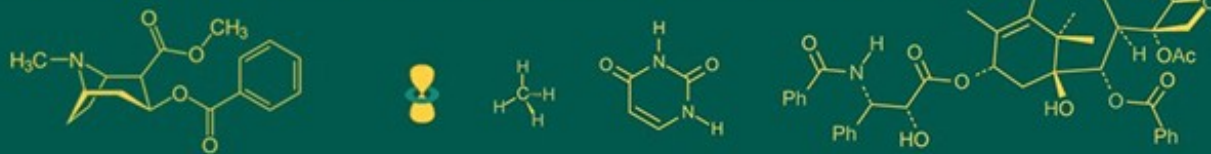


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Study on egg quality traits of Kadaknath hens

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ABSTRACT

An experiment was conducted to evaluate the effect of different dietary nutrient levels on egg quality traits of Kadaknath hens during the late laying phase. A total of 96 Kadaknath hens at 50 weeks of age were randomly allotted to four dietary treatment groups on an equal body weight basis, with three replicates per treatment. The control group (T_1) was fed a diet containing 16% crude protein (CP), 2600 kcal/kg metabolizable energy (ME), 0.85% methionine, 0.31% lysine, 3.0% calcium and 0.30% phosphorus, as per the recommendations of ICAR. The other groups received diets containing 15% CP, 2550 kcal/kg ME, 0.80% methionine, 0.28% lysine, 3.0% calcium and 0.30% phosphorus (T_2); 17% CP, 2650 kcal/kg ME, 0.90% methionine, 0.35% lysine, 3.25% calcium and 0.35% phosphorus (T_3); and 18% CP, 2700 kcal/kg ME, 0.95% methionine, 0.40% lysine, 3.50% calcium and 0.40% phosphorus (T_4). During the overall experimental period from 50 to 72 weeks of age, dietary nutrient levels did not significantly ($P > 0.05$) influence shape index, albumin index, yolk index, Haugh unit score, shell thickness, shell weight, albumin weight or yolk weight. The findings indicate that variation in dietary nutrient levels within the tested range did not significantly affect the egg quality traits of Kadaknath hens during the late laying phase.

Keywords: Dietary nutrient levels, Egg quality, Haugh unit, Kadaknath hens, Late laying phase

Introduction

India possesses a rich diversity of indigenous chicken genetic resources, with nineteen native chicken breeds registered with the National Bureau of Animal Genetic Resources (NBAGR). These indigenous breeds represent valuable genetic resources because of their adaptation to diverse agro-climatic conditions, low-input production systems and traditional backyard farming practices (Chatnallikar *et al.*, 2025) [1]. Indigenous chickens are generally characterized by relatively slow growth, lower egg production and smaller egg size than specialized commercial strains. However, they possess several desirable attributes, including good mothering and brooding ability, efficient foraging behaviour, hardiness, adaptability and the ability to survive under low-input management systems. Their relatively small body size is advantageous under tropical and subtropical environmental conditions, while their ability to withstand environmental stresses and utilize locally available feed resources makes them particularly suitable for rural poultry production. Differences among indigenous breeds in production performance, egg quality and biochemical characteristics have also been documented (Haunshi *et al.*, 2012; Kumar *et al.*, 2022) [2, 3]. In addition, the distinctive flavour, taste and nutritional characteristics of meat and eggs from indigenous chickens contribute to consumer preference and market value (Singh *et al.*, 2017; Haunshi *et al.*, 2022) [5, 4]. Thus, indigenous chickens constitute an important source of animal protein and contribute substantially to rural livelihoods, food security and nutritional security.

Among the indigenous chicken breeds of India, Kadaknath is one of the most well-known and economically important breeds. The breed originated mainly in the Jhabua and Dhar regions of Madhya Pradesh and is locally known as "Kalamasi." Kadaknath is recognized for its characteristic black pigmentation and distinctive production and meat-quality attributes (Haunshi *et al.*, 2021) [6]. Three major varieties of Kadaknath have been described, namely Jet Black, Golden and Pencilled (Rao *et al.*, 1984; Thakur *et al.*, 2006) [7, 8]. The Jet Black variety has predominantly black plumage, whereas the Golden variety possesses golden feathers particularly around the head and neck, and the Pencilled variety exhibits characteristic colour patterns over the black plumage. These distinct phenotypic characteristics contribute to the unique identity and genetic value of the breed.

