Indian J. Anim. Nutr. 2022. 39 (3): 325-331
doi: 10.5958/2231-6744.2022.00039.1

Indian Journal of
Animal Nutrition

Comparative Feeding Value of Quality Protein Maize and Normal Maize in Broiler Chicken

A.V. Elangovan*, S. Anandan, K. Giridhar, S.B.N. Rao, V.B. Awachat, S. Parthipan, M. Nalina, M. Bagath and R. Bhatta
ICAR - National Institute of Animal Nutrition and Physiology, Bangalore - 560030, India.
*Correspondence: avelango@gmail.com

ABSTRACT

The present study was conducted to compare the performance of broiler chicken fed quality protein maize (QPM) and normal maize (NM). A feeding trial of five weeks duration was undertaken in a completely randomized design with three dietary treatments, normal maize diet, 100% QPM diet replacing maize completely and 50% QPM diet replacing 50% of normal maize. Two hundred and seventy day-old chicks were divided into three dietary regimes with six replicates having 15 chicks in each replicate. The present QPM variety, HQPM-1, had higher levels of lysine, arginine and tryptophan but lower leucine than NM. There was no significant difference (P>0.05) in body weight gain with QPM supplementation during the experimental period. The feed intake was similar (P>0.05) during 0-3wk of age. Better (P<0.001) FCR was observed in both the QPM diets during 0-3wk of age. However, during 4-5wk and overall phase, lower (P<0.001) feed intake and better (P<0.001) FCR was observed in 100% QPM diet. No significant difference (P>0.05) was observed in development of duodenum, jejunum, ileum and caecum. It could be concluded that feeding of quality protein maize (on amino acid adjustment) resulted in similar body weight gain like that of normal maize but with a better efficiency in broiler chicken. Quality protein maize with a higher lysine content will reduce the need for supplemental lysine in the broiler diet.

KEYWORDS: Broiler chicken, Gut development, feed efficiency, Quality protein maize,

Article received: 17 August 2022; Article accepted: 21 September 2022

INTRODUCTION

Maize and soybean meal are the major energy and protein sources used conventionally in most commercial poultry feeds. The maize is preferred in poultry rations because of its high energy, available carbohydrates and pigment contents and absence of anti-nutritional factors. Maize contributes about 25-30% of dietary protein in broiler diets and has lower protein value for poultry, as methionine and lysine are the major limiting amino acid in maize-soybean meal-based diets. On lower protein diets in broiler chicken, threonine and tryptophan are the next limiting amino acid. Therefore, while formulating the diets, these amino acids need to be supplemented in synthetic form to meet the requirement. Scientific advancement in plant breeding facilitated the bio-fortification of amino acids, vitamins and much other nutritive substance in maize, which can reduce and/or replace the use of synthetic nutrient supplements (Goredema-Matongera et al., 2021). Breeding for improved protein quality in maize began in the mid-1960s with the discovery of mutants, such as opaque-2 (Mertz et al., 1964; Maqbool et al., 2021) and floury-2 (Nelson et al., 1965; Maqbool et al., 2021), that produce enhanced levels of lysine and tryptophan, the two amino acids deficient in maize endosperm proteins. However, adverse pleiotropic effects imposed severe constraints on successful exploitation of these mutants. However, further research efforts led to the present quality protein maize (QPM) variety that holds superior nutritional and biological value and is essentially interchangeable with normal maize (NM) in cultivation and kernel phenotype (Prasanna et al., 2001). Only limited information is available with respect to the utilization of QPM in the diet of broiler and layer chicken (Osei et al., 1998; Tyagi et al., 2008; 2010; Onimisi et al., 2009; Panda et al., 2010; 2011; 2012a,b,c; Mushipe et al., 2017). Also effect of combined diet, QPM with cottonseed meal and QPM with guar meal were studied for nutrient utilization and body weight gain in broiler chicken (Rajasekhar et al., 2020). The present experiment was conducted to study the effect of QPM variety, HQPM 1, in replacing normal maize on the performance and gut development of broiler chicken. HQPM 1 is a single cross QPM hybrid registered in the year 2010 for cultivation across India with an average grain yield of 62 q/ha. It is a yellow grain type hybrid.

