.5 %. The result in case of 1.5 % arginine level can be explained by the smallest yolk weight, they laid (table 4). Birds normally produce eggs in chains. The first yolk in a long chain is the largest and as chicken progress in lay, the yolk gets smaller toward the end of the chain (North, 1984). These birds also had the highest production rate, which mean longer chains. The cause for larger yolk index in 2 % arginine treatment level is not clear and open for speculation.

As mentioned earlier, level of lysine added to the diet was 0.5 %. This level may or may not be the optimum level to be used with higher arginine diet since it was only one level. This area needs further investigation using different levels of arginine and different levels of lysine for the Baladi birds.

Table (4)

Effect of incorporating Arginine levels on Baladi layers, fed extra amount of Lysine (0.5 %) on performance and egg production[1]

SOURCE OF VARIATION	HD	EW	EM	FC	FI	SHWT	ALWT	YOWT	YOIN
TRT LEVELS, %[2]	NS	NS	NS	NS	NS	NS	NS	**	NS
0	48.21[a]	44.83[a]	21.38[a]	4.762[a]	89.7[a]	6.04[a]	23.22[a]	14.46[a]	76.30[ab]
1	55.36[a]	45.17[a]	24.94[a]	3.862[a]	94.1[a]	5.95[a]	23.49[a]	15.05[bc]	79.98[ab]
1.5	67.86[a]	43.58[a]	29.61[a]	2.943[a]	86.2[a]	5.91[a]	22.16[a]	14.95[bc]	74.46[b]
2	64.29[a]	44.16[a]	28.51[a]	3.630[a]	101.6[a]	6.28[a]	23.08[a]	15.56[ab]	81.70[a]
2.5	44.64[a]	44.86[a]	20.24[a]	8.360[a]	85.9[a]	6.31[a]	23.40[a]	15.88[c]	76.55[ab]
P	0.2679	0.6428	0.3403	0.4459	0.6046	0.1214	0.1557	0.0001	0.1319
± SEM	3.888	0.346	1.720	0.964	3.392	0.306	0.193	0.103	1.036
LINEAR	0.8412	0.5516	0.8434	0.3725	0.5401	0.3044	0.4921	0.0002	0.5056
QUADRATIC	0.0507	0.4549	0.0621	0.1523	0.2882	0.6072	0.3832	0.5876	0.1637

[1]Means within columns having different superscripts, are significantly different, P<0.05
[2]Percent level of arginine in the diets
TRT, treatment; HD, % hen-day production; EW, gram egg weight ; EM, Egg mass, gm; FC, kg/feed/kg eggs, feed conversion; FI, gram/bird/day feed intake; SHWT, Shell weight; ALWT, Albumen weight; YOWT, Yolk weight; YOIN, Yolk index. Yolk index = yolk height / yolk diameter X 100

Conclusion:

There was a clear evidence that incorporating Arginine in excess of the leghorn requirement to the Baladi birds enhance egg production parameters. However, when lysine was added in amount higher than the leghorn needs, the result were even better. Therefore, It is suggested that Arginine and Lysine requirement of the Baladi chickens could be around 1.5 % and 1.2 %, respectively. It is also suggested that further physiological studies are needed to investigate the relationship, if any, between Arginine inclusion, egg production and lueitnizing hormone (LH) level. Further study is also, needed to determine the best combination levels between arginine and lysine for Baladi layers.

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تقدير إحتياجات الدجاج البلدي الغذائية:
١. تأثير إضافة كميات (تزيد عن إحتياجات دجاج الليجهورن) من الأرجنين على أداء الدجاج البلدي السعودي

هذيل نجيب و غازي بسيوني

قسم علوم الإنتاج الحيواني - كلية العلوم الزراعية والأغذية

جامعة الملك فيصل - الأحساء

المملكة العربية السعودية

الملخص:

عرف الأرجنين المحفز للتبويض في حيوانات المزرعة بدوره في تحفيز إفراز هرمون الإباضة في الماعز والأغنام. لذا فإن تغذية الطيور القليلة الإنتاج بعليقة تحتوي على كمية من الأرجنين اكبر مما هو مستخدم في عليقة دجاج الليجهورن قد يحفز إنتاج البيض في هذه الطيور.

هدفت هذه الدراسة الى محاولة تحسين انتاج البيض في الدجاج البلدي وذلك بتغذيتها على عليقة تحتوي على الأرجنين بمعدلات اكبر من تلك المستخدمة في عليقة الليجهورن كما هدفت الى دراسة تأثير هذه المعدلات مع زيادة نسبة اللايسين على اداء الدجاج البلدي.

وقد تم تنفيذ دراستين ، الأولى شملت ٤ مستويات من الأرجنين و عليقة مقارنة (دون إضافة أرجنين) وفي الدراسة الثانية تم استخدام نفس المعاملات مع رفع نسبة اللايسين بمقدار ٠,٥ ٪ في عليقة الأساس ليصبح ١,٢ ٪.

وقد أظهرت النتائج أن رفع نسبة الأرجنين الى ١,٥ ٪ في عليقة الدجاج البلدي حسّن من معدل الإنتاج (٥٩,٢٢ ٪) ومعدل التحويل الغذائي (٤,٨٦ كجم/كجم) لكنّ تأثيرا عكسيا وبشكل خط مستقيم على إستهلاك العلف والوزن النوعي للبيضة ظهر عند زيادة كمية الأرجنين تدريجيا من ١ – ٢,٥ ٪ ومن ٠ – ٢,٠ ٪ على التوالي.

إن رفع نسبة اللايسين في العليقة الى ١,٢ ٪ قد صاحبه زيادة في معدل الإنتاج (٦٧,٨٦ ٪) وفي معدل التحويل الغذائي (٢,٩٤ كجم/كجم) ولم يكن لهذه الزيادة أي تأثير معنوي على مكونات البيضة فيما عدا وزن الصفار في مجموعة ٢,٥ ٪ أرجنين.

وقد خلصت هذه الدراسة الى ان إحتياج الدجاج البلدي من الحامض الأميني الأرجنين واللايسين يمكن أن تكون في حدود ١,٥ ٪ و ١,٢ ٪ على التوالي.