Kadaknath chickens are well adapted to diverse and challenging environmental conditions and are capable of performing under relatively low-input production systems. Their adaptability to harsh environmental conditions and backyard management has contributed to their popularity among small and marginal farmers (Rahangdale *et al.*, 2017; Haunshi *et al.*, 2021) [9, 6]. The breed is also characterized by intense black pigmentation of the skin and several internal tissues, which is associated with extensive melanin deposition

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(Rao *et al.*, 1984) [7]. Kadaknath meat is recognized for its distinctive flavour, nutritional composition and characteristic black pigmentation. Haunshi *et al.* (2022) [4] reported that Kadaknath meat possesses desirable carcass and meat-quality characteristics and contains a relatively high crude protein concentration. The unique quality of Kadaknath meat has contributed to its premium market value and increasing consumer interest. Quality characterization of giblets has also demonstrated differences among indigenous Indian chicken breeds, further emphasizing the distinct product characteristics of native germplasm (Singh *et al.*, 2017) [5]. However, Kadaknath is traditionally considered a relatively poor egg-producing breed, with lower annual egg production than commercial layer strains (Rahangdale *et al.*, 2017) [9].

Production performance of Kadaknath under different production systems has been investigated by several researchers. Thakur *et al.* (2006) [8] studied growth performance in Kadaknath, while Rahangdale *et al.* (2017) [9] compared growth performance under intensive and backyard rearing systems. Ezhilvalavan *et al.* (2016) [10] also evaluated the production performance of Kadaknath under organized farm conditions. These studies demonstrate that production performance of Kadaknath can vary according to the production environment, management and nutritional conditions. Consequently, optimization of nutrition is important for improving the productive efficiency of this indigenous breed.

Egg quality is another important characteristic influencing the economic value and acceptability of indigenous chicken eggs. Parmar *et al.* (2006) [11] evaluated egg quality traits of Kadaknath and demonstrated the characteristic external and internal egg-quality attributes of the breed. Pathak *et al.* (2018) [12] subsequently compared egg-quality parameters of Kadaknath and Vanaraja chickens under intensive farming conditions. Similarly, Kumar *et al.* (2022) [3] evaluated egg quality and biochemical parameters of Aseel and Kadaknath chickens maintained under backyard production systems and demonstrated differences in egg-quality and biochemical characteristics between indigenous breeds. Haunshi *et al.* (2012) [2] also reported differences among native chicken breeds with respect to persistency of egg production, egg quality and biochemical traits, indicating the importance of genetic background in determining these characteristics.

Nutritional management is an important factor affecting production performance and egg quality in laying hens. Several studies have investigated the effects of dietary energy, protein, amino acids and nutrient density in indigenous or native-type chickens. Mandal *et al.* (2013) [13] evaluated energy, protein and amino acid requirements of Kadaknath layers, highlighting the importance of dietary nutrient balance for maintaining production. Haunshi *et al.* (2015) [14] investigated varying nutrient densities in Aseel layers, while Hussein *et al.* (2010) [15] evaluated optimal metabolizable energy and crude protein levels for Sinai laying hens. Panda (2021) [16] reported that moderate reductions in dietary nutrient density in Vanaraja layers did not substantially alter several egg-quality characteristics, although production performance and body weight were affected. Similarly, supplementation of limiting amino acids such as methionine and lysine in low-protein diets has been investigated in Vanaraja laying hens, demonstrating the importance of amino-acid balance in maintaining productive performance and egg characteristics (Mohapatra *et al.*, 2018) [17].

