SUPPLEMENTARY MATERIAL AVAILABLE ONLINE

Indian Journal of Animal Sciences **93** (6): 598–601, June 2023/Article
DOI: https://doi.org/10.56093/ijans.v93i6.131971

Effect of low crude protein breeder diets with balanced limiting amino acids on progeny chick quality and juvenile growth performance in Swarnadhara birds

BEENA C JOSEPH[1]✉, JAYANAIK[2], BINOJ CHACKO[3] and SUJA C S[3]

Veterinary College, Hebbal, Bengaluru, Karnataka 560 024 India

Received: 3 January 2023; Accepted: 25 April 2023

ABSTRACT

A study was carried out to evaluate the effects of low crude protein diets supplemented with limiting amino acids on progeny chick quality and growth performance utilizing Swarnadhara laying hens. The feeding trial was done in 240 Swarnadhara layers from 29 to 40 weeks in a completely randomized design in five treatment groups with six replications of eight birds. The first treatment consisted of control diet (T1) based on corn soybean meal formulated at 16% CP and 2700 kcal ME meeting the ICAR (2013) requirements for CP and ME and also for the first four limiting amino acids at the following concentrations: methionine 0.35%, lysine 0.75%, threonine 0.52%, and tryptophan 0.16%. The other treatment diets (T2 to T5) were made isocaloric with control while reducing CP content to 15.5, 15, 14.5, and 14%, respectively, incorporating synthetic amino acids in sufficient quantities to match control amino acid levels. Chick quality was evaluated by grading chicks for appearance, activity and down conditions replicate-wise and individual chick hatch weights were recorded in 5 different breeder diet groups. The chicks in all the replicates were fed with the same basal diet containing 21% CP and 2800 kcal/kg ME as per ICAR (2013) requirements during first six weeks of age. The data on chick quality, body weight, feed consumption and feed efficiency showed no significant difference. Hence it can be concluded that the crude protein content of the Swarnadhara breeder diet could be reduced to 14% with essential amino acid supplementation without affecting the progeny performance.

Keywords: Breeder diet, Chick quality, Dietary crude protein, Limiting amino acids, Progeny performance

Energy and protein in hens' diet play important roles in optimum egg production, as well as the quality and performance of their offspring. The nutrients deposited in the egg are entirely what the growing embryo and the newly emerged chick need to grow and develop. Consequently, the nutrition of the breeder hen has a significant impact on the physiological health of the chick at hatching, which will affect the chick's size, vigour and immune status. When compared to the total cost of feed consumed by the broiler breeder until it is culled, the effect of changing the nutrients in the maternal diet on the expenses of producing broilers is only approximately 7%. Recently, there has been growing interest in manipulating maternal dietary nutrition to improve broiler quality and carcass composition. However, researches are scanty regarding supplementing amino acids in low CP diets in native Indian breeds. Swarnadhara is a backyard poultry strain developed and released by Veterinary College, Karnataka Veterinary, Animal and Fisheries Science University, Bengaluru. In a study by Joseph *et al.* (2017), the reproductive parameters and the number of saleable chicks in Swarnadhara breeders remained unaffected by reducing the CP level up to 2%. Another study revealed that the egg production efficiency and egg characteristics of Swarnadhara birds were insignificant in low CP amino acid supplemented diets though a tendency to decline the egg production potential beyond 1% CP reduction was observed (Joseph *et al.* 2022). The current study evaluated the effects of feeding reduced CP breeder diets with supplemental limiting amino acids on progeny chick quality and chick juvenile growth performance up to six weeks of age.

Present address: [1]College of Veterinary and Animal Sciences, Pookode, Wayanad, Kerala. [2]Veterinary College, Hebbal, Bengaluru, Karnataka. [3]College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala. ✉Corresponding author email: beenajoseph@kvasu.ac.in

MATERIALS AND METHODS

The experiment was conducted in the Department of Poultry Science, Veterinary College, Bengaluru, an Indian city having moderate climate exhibiting semi-arid characteristics. A total of 240 Swarnadhara layers of 20 weeks of age were weighed and distributed in a completely randomized design into five treatments with six replications of eight birds. The experimental period was from 28 to 40 weeks, divided into three cycles of 28 days each. The light schedule was increased from the start of the laying period peaking at 17 hours.