MATERIALS AND METHOD

Experimental design, birds and housing

The animal trial was approved by the Ethical committee of ICAR-National Institute of Animal Nutrition and Physiology, Bangalore, India. A feeding trial of five weeks duration was undertaken in a completely randomized design with three dietary treatments, normal maize diet (T1), 100% QPM diet (T2, replacing normal maize completely) and 50% QPM diet (T3, replacing 50% of normal maize). Two hundred and seventy day-old chicks were divided into three dietary regimes with six replicates having 15 chicks in each replicate. The experimental birds were housed group wise randomly in deep litter compartment, fitted with heating arrangement through electric bulbs and separate feeders and waterers. The house was well ventilated, open sided one with 24 hours lighting and uniform management. The temperature inside the compartment was maintained at 33ºC on day 1 and gradually reduced to around 24ºC by third week. They were vaccinated against Ranikhet and Infectious bronchitis on day 1 and Infectious Bursal disease on day 13.

Experimental diets

The dietary treatments consisted of a control normal maize diet (T1), 100% QPM diet (T2) and 50% QPM diet (T3). The ingredient and nutrient composition of diet is presented in Table 1. A weighed quantity of the respective diets was offered *ad lib* daily to the replicate groups with care to avoid spillage and wastage. The fresh water was made available round the clock in waterer to all the birds during the study period.

Table 1. Ingredient and nutrient composition of experimental diets

Particulars	Starter phase, 0-3wk			Finisher phase, 4-5wk		
	Normal Maize (T1)	100% QPM (T2)	50% QPM (T3)	Normal Maize (T1)	100% QPM (T2)	50% QPM (T3)
Ingredients (%)						
Normal Maize	60.1	0	29.5	64.77	0	31.8
QPM	0	58.5	29.5	0	62.9	31.8
Soybean meal	34.28	35.73	35.21	30	31.74	31.01
Sunflower oil	1.8	2	2	1.8	2	2
Lime stone	1	1	1	1	1	1
DCP	1.75	1.75	1.75	1.5	1.5	1.5
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Lysine	0.27	0.22	0.24	0.16	0.1	0.13
Methionine	0.2	0.2	0.2	0.17	0.16	0.16
Trace min mix	0.15	0.15	0.15	0.15	0.15	0.15
Vit. mix	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100

Nutrient composition (%)						
ME (kcal/kg)	2998	2997	3002	3052	3049	3055
CP	22.2	22.1	22.2	20.6	20.5	20.6
Lysine	1.346	1.35	1.348	1.134	1.136	1.138
Methionine	0.526	0.519	0.523	0.479	0.463	0.466
Threonine	0.787	0.816	0.804	0.725	0.759	0.744
Arginine	1.398	1.437	1.423	1.278	1.325	1.305
Ca	1.036	1.036	1.036	0.978	0.978	0.978
P, avail.	0.444	0.447	0.446	0.394	0.397	0.396

*Trace mineral premix 0.15%, Vit. Premix 0.1%, B - Complex 0.02%, Choline 0.05 %. Trace mineral premix supplied mg/ kg diet: Mn, 75; Se, 0.2; Fe, 40; Zn, 70; Cu, 10. The vitamin premix supplied per kg diet: Vit. A, 8250 IU; Vit. D_3,1200 ICU; Vit. K, 1mg; Vit. E, 40 IU; Vit. B_1, 2mg; Vit. B_2 4mg; Vit. B_{12}, 10 mcg; niacin, 60 mg; pantothenic acid, 10 mg.

Growth performance

The body weight gain of chicks and feed intake of each replicated group allotted for different treatment was recorded at day old, 3 and 5 weeks of age. The feed conversion ratio (FCR) was calculated for each replicate separately on the basis of unit feed consumed per unit body weight gain.

Gut development

At the end of 35 days of experimental period, 12 birds from each dietary group (2 birds/replicate), making a total of 36 birds were selected randomly and sacrificed by cervical dislocation for evaluation of different parameters. The weight and / or length of liver, gizzard, duodenum, jejunum, ileum and caeca were measured.

Chemical and statistical analyses

The amino acid content of feed ingredients was analyzed by AMINO Lab, Evonik Industries. The data pertaining to the various parameters were subjected to One way ANOVA (SPSS Version 16.0, SPSS Inc, Chicago, USA).