Dietary supplementation with specific nutrients or feed additives may also influence the productive characteristics of Kadaknath hens. Biswas *et al.* (2010) [18] reported that vitamin E supplementation influenced production performance and egg-quality traits in Indian na-

tive Kadaknath hens. Kaswan (2018) [19] evaluated garlic (*Allium sativum*) powder supplementation in Kadaknath layers, further demonstrating the potential role of dietary feed additives in improving productive efficiency. These studies indicate that both nutrient density and specific dietary supplements can influence the physiological and productive responses of indigenous laying hens.

In recent years, the nutritional and commercial importance of Kadaknath has increased because of its unique meat quality, distinctive appearance, adaptability and consumer perception regarding its nutritional value. Haunshi *et al.* (2021) [6] emphasized the unique characteristics and increasing popularity of Kadaknath as a native chicken breed of India, while Haunshi *et al.* (2022) [4] documented its distinctive carcass characteristics, meat quality and nutritional composition. These attributes have contributed to increasing demand for Kadaknath birds and their products. However, despite its economic importance, information concerning the precise nutrient requirements of Kadaknath hens during different stages of the laying cycle, particularly during the late laying phase, remains comparatively limited. Nutrient recommendations developed for commercial layer strains may not necessarily be directly applicable to indigenous breeds because of differences in body size, growth pattern, production potential, genetic background and physiological characteristics.

The present study was therefore undertaken to evaluate the effect of dietary nutrient levels on production performance, egg-quality characteristics and economic efficiency of Kadaknath hens during the late laying phase, with the objective of identifying an appropriate dietary regimen for maintaining productive performance and egg quality in this valuable indigenous breed.

Materials and Methods

Experimental design, management and feeding

A biological experiment was conducted on Kadaknath layer birds ($n = 96$) for period of 22 weeks which were randomly assigned into four groups (A to D) in such a way that each treatment have 24 birds. Each treatment group was divided into three replicates of 8 birds each. The allocation of birds in each treatment was based on egg production at the start of the experiment. The experiment was conducted for 22 weeks (50th to 72nd weeks of age). The experimental layer birds were reared on deep litter system and all the groups had been provided similar environmental and managerial condition throughout experimental period of (50-72) weeks of age. The birds were provided with 4.00 sq. feet space per bird till end of experiment. The standard management was carried out to optimize egg production performance. Ample amount of water was given to bird by bell drinker; feed had been given to birds replicate wise (in group) @100gm/bird/day by weighing. As per the day length, artificial light was provided to meet the requirement of 16 hrs of light including day light, egg collected in evening time daily.

Group T_1 received control diet containing CP-16%, ME-2600kcal/kg, Methionine-0.85%, Lysine-0.31%, Calcium-3, Phosphorus-0.30% as per data available in the book (Nutrient requirement of poultry) published by Indian Council of Agriculture Research, New Delhi. Group T_2 was fed with CP-15%, ME-2550kcal/kg, Methionine-0.80%, Lysine-0.28%, Calcium-3%, Phosphorus-0.30%. Group T_3 was fed with CP-17%, ME-2650 kcal/kg, Methionine-0.90%, Lysine-0.35%, Calcium-3.25%, Phosphorus-0.35% and group T_4 was fed with CP-18%, ME-2700 kcal/kg, Methionine-0.95%, Lysine-0.40%, Calcium-3.50%, Phosphorus-0.40%. Egg quality traits were studied every 14 days interval.

Table 1. Different dietary treatments of experimental groups

Treatment groups	Details of dietary treatments	No. of replicates /treatment	No. of layers /replicate	No. of layers /treatment
A	Control- Layer fed on diet containing CP-16%, ME- 2600kcal/kg, Methionine-0.85%, Lysine-0.31% Calcium-3, Phosphorus-0.30%	03	8	24

(continued on next page)