Diet formulation: The experimental diet was formulated to meet the nutritional requirements recommended by

Table 1. Nutrient composition of layer trial diets

Nutrient (%)	Treatment				
	T1	T2	T3	T4	T5
CP	15.998	15.525	15.056	14.999	14.034
ME	2712	2711	2709	2704	2699
Ca	3.611	3.607	3.604	3.599	3.596
P ava	0.466	0.467	0.468	0.470	0.471
P total	0.589	0.595	0.602	0.612	0.621
Fat	2.839	2.839	2.837	2.828	2.820
Crude fiber	3.006	3.137	3.277	3.475	3.640

ICAR (2013) for improved desi crosses developed in India. The amino acid composition of the feed ingredients were tested and the data is given in Supplementary Table 1. The first treatment consisted of control diet (T1) based on corn soybean meal formulated at 16% CP and 2700 kcal ME meeting ICAR 2013 requirements for the first four limiting amino acids at the following concentrations: methionine 0.35%, lysine 0.75%, threonine 0.52%, tryptophan 0.16%. The other treatment diets (T2 to T5) were made isocaloric with control while reducing CP content to 15.5, 15, 14.5, and 14%, respectively, incorporating synthetic amino acids in sufficient quantities to match control amino acid levels. The analyzed nutritional composition of the layer feed is given in Table 1 and the feed ingredient composition of the layer feed is given in Supplementary Table 2.

The study period in the breeder flock was from 29th to the 40th week of age. The eggs were collected for ten days in the last cycle of 28 days, each weighed, graded and set in an incubator. Candling was done on the seventh and 18th day, and the eggs were transferred into a hatcher on the 18th day. The chicks were pulled out on the 22nd day and counted dead in shells, pipped, and weaklings were separated from five treatment groups. Individual chick hatch weights were recorded replicate-wise from five different treatment groups. Chicks were assessed for quality by grading for appearance, activity and down conditions replicate-wise and recorded as per Tona score (Tona *et al*. 2003). Four hatches were taken similarly to assess the various chick quality parameters. All the chicks in the final hatch from different groups (T1 to T5) were fed the same basal diet containing 21% CP and 2800 kcal/Kg ME as per ICAR (2013) requirements during first to sixth week of age in order to assess the growth performance. Chicks were reared in the deep litter system under standard management practices. Cumulative body weight was recorded at the end of every week and the end of the trial. Average weekly feed consumption for each replicate group was calculated by subtracting the residual feed from the total feed provided at the end of each week, and overall cumulative feed consumption was calculated at the end of the experimental period. The feed conversion ratio, expressed as the amount of feed consumed to weekly weight gain for each dietary group of birds, was calculated for each week and cumulative for the entire experimental period (0-42 days).

Statistical analysis: General linear model ANOVA in a completely randomized design was used to analyze the data following the methods described by Snedecor and Cochran (1989). Significance was set at $P<0.05$ in all cases.

RESULTS AND DISCUSSION

In the present trial, chicks were graded according to Tona Score described in the materials and methods. The Tona score obtained in chick quality parameters like activity, retracted yolk, eyes, legs and remaining yolk, down appearance, condition of navel region and presence of membranes were different in chicks, and they were graded accordingly, and the percentage of chicks with maximum score in these parameters was calculated and data is presented in the Table 2 and 3.