RESULTS AND DISCUSSION

The present QPM variety had a higher level of lysine, arginine and tryptophan values and lower leucine values than NM (Table 2). The present variety of maize, HQPM-1, had comparatively lower difference in the amino acid values compared to the normal maize (24% higher lysine, 18% higher tryptophan, 15% higher arginine and 19% lower leucine). In the earlier reports, the crude protein (CP) content of NM and QPM was variable but the Lysine was 33-57% and Tryptophan content was 33-40% higher in QPM than that of NM (Ortega et al., 1986; Sproule et al., 1988; Osei et az, 1999; Onimisi et al., 2008; Tyagi et al., 2008; Panda et al., 2011). Osei et al. (1999) and Panda et al. (2011) reported 20-22% lower leucine in QPM compared to NM. The excess leucine in NM is known to cause amino acid imbalances which impairs protein synthesis and reduces the conversion of tryptophan to niacin (Onimisi et al., 2008; Panda et al., 2014; Gasperi et al., 2019).

Table 2. Crude protein and amino acid composition (% of CP) of ingredients

Attributes	Normal Maize	Quality Protein Maize	Soybean Meal
DM (%)	88.36	88.57	92.6
CP (%)	9.66	8.71	46.5
Methionine	2.175	2.049	1.226
Cystine	2.297	2.353	1.288
Lysine	2.695	3.362	5.753
Threonine	3.507	3.614	3.699
Tryptophan	0.704	0.833	1.297
Arginine	4.638	5.354	7.191
Isoleucine	3.419	3.279	4.338
Leucine	12.026	9.654	7.310
Valine	4.759	4.872	4.518
Histidine	3.018	3.148	2.581
Phenylalanine	4.915	4.872	4.920

Figures are given in % as such basis. Analysed at AMINO Lab, Evonik Industries.

There was no significant difference (P>0.05) in body weight gain with QPM supplementation during the experimental period (Table 3). The feed intake was similar (P>0.05) during 0-3wk of age. Better (P<0.001) FCR was observed in both the QPM diets during 0-3wk of age. However, during 4-5wk and overall phase, lower (P<0.001) feed intake and better (P<0.001) FCR was observed in 100% QPM diet. Osei et al. (1998) observed a significantly higher weight gain in the QPM diet (1944 g) compared to the NM diet (1904 g) in broiler chicken. In a study of Bai (2002), the dietary replacement of NM with QPM (without amino acids supplementation) improved body weight gain (2.23 kg in NM vs. 2.26 kg in QPM) and feed conversion ratio (2.07 vs. 2.03) in broilers. Amonelo and Roxas (2008) reported higher weight gain and better feed conversion efficiency in broilers on a QPM based diet compared to a NM based diet. In another study, Onimisi et al. (2009) replaced NM at 0, 25, 50, 75 and 100% with QPM in diets for broiler chicken and reported that 100% dietary replacement of NM by QPM significantly increased body weight gain and FCR. Tyagi et al. (2008) found comparable body weight gain and feed conversion between QPM and NM based diets in broiler chickens.

Table 3. Growth performance of broiler chicken

Group Code	Body weight gain (g/b)			Feed intake (g/b)			FCR		
	0-3 wk	4-5 wk	0-5 wk	0-3 wk	4-5 wk	0-5 wk	0-3 wk	4-5 wk	0-5 wk
T1	933	1305	2237	1316	2208[a]	3524[a]	1.41[a]	1.69[a]	1.58[a]
T2	945	1274	2218	1263	2027[b]	3290b	1.34[b]	1.59[b]	1.48[b]
T3	962	1267	2229	1288	2196[a]	3483[a]	1.34[b]	1.73[a]	1.56[a]
SEM	6.9	11.7	13	9.7	26.7	32	0.01	0.019	0.011
Sig.	0.24	0.387	0.853	0.075	0.002	0.001	0.001	0.001	0.001

SEM bearing different superscript ([a,b]) in a column differ significantly.

No significant difference (P>0.05) was observed in length or weight of duodenum, jejunum, ileum and caecum between the treatments (Table 4).