Table 1. Different dietary treatments of experimental groups

B	Layer fed on diet containing CP-15%, ME-2550 kcal/kg, Methionine-0.80%, Lysine- 0.28%, Calcium-3%, Phosphorus-0.30%	03	8	24
C	Birds fed on diet containing CP-17% , ME-2650 kcal/kg, Methionine-0.90%, Lysine-0.35%, Calcium-3.25%, Phosphorus-0.35%	03	8	24
D	Birds fed on diet containing CP-18% , ME-2700 kcal/kg, Methionine-0.95%, Lysine-0.40%, Calcium-3.50%, Phosphorus-0.40%	03	8	24
Total number of birds				96

The effect of dietary nutrient levels on egg quality traits, including shape index, albumen index, yolk index, Haugh unit, shell thickness, shell weight, albumen weight and yolk weight of Kadaknath layers during different phases of the late laying period is presented in Tables 3 to 6.

During 50–53 weeks of age, dietary nutrient levels did not significantly ($P > 0.05$) influence shape index, albumen index, yolk index, Haugh unit, shell weight, albumen weight or yolk weight. However, shell thickness differed significantly ($P < 0.05$) among dietary treatments. The highest shell thickness was recorded in T_2 (0.44 mm), followed by T_4 (0.39 mm), T_1 (0.37 mm) and T_3 (0.35 mm). The higher shell thickness observed in T_2 may indicate a favourable response of calcium and phosphorus utilization or mineral deposition under this particular nutrient combination.

During 54–57 weeks of age, none of the measured egg quality parameters differed significantly ($P > 0.05$) among dietary treatments except yolk weight. Yolk weight was significantly ($P < 0.05$) higher in T_2 (18.31 g), whereas the lowest value was recorded in T_1 (16.16 g). The increased yolk weight in T_2 may be associated with improved nutrient availability for yolk precursor synthesis and deposition.

However, the absence of significant differences in the other egg quality traits indicates that dietary nutrient variation had limited influence on overall egg quality during this phase.

During 58–61 weeks of age, albumen weight was significantly ($P < 0.01$) influenced by dietary treatment. The highest albumen weight was recorded in T_4 (32.45 g), followed by T_2 (29.48 g), T_3 (27.51 g) and T_1 (25.53 g). Despite this difference in albumen weight, shape index, albumen index, yolk index, Haugh unit, shell thickness, shell weight and yolk weight remained statistically similar ($P > 0.05$) among treatments.

No significant ($P > 0.05$) differences were observed among dietary treatments for any of the studied egg quality parameters during 62–65 and 66–69 weeks of age. Similarly, during 70–72 weeks of age, most egg quality parameters remained unaffected by dietary nutrient levels. However, Haugh unit score differed significantly ($P < 0.05$), with higher values in T_2 (87.85) and T_3 (86.93) compared with T_1 (73.65) and T_4 (81.09). The higher Haugh unit values in T_2 and T_3 indicate better albumen quality and internal egg freshness during the final phase of the laying period.

Table 2. Feed ingredients and nutrient composition for experimental birds

Feed Ingredient	Treatments			
	A	B	C	D
Maize	56.38	52.42	57.87	55.38
Soyabean Meal	19.80	18.50	24.00	28.10
DORB	14.50	14.68	8.00	4.50
Shell Grit	5.30	11.5	5.80	6.30
Vegetable oil	-	1.5	-	1.10
Dicalcium Phosphate	0.50	0.35	0.80	1.10
Limestone Powder(LSP)	2.50	-	2.50	2.50
Salt (NaCl)	0.28	0.35	0.28	0.28
Trace mineral mixture	0.10	0.12	0.10	0.10
Vitamin Premix	0.05	0.05	0.05	0.05
DL- Methionine	0.05	0.10	0.07	0.10
L-Lysine	0.08	0.01	0.07	0.03
Choline chloride, 60%	0.10	0.05	0.10	0.10
Toxin binder	0.10	0.10	0.10	0.10
Phytase	0.01	0.01	0.01	0.01
Liver Tonic	0.05	0.05	0.05	0.05
Sodium bicarbonate	0.10	0.15	0.10	0.10
Acidifier	0.10	0.02	0.10	0.10
Calculated nutrient composition				
ME Kcal/Kg	2600	2550	2650	2700
		50		
Crude Protein (%)	16.00	15.00	17.00	18.00
Lysine (%)	0.85	0.80	0.90	0.95
Methionine (%)	0.31	0.28	0.35	0.40