There were chicks with inferior down appearance, inferior navel region and remaining membranes in every treatment group (T1-T5). However, in grading other parameters, the number of chicks with abnormality was significantly less. In each treatment, number of chicks having a maximum score in these qualities were counted based on Tona score. The chicks having a maximum score in all the criteria were given a total score of 100. The percentage of chicks having total score of 100 were calculated and analysed. The results revealed no significant difference in the number of chicks with maximum score in down appearance and quality of navel region, and the number of chicks without any remaining membranes among various groups. Hence the number of chicks with a maximum score of 100 did not vary significantly among treatments. However, the lowest CP-reduced group (T5) produced a smaller number of chicks with a maximum score of 100. It is evident from the results that there were more chicks with remaining membranes in the T5 group, resulting in fewer quality chicks. Duration of egg storage, incubation factors and age of the breeders are other factors apart from egg weight that affect the chick's total quality. According to Sreenivasayya (2006), the membranes are caused by high incubation temperatures, which leads to

Table 2. Effect of reduced CP breeder diet balanced with LAA on Swarnadhara progeny chick quality parameters

Treatment	Maternal CP (%)	% of chicks which are fully active having score 6	% of chicks with Down having score 10	% of chicks with perfect retracted yolk of score 12	% of chicks with bright eyes of score 16
T_1	16	100±0.0	99.12±0.88	99.31±1.70	100±0.0
T_2	15.5	98.28±1.09	96.93±1.57	100±0.0	99.36±1.57
T_3	15	96.88±3.13	99.12±0.88	100±0.0	100±0.0
T_4	14.5	100±0.0	96.76±2.12	100±0.0	100±0.0
T_5	14	100±0.0	95.70±2.72	100±0.0	100±0.0

Table 3. Effect of reduced CP breeder diet balanced with LAA on Swarnadhara progeny chick quality parameters

Treatment	T1	T2	T3	T4	T5
Maternal CP %	16	15.5	15	14.5	14
% of chicks with normal healthy legs of score 16	99.36±1.57	99.07±2.27	100±0.0	99.21±1.94	100±0.0
% of chicks with Navel region having score 12	97.69±1.51	99.24±0.76	97.92±2.08	97.44±2.56	98.64±0.86
% of chicks with fully absorbed yolk of score 16	100±0.0	98.41±1.59	100±0.0	99.21±1.94	100±0.0
% of chicks without Remaining membranes with score 12	92.77±2.41	95.15±1.87	95.99±1.34	94.86±1.93	88.72±3.35
% of chicks with total score 100	89.58±1.78	91.32±1.88	91.98±1.95	89.31±2.4	86.16±5.47

premature hatching and closing of skin around the navel before the extra-embryonic membranes are drawn into the body cavity. However, in the present trial, all these factors remained identical, and only diet differed. The reason for the higher incidence of remaining membranes in T5 cannot be specifically explained.

The effect of weekly body weight, feed consumption and feed conversion ratio as influenced by a reduced CP breeder diet balanced with LAA is presented in Table 4. The day-old body weight of progeny chicks recorded in the T2 group was the highest but was not significantly different from other groups, justifying the benefits of LAA supplementation in LCP diets in the maternal flock. Several studies reported a strong positive relationship between egg weight and chick size (Pinchasov 1991). According to the findings of Proudfoot and Hulan (1981), chick weight constitutes usually 62-76% of egg weight. Variation in chick weight at hatch is mostly attributed by differences in fresh egg weight, incubation weight loss and shell weight, and breeder age (Lopez and Leeson 1994). The current results agree with the above authors regarding chick weight because the egg weight recorded in the T2 group was higher compared to other groups though non-significant. Since there is no significant difference in chick weight even in the 2 % CP reduced group, it is evident that the content of LAA in the CP-reduced maternal diets was adequate to produce chicks of the same body weight as the control.

On physical examination on the seventh day, the fluff condition and the navel region were normal among all the treatment groups. Also, no remaining membranes could be detected in any of the groups. According to Tona *et al.* (2003), the most significant factor was the navel area which deteriorate chick quality and the condition of navel area was closely associated with appearance, membranes, retracted yolk and relative growth up to seven days. Tona *et al.* (2005) observed that qualitative aspects of day-old chicks are vital in judging the quality but some parameters may be more critical as well as influential in evaluating the growth potential of the chick to seven days of age. These factors invariably affect the subsequent broiler performances at slaughter age. In the current study, the body weight recorded in T5 on the seventh day was the lowest among the groups supporting the above findings. Previous studies have proved that day-old weight of broiler chicks was not correlated to the broiler weight at slaughter age but had correlation with seven day old weight. Hence the seven day old body weight can be considered as an indicator for predicting growth performance and also for confirming day-old chick quality (Deeming 1995).