Table 4. Digestive organ weight (% of live weight) and length (cm / 100g live weight) of broiler chicken

Group	Length				Weight					
Code	Duodenum	Jejunum	Ileum	Caecum	Duodenum	Jejunum	Ileum	Caecum	Liver	Gizzard
T1	12.5	32.1	28.4	5.23	6.2	15.9	14.2	5.81	20.4	23.0^{a}
T2	12.3	29	28.3	5.52	6.24	14.7	15.5	5.67	18.7	20.5^{b}
T3	12.4	30.2	27.3	5.35	6.23	16.9	14.5	5.57	19.1	19.3^{b}
SEM	0.24	0.6	0.66	0.158	0.142	0.55	0.54	0.258	0.33	0.45
Sig.	0.944	0.11	0.79	0.77	0.995	0.255	0.611	0.933	0.1	0.001

SEM bearing different superscript (^{a,b}) in a column differ significantly

Liver weight was also non-significant (P>0.05) but gizzard weight was lower in both QPM diets (Table 4). A series of trials on the utilisation of QPM in broiler chickens was conducted by Panda et al. (2010; 2011; 2012 a,b,c) by replacing NM with QPM (part by part) at 0, 25, 50, 75 and 100% and with or without supplementation of synthetic lysine and observed dietary replacement of NM with QPM at 50% level resulted in better performance, and higher breast muscle yield as compared to broilers fed the NM diet. These variations noticed on the performance could be attributed to variation in nutrient composition among the QPM cultivars used in different studies. It is well known that lysine is crucial in protein synthesis for growth of tissues. Lysine is also involved in the cross linking process of bone collagen and in the biosynthesis of carnitine and elastin (Civitelli et al., 1992; Flodin, 1997). Similarly, tryptophan is an essential amino acid and the biological precursor of niacin.

Most researchers did not find any changes on carcass traits (dressed meat yield, giblet, abdominal fat and cut off parts) in broiler chickens in response to dietary QPM (Osei et al., 1998; Tyagi et al., 2008; Onimisi et al., 2009; Panda et al., 2010; 2011). In the present study also, there was no influence on gut development.

CONCLUSION

It could be concluded that feeding of quality protein maize (on amino acid adjustment) resulted in similar body weight gain like that of normal maize but with a better efficiency in broiler chicken. Quality protein maize with a higher lysine content will reduce the need for supplemental lysine in the broiler diet.

REFERENCES

Amonelo, M. O. and Roxas, D. B. 2008. Growth performance of broilers fed a quality protein maize (QPM)-based diet. Philippine Journal of Veterinary and Animal Sciences. 34(1): 11-22.

Bai, X. F. 2002. Nutritional evaluation of utilisation of quality protein maize Zhong Dan 9409 in broiler feed. MSc Thesis, Chinese Academy of Agricultural Sciences, Beijing.

Civitelli, R., Villareal, D. T., Agnusdei, D., Nardi, P., Avioli, L. V. and Gennari, C. 1992. Dietary L-lysine and calcium metabolism in humans. Nutrition (Burbank, Los Angeles County, Calif), 8(6): 400-405.

Flodin, N. W. 1997. The metabolic roles, pharmacology and toxicology of lysine. Journal of the American College of Nutrition. 16(1): 7-21.

Gasperi, V., Sibilano, M., Savini, I. and Catani, M. V. 2019. Niacin in the central nervous system: an update of biological aspects and clinical applications. International Journal of Molecular Sciences. 20(4): 974.

Goredema-Matongera, N., Ndhlela, T., Magorokosho, C., Kamutando, C. N., Van biljon, A. and Labuschagne, M. 2021. Multinutrient biofortification of maize (Zea mays L.) in Africa: current status, opportunities and limitations. Nutrients, 13: 1039.

Maqbool, M. A., Beshir Issa, A. and Khokhar, E. S. 2021. Quality protein maize (QPM): Importance, genetics, timeline of different events, breeding strategies and varietal adoption. Plant Breeding. 140:375-399.

Mertz, E. T., Bates, L. S. and Nelson, O. E. 1964. Mutant gene that changes protein composition and increases lysine content of maize endosperm. Science, 145(3629): 279-280.

Mushipe. J, Kunaka. K, Masaka. J and Chivandi. E. 2017. Effects of Dietary Substitution of Ordinary Maize Meal with Quality Protein Maize Meal on the Performance of Broiler Chicken. Asian Journal of Animal and Veterinary Advances.12: 197-204.

Nelson, O. E., Mertz, E. T. and Bates, L. S. 1965. Second mutant gene affecting the amino acid pattern of maize endosperm proteins. Science. 150 (3702): 1469-1470.