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Feed Ingredient		Treatments		
Calcium (%)	3.00	3.00	3.25	3.50
Available phosphorous	0.30	0.30	0.35	0.40

When the entire experimental period of 50–72 weeks was considered, dietary nutrient levels did not significantly ($P > 0.05$) influence any of the evaluated egg quality traits. Thus, although significant treatment effects were observed for individual traits during particular age intervals, these responses were not sufficiently consistent across the complete late laying period to produce an overall significant dietary effect.

The present findings are in agreement with earlier observations indicating that several egg-quality traits of indigenous chickens may remain relatively stable across moderate variations in dietary nutrient supply. Mandal *et al.* (2013) [13] reported that dietary energy and protein levels did not significantly influence several egg-quality parameters in Kadaknath layers, including shape index, albumen index, yolk index, Haugh unit, shell weight and shell thickness. Similarly, Panda (2021) [16] observed that reducing dietary nutrient density in Vanaraja layers did not significantly affect several major egg-quality characteristics, although production performance and body weight were influenced. These findings suggest that laying hens may maintain relatively stable egg quality over a moderate range of nutrient concentrations through physiological regulation of nutrient partitioning towards egg formation.

The present observations are also supported by studies describing the characteristic egg-quality attributes of Kadaknath. Haunshi *et al.* (2022) [4] reported characteristic external and internal quality parameters in Kadaknath eggs, including a mean egg weight of 40.59 g, shell thickness of 0.34 mm, shape index of 74.02%, albumen index of 8.52% and yolk index of 36.66%. Dinesh *et al.* (2024) [20] reported an average egg weight of 43.87 g, shape index of 76.20% and shell thickness of 0.34 mm in Kadaknath hens evaluated under the western Himalayan production environment. Similarly, Usman *et al.* (2014) [21], while evaluating Lakha Aseel chickens at different ages, reported that egg weight increased with advancing age, whereas egg production and egg mass declined. They also observed significant age-related changes in egg geometry and Haugh unit, while yolk index and shell thickness remained relatively unaffected. The shell thickness observed in the present study (0.35–0.44 mm across treatments and experimental phases) was therefore within the range reported for Kadaknath eggs under different production environments. Differences observed between studies may be associated with variations in age, genetic background, environmental conditions, housing, management and dietary composition. Environmental conditions may also contribute to variation in egg-quality characteristics. SenthilMurugan (2017) [22], who evaluated Kadaknath and other chicken varieties under the hilly conditions of Wayanad, Kerala, reported significant differences among varieties in egg weight, shape index, surface area, yolk characteristics and albumen height, indicating that genetic background and environmental adaptation may contribute to variation in egg-quality traits.

Further, Rath *et al.* (2025) [23] reported mean values for shape index, albumen index, yolk index, shell weight and Haugh unit of 74.42%, 0.06%, 0.44%, 3.69 g and 72.47, respectively, in Kadaknath eggs. The authors also reported moderate to high heritability estimates for several egg-quality traits, indicating that genetic factors may contribute substantially to variation in egg quality. The relatively small response of most egg-quality parameters to dietary nutrient levels in the present study may therefore partly reflect the inherent genetic characteristics of the breed.

The present findings are also consistent with observations from other indigenous chicken populations. Haunshi *et al.* (2012) [2] demonstrated breed-associated variation in egg production persistence, egg quality and biochemical traits among native chicken breeds. Kumar *et al.* (2022) [3] similarly reported differences in egg-quality and bio-