The cumulative body weight at 42 days did not show any significant difference in the current trial. Many earlier literature reviews have shown that chick hatch weight affected subsequent broiler growth while Pinchasov (1991) proved that any residual effect of chick weight disappeared quickly. Kidd (2003) observed that low maternal dietary protein concentrations did not affect progeny performance at slaughter which is strongly supported in this trial. He concluded that even though deficient protein diets reduced egg and chick weights, there was no significant effect on the final body weight of broiler breeders at 30 weeks. However, in the current trial, the chick weight of all the CP-reduced groups (T2-T5) was comparable with control (T1), justifying a sufficient concentration of nutrients, including amino acids in the CP-reduced maternal diets to support comparable tissue protein accretion in the progenies. Further, all dietary treatment groups (T1-T5) were found

Table 4. Hatching egg weight, chick body weight, feed consumption and feed conversion ratio as influenced by reduced CP breeder diet balanced with LAA in progeny chicks

Parameter	T1 (Maternal CP-16%)	T2 (Maternal CP-15.5%)	T3 (Maternal CP-15%)	T4 (Maternal CP-14.5%)	T5 (Maternal CP-14%)
40th week EW(g)	62.58±0.94	63.73±0.84	61.97± 0.72	62.79±0.97	61.52±0.72
BW 0 day (g)	42.59±0.39	43.33±0.43	42.39±0.40	42.60±0.40	42.50±0.38
BW 7 days (g)	104.84±1.58^{ab}	107.01±1.45^{ab}	104.71±1.34^{ab}	108.77±1.29^{b}	101.89±1.44^{a}
BW 21 days g	343.74±7.28	361.61±6.37	360.67±4.57	350.04±5.25	351.58±6.37
FC 21 days (g)	620.37±10.13	619.97±16.22	633.93±7.56	630.96±9.87	628.65±10.97
FCR 21 days	1.80±0.03	1.71±0.06	1.76±0.03	1.80±0.05	1.79±0.03
BW 42 days (g)	826.49±16.48	852.90±14.17	852.89±12.16	826.29±12.08	825.35±14.18
FC 42 days (g)	2101.9±10.92	2134.4±50.79	2120.7±7.75	2110.3±12.42	2089.1±16.8
FCR 42 days	2.55±0.1	2.5±0.03	2.49±0.08	2.56±0.08	2.53±0.03

to be statistically similar in cumulative feed consumption, proving that reduction of CP in the maternal diet did not affect feed consumption characteristics of Swarnadhara offspring. This is in agreement with findings in the study conducted in indigenous layers by Kingori *et al.* (2010). The mean value of the feed conversion ratio as influenced by supplementation of LAA by reducing levels of dietary crude protein in Swarnadhara breeder diets on progeny chicks from day one to six weeks of age on a weekly cumulative basis was found to be non-significant among various groups with a range of 2.49-2.56. Current results are in agreement with findings by Kingori *et al.* (2010) in indigenous layers. Studies are insufficient to determine the effect of maternal dietary protein and amino acid intake on the resulting offspring growth and production performance. However, in the current trial, the reduced CP breeder diets were formulated with a constant ratio of LAA and hence, progeny FCR was not affected by the treatment, which is in agreement with the previous study by Lopez and Leeson (1995). Regarding chick mortality, Lopez and Leeson (1994), observed inconsistent results on chicken mortality with relation to egg size. In contrast, Enting *et al.* (2007) observed that low-density broiler breeder diets could reduce mortality in the progeny. However, the effect of reducing the dietary crude protein levels with LAA supplementation in the breeder diet on the overall survivability percentage of progeny chicks during 42 days of the experimental period was non-significant among various treatment groups in the current study.