Onimisi, P. A., Dafwang, I. I., Omage, J. J. and Onyibe, J. E. 2008. Apparent digestibility of feed nutrients, total tract and ileal amino acids of broiler chicken fed quality protein maize (Obatampa) and normal maize. International Journal of Poultry Science.7: 959-963.

Onimisi, P. A., Omage, J. J., Dafwang, I. I. and Bawa, G. S. 2009. Replacement value of normal maize with quality protein maize (Obatampa) in broiler diets. Pakistan Journal of Nutrition. 8(2): 112-115.

Ortega, E. I., Villegas, E. and Vasal, S. K. 1986. A comparative study of protein changes in normal and quality protein maize during tortilla making. Cereal Chemistry. 63(5): 446-451.

Osei, S. A., Atuahene, C. C., Okai, D. B., Donkoh, A. and Tuah, A. K. 1998. The nutritive value of quality protein maize in the diets of broiler chickens. Ghana Journal of Agricultural Science. 31(1): 1-5.

Osei, S. A., Dei, H. K. and Tuah, A. K. 1999. Evaluation of quality protein maize as a feed ingredient for layer pullet. Journal of Animal Feed Science. 8:181-189.

Panda, A. K., Lavanya, G., Reddy, E. P. K., Rao, S. R., Raju, M.V.L.N. and Sunder, G.S. (2012b). Effect of replacement of normal maize with high quality maize on the performance of white leghorn female chicks. Indian Journal of Animal Nutrition. 29(1): 95-99.

Panda, A. K., Lavanya, G., Reddy, E. P. K., Rao, S. R., Raju, M.V.L.N. and Sunder, G.S. 2012a. Utilization of quality protein maize in the diet of White Leghorn layers. Animal feed science and technology. 172 (3-4): 210-216.

Panda, A. K., Raju, M. V. L. N., Rao, S. V., Lavanya, G., Reddy, E. and Sunder, G. S. 2010. Replacement of normal maize with quality protein maize on performance, immune response and carcass characteristics of broiler chickens. Asian-Australasian Journal of Animal Sciences. 23(12):1626-1631.

Panda, A. K., Raju, M.V.L.N., Rama Rao, S. V., Lavanya, G., Pradeep Kumar Reddy, E. and Shyam Sunder, G. 2012c. Substitution of normal maize with quality protein maize on growth performance, serum biochemical parameters and carcass characteristics of coloured broiler chickens. Indian Journal of Poultry Science. 46: 183-187.

Panda, A. K., Raju, M.V.L.N., Rao, S. R., Lavanya, G., Reddy, E. P. K. and Sunder, G. S. 2011. Nutritional evaluation and utilisation of quality protein maize, Nityashree hybrid maize, and normal maize in broiler chickens. British Poultry Science. 52(5): 632-638.

Panda, A. K., Zaidi, P. H., Rama Rao, S. V. and Raju, M.V.L.N. 2014. Efficacy of quality protein maize in meeting energy and essential amino acid requirements in broiler chicken production. Journal of Applied Animal Research. 42(2): 133-139.

Prasanna, B. M., Vasal, S. K., Kassahun, B. and Singh, N. N. 2001. Quality protein maize. Current Science. 81(10):1308-1319.

Rajasekhar, K. V., Prakash, B., Lakshmi, K. V., Rao, S. R. and Raju, M. V. L. N. 2020. Effect of feeding diet with alternate protein sources and quality protein maize on performance and nutrient utilization in broiler chickens. Tropical Animal health and Production. 52(5): 2297-2302.

Sproule, A. M., Saldivar, S. O., Bockholt, A. J., Rooney, L. W. and Knabe, D. A. 1988. Nutritional evaluation of tortillas and tortilla chips from quality protein maize. Journal of cereal science. 7(1): 83-94.

SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Inc.

Tyagi, P. K., Shrivastav, A. K., Mandal, A. B., Tyagi, P. K. and Elangovan, A. V. 2010. The feeding value of quality protein maize is similar to commercial maize for egg production and quality traits in laying hens. Indian Journal of Poultry Science. 45(2):217-219.

Tyagi, P. K., Shrivastav, A. K., Mandal, A. B., Tyagi, P. K., Elangovan, A. V. and Deo, C. 2008. The apparent metabolizable energy and feeding value of quality protein maize for broiler chicken. Indian Journal of Poultry Science. 43(2):169-174.