chemical characteristics between Aseel and Kadaknath maintained under backyard production systems. Rehman *et al.* (2017) [24] reported variation in egg morphometry and quality traits of Aseel hens under different rearing systems, emphasizing the contribution of both genetic and management factors to egg characteristics. Senthilmurugan (2017) [22] also evaluated egg-quality traits of chickens maintained under hilly environmental conditions, demonstrating the relevance of environmental and management conditions in determining egg characteristics. Rehman *et al.* (2017) [24] evaluated four varieties of Aseel hens under free-range, semi-intensive and confinement rearing systems and reported that rearing system did not significantly affect most egg-quality traits, including eggshell thickness, Haugh unit and yolk index. However, significant differences among Aseel varieties were observed for several egg morphometric traits, indicating that genetic background may contribute substantially to variation in egg characteristics. These findings support the present observation that several egg-quality traits of Kadaknath remained relatively stable despite variation in dietary nutrient levels.

The isolated significant increase in shell thickness in T_2 during 50–53 weeks, yolk weight in T_2 during 54–57 weeks, albumen weight in T_4 during 58–61 weeks and Haugh unit in T_2 and T_3 during 70–72 weeks indicates that certain nutrient combinations may influence specific components of egg quality at particular stages of lay. Nevertheless, these effects were phase-specific rather than persistent throughout the experimental period. The observations are broadly consistent with the concept that egg-quality traits are influenced by a combination of genetic background, age, nutritional status and environmental conditions rather than by dietary nutrient concentration alone. The influence of rearing environment on egg characteristics has also been demonstrated in indigenous chickens evaluated under backyard, intensive and region-specific production systems (Pathak *et al.*, 2018; Kumar *et al.*, 2022; Dinesh *et al.*, 2024) [12, 3, 20].

The findings from the present study should also be considered in relation to the broader nutritional literature on indigenous laying hens. Studies in Aseel, Vanaraja and other native-type chickens have demonstrated that alterations in dietary nutrient density or amino-acid supply can affect production performance without necessarily producing proportional changes in all egg-quality parameters (Haunshi *et al.*, 2015; Mohapatra *et al.*, 2018; Panda, 2021) [14, 17, 16]. Similarly, the work of Biswas *et al.* (2010) [18] indicates that targeted supplementation with antioxidants such as vitamin E may influence production and egg-quality responses in Kadaknath. Therefore, nutritional strategies for indigenous chickens should consider not only nutrient concentration but also nutrient balance, age, production stage and the physiological characteristics of the breed.

Overall, the present findings demonstrate that variation in dietary nutrient levels within the tested range did not significantly alter the major external and internal egg-quality characteristics of Kadaknath hens during 50–72 weeks of age. The breed appeared capable of maintaining relatively stable egg quality during the late laying phase. The results are consistent with previous observations that several egg-quality characteristics of Kadaknath and other indigenous chickens exhibit relatively limited responses to moderate changes in dietary nutrient concentration (Mandal *et al.*, 2013; Panda, 2021) [13, 16]. Therefore, dietary manipulation within the tested nutrient range may have greater relevance for production performance and economic efficiency than for modifying the basic egg-quality characteristics of Kadaknath hens. The findings further reinforce the importance of developing breed-specific nutritional strategies for indigenous chickens rather than directly adopting nutrient recommendations established for high-producing commercial layer strains.

Table 4 Effect on egg quality traits in Kadaknath layers (54-57th wk)

Treatment	Shape index (%)	Albumin index	Yolk index	Haugh Unit	Shell thickness (mm)	Shell weight (g)	Albumin weight (g)	Yolk weight (g)	Yolk cholesterol (mg/g of yolk)
T_1 -Control	75.12 ±1.27	0.62 ±0.02	0.33 ±0.00	72.19 ±0.95	0.36 ±0.00	4.54 ±0.09	26.59 ±0.87	16.16 ^c ±0.51	16.33 ±0.73
T_2	75.13 ±1.01	0.57 ±0.05	0.30 ±0.01	71.57 ±3.59	0.37 ±0.02	4.60 ±0.13	26.36 ±0.63	18.31 ^a ±0.50	14.50 ±0.29
T_3	76.03 ±0.71	0.63 ±0.01	0.35 ±0.02	71.95 ±0.44	0.34 ±0.01	4.19 ±0.20	29.22 ±2.30	16.45 ^{bc} ±0.32	15.00 ±0.00
T_4	74.40 ±1.12	0.60 ±0.01	0.33 ±0.00	68.71 ±0.82	0.40 ±0.04	4.73 ±0.30	29.37 ±1.23	18.00 ^{ab} ±0.63	14.83 ±0.17
SEM	0.48	0.01	0.01	0.92	0.01	0.10	0.74	0.35	0.21
P	NS	NS	NS	NS	NS	NS	NS	$P < 0.05$	NS