Improving broiler performance and health responses through maternal feed manipulation is a new concept being explored as it can have an economic impact on the overall cost of broiler production. Apart from this, these diets reduce environmental pollution, benefiting the farm's flock and labourers. The current trial evaluated whether the progenies of breeders fed reduced crude protein balanced with limiting amino acids can perform equally with progenies of regular crude protein diets, and the observations on chick quality and growth parameters of progenies have proved that low crude protein maternal diets have not impaired progeny performance. This trial also supports the findings of many previous studies that the subsequent growth of chicks after hatch may not be affected significantly since the residual effect does not persist for long. So, crude protein reduction is also recommended in the breeder diet since it does not affect progeny performance.

ACKNOWLEDGEMENTS

This study was supported by the Department of Poultry Science, Veterinary College, KVAFSU, Hebbal, Bengaluru, India. The supply of experimental birds and other necessary infrastructure from this institution is gratefully acknowledged. The author is also grateful to Kerala Veterinary and Animal Sciences University for providing support and assistance to carry out the Ph D research program.

REFERENCES

Deeming D C. 1995. What is chick quality? *World's Poultry Science Journal* **11**(2): 20–23.

Enting H, Boersma W J A, Cornelissen B W J, Van Winden S C L, Verstegen M W A and Van Der P J. 2007. The effect of low-density broiler breeder diets on performance and immune status of their offspring. *Poultry Science* **86**: 282–90.

ICAR 2013. *Nutrient Requirements of Poultry*. (Third Ed.). pp 52. Indian Council of Agricultural Research, New Delhi.

Joseph B C, Jayanaik and Nagaraja C S. 2017. Effect of reduced dietary crude protein with balanced limiting amino acids on egg weight and reproductive performance of Swarnadhara layers. *Indian Journal of Veterinary Sciences and Biotechnology* **12**(4): 70–73.

Joseph B C, Jayanaik, Chacko B and Suja C S. 2022. Effect of low protein diets balanced with limiting amino acids on production efficiency and egg characteristics in Swarnadhara layers. *International Journal of Livestock Research* **12**(5): 9–14.

Kidd M T. 2003. A treatise on chicken dam nutrition that impacts on progeny. *World's Poultry Science Journal* **59**(4): 475–94.

Kingori A M, Tuitoek J K, Muiruri H K and Wachira A M. 2010. Effect of dietary crude protein levels on egg production, hatchability and post-hatch offspring performance of indigenous chickens. *International Journal of Poultry Science* **9**(4): 324–29.

Lopez G and Leeson S. 1994. Egg weight and offspring performance of older broiler breeders fed low protein diets. *Journal of Applied Poultry Research* **3**: 164–70.

Lopez G and Leeson S. 1995. Response of broiler breeders to low-protein diets 2. Offspring performance. *Poultry Science* **74**: 696–701.

Pinchasov Y. 1991. Relation between the weight of hatching egg and subsequent early performance of broiler chicks. *British Poultry Science* **32**: 109–15.

Proudfoot F G and Hulan H W. 1981. The influence of hatching egg size on the subsequent performance of broiler chickens. *Poultry Science* **60**: 2167–70.

Snedecor G W and Cochran W G. 1989. *Statistical Methods.* Pp. 71-82. (Ninth Ed.). Iowa State University Press, Ames, Iowa.

Sreenivasayya P V. 2006. *Incubation and Hatching*. Pp. 364-428. Scientific Poultry production. (Third Ed.). International Book Distributing Co., Lucknow, U.P.

Tona K, Bamelis F, De Ketelaere B, Bruggeman V, Moraes V M B, Buyse J, Onagbesan O and Decuypere E. 2003. Effects of egg storage time on spread of hatch, chick quality and chick juvenile growth. *Poultry Science* **82**: 736–41.

Tona K, Onagbesan O, Ketelaere D B, Bruggeman V and Decuypere E. 2005. Interrelationships between chick quality parameters and the effect of individual parameter on broiler relative growth to 7 days of age. *Archiv für Geflügelkunde* **69**(2): 67–72.