NS-Non-significant

Table 5 Effect on egg quality traits in Kadaknath layers (58-61st wk)

Treatment	Shape index (%)	Albumin index	Yolk index	Haugh Unit	Shell thickness (mm)	Shell weight (g)	Albumin weight (g)	Yolk weight (g)	Yolk cholesterol (mg/g of yolk)
T_1 -Control	75.06 ±1.22	0.71 ±0.04	0.26 ±0.01	76.07 ±2.41	0.34 ±0.02	4.49 ±0.10	25.53 ^c ±0.87	16.85 ±0.19	15.33 ±0.44
T_2	73.80 ±0.14	0.80 ±0.03	0.26 ±0.01	78.22 ±1.18	0.36 ±0.00	4.47 ±0.00	29.48 ^{ab} ±0.06	16.23 ±0.55	14.67 ±0.17
T_3	72.79 ±0.73	0.78 ±0.04	0.27 ±0.01	81.08 ±2.35	0.34 ±0.02	4.30 ±0.09	27.51 ^{bc} ±0.41	15.48 ±0.36	14.17 ±0.33
T_4	75.03 ±0.44	0.81 ±0.05	0.28 ±0.01	76.93 ±3.61	0.36 ±0.03	4.34 ±0.23	32.45 ^a ±1.66	16.23 ±0.30	14.50 ±0.00
SEM	0.43	0.02	0.01	1.22	0.01	0.06	0.87	0.22	0.14
P	NS	NS	NS	NS	NS	NS	$P < 0.01$	NS	NS

NS-Non-significant

Table 6 Effect on egg quality traits in Kadaknath layers (62-65th wk)

Treatment	Shape index (%)	Albumin index	Yolk index	Haugh Unit	Shell thickness (mm)	Shell weight (g)	Albumin weight (g)	Yolk weight (g)	Yolk Cholesterol (mg/g of yolk)
T_1 -Control	73.60 ±1.93	0.88 ±0.08	0.29 ±0.01	82.40 ±3.13	0.39 ±0.01	3.95 ±0.22	23.48 ±0.58	16.17 ±1.07	15.50 ±0.29
T_2	77.35 ±5.02	0.83 ±0.04	0.29 ±0.01	83.04 ±1.59	0.39 ±0.01	3.97 ±0.03	24.20 ±0.61	15.87 ±0.78	14.83 ±0.88
T_3	73.17 ±1.62	0.69 ±0.03	0.28 ±0.01	73.58 ±1.14	0.39 ±0.01	4.28 ±0.06	25.42 ±1.81	16.68 ±0.98	15.50 ±0.76
T_4	73.82 ±1.57	0.84 ±0.07	0.25 ±0.03	79.80 ±3.04	0.36 ±0.01	3.76 ±0.24	23.68 ±0.67	15.73 ±0.46	15.17 ±0.88
SEM	1.34	0.03	0.01	1.52	0.01	0.09	0.50	0.38	0.33
P	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS-Non-significant

Table 7 Effect on egg quality traits in Kadaknath layers (66-69th wk)

Treatment	Shape index (%)	Albumin index	Yolk index	Haugh Unit	Shell thickness (mm)	Shell weight (g)	Albumin weight (g)	Yolk weight (g)	Yolk Cholesterol (mg/g of yolk)
T_1 -Control	75.66 ±0.37	0.78 ±0.06	0.27 ±0.00	79.10 ±2.82	0.38 ±0.03	4.22 ±0.12	26.51 ±0.81	15.06 ±0.83	16.50 ±0.29

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Table 7 Effect on egg quality traits in Kadaknath layers (66-69th wk)

T_2	76.19	0.81	0.27	81.64	0.42	4.54	26.32	15.55	15.50
	±1.40	±0.08	±0.01	±3.08	±0.00	±0.06	±1.59	±0.76	±0.76
T_3	75.14	0.67	0.28	75.50	0.38	4.39	24.73	15.89	15.83
	±1.79	±0.04	±0.01	±2.39	±0.01	±0.20	±1.07	±0.53	±0.60
T_4	77.96	0.88	0.25	83.33	0.38	4.21	26.43	14.99	16.00
	±3.23	±0.02	±0.01	±0.21	±0.01	±0.28	±1.60	±0.88	±0.76
SEM	0.90	0.03	0.00	1.36	0.01	0.09	0.60	0.34	0.33
P	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS-Non-significant

Table 8 Effect on egg quality traits in Kadaknath layers (70-72nd wk)

Treatment	Shape index (%)	Albumin index	Yolk index	Haugh Unit	Shell thickness (mm)	Shell weight (g)	Albumin weight (g)	Yolk weight (g)	Yolk Cholesterol (mg/g of yolk)
T_1 -Control	73.11	0.65	0.25	73.65 ^b	0.37	4.66	28.51	16.21	16.33
	±0.45	±0.04	±0.02	±2.46	±0.01	±0.24	±0.53	±1.09	±0.44
T_2	74.25	0.94	0.24	87.85 ^a	0.38	4.46	27.02	15.33	15.50
	±1.47	±0.11	±0.01	±3.20	±0.01	±0.06	±1.69	±1.28	±0.00
T_3	75.81	0.96	0.24	86.93 ^a	0.38	4.53	27.53	16.11	16.17
	±0.12	±0.09	±0.00	±2.03	±0.03	±0.36	±0.68	±0.86	±0.44
T_4	74.65	0.77	0.26	81.09 ^{ab}	0.40	4.19	26.78	17.57	14.83
	±2.06	±0.04	±0.01	±2.61	±0.04	±0.09	±1.38	±0.83	±0.73
SEM	0.62	0.05	0.01	2.04	0.01	0.11	0.54	0.50	0.23
P	NS	NS	NS	$P < 0.05$	NS	NS	NS	NS	NS

NS-Non-significant

Table 9 Effect on egg quality traits in Kadaknath layers (50-72nd wk)

Treatment	Shape index (%)	Albumin index	Yolk index	Haugh Unit	Shell thickness (mm)	Shell weight (g)	Albumin weight (g)	Yolk weight (g)	Yolk cholesterol (mg/g of yolk)
T_1 -Control	74.46	0.72	0.26	76.37	0.37	4.46	26.64	16.13	15.64
	±0.29	±0.03	±0.01	±1.34	±0.01	±0.09	±0.24	±0.22	±1.17
T_2	75.51	0.80	0.25	79.66	0.39	4.51	26.91	16.26	14.19
	±1.41	±0.04	±0.00	±1.55	±0.00	±0.04	±0.89	±0.59	±0.78
T_3	74.77	0.74	0.27	77.56	0.36	4.42	26.94	16.25	15.42
	±0.56	±0.01	±0.00	±0.63	±0.01	±0.12	±0.25	±0.18	±1.46
T_4	75.31	0.78	0.26	77.47	0.38	4.35	27.74	16.61	15.86
	±0.56	±0.03	±0.00	±1.11	±0.01	±0.10	±0.20	±0.35	±0.98
SEM	0.37	0.02	0.00	0.63	0.00	0.04	0.24	0.17	0.50
P	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS-Non-significant

Conclusion

From the results, it is observed that all the treatment groups in terms of egg quality parameters were non-significantly differ among each other. Hence it is concluded that the dietary regime given by ICAR can be effectively utilised for improving the egg quality performance of Kadaknath hens during late laying phase (50-72 week).

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