GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gscbps.gsconlinepress.com/

(RESEARCH ARTICLE)

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EFFECT OF CASHEW NUT CAKE IN FEED ON THE LAYING PERFORMANCE AND EGG QUALITY OF MEAT QUAILS (*COTURNIX JAPONICA*, TEMMINCK & SCHLEGEL, 1849)

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GSC Biological and Pharmaceutical Sciences, 2026, 36(02), 051–060

Publication history: Received on 04 May 2026; revised on 12 August 2026; accepted on 14 August 2026

Article DOI: https://doi.org/10.30574/gscbps.2026.36.2.0288

ABSTRACT

Fluctuations in the price of raw materials, particularly soya, which is used as the main source of protein, are driving the search for local by-products that could contribute to the sustainability of quail production. This study assessed the effect of incorporating cashew nut cake on laying performance, as well as on the internal and external physical characteristics of meat-type quail eggs. A total of 270 quails, aged 42 days, were randomly allocated to three groups of 30 birds each, with three replicates. Three diets were formulated: a control diet (CD) containing only soya meal as the protein source, and two experimental diets incorporating 25 per cent (D25%) and 50 per cent (D50%) cashew nut cake respectively, as a substitute for soya meal. The experiment lasted seven weeks. The quails on the CD and D25% diets began laying at 48 days, compared with 50 days for those on the D50% diet. At the end of the trial, the laying rates were 53 per cent, 55 per cent and 57.5 per cent for CD, D25% and D50% respectively, with no significant difference ($P > 0.05$). However, egg weight was significantly lower in the D50% group ($P < 0.05$). The shape index and Haugh unit remained satisfactory in all three groups. However, the shell index was significantly lower with D50% (12.23 ± 2.04 per cent) than with CD (14.33 ± 1.45 per cent) and D25% (13.20 ± 2.13 per cent). Thus, cashew nut cake can replace soya meal by up to 50 per cent without significantly affecting laying performance or the overall quality of the eggs, apart from their weight and the shell index. A technical and economic analysis would be required to determine the profitability of these diets.

Keywords: Cashew Nut Cake, Eggs-lying, Egg quality, Quail

1 INTRODUCTION

Improving livestock production is one of the key drivers for contributing to food security and self-sufficiency in emerging economies, particularly in Côte d'Ivoire [1]. Achieving this objective requires the development of innovative livestock farming systems, in particular through the promotion of short-cycle species capable of rapidly producing animal-sourced foodstuffs. In this context, the Japanese quail (*Coturnix japonica*), recognised for its hardiness, early maturity and high fertility, appears to be an attractive alternative to conventional poultry species. Furthermore, the high protein and mineral content of eggs – including magnesium, calcium and potassium – makes them a healthy food [2]; [3]; [4]. However, the full realisation of its zootechnical potential and the production of high-quality products remain closely linked to ensuring that its nutritional requirements are adequately met.

However, the country's dependence on certain inputs such as wheat bran and soya, combined with import duties on livestock inputs, has led to an increase in the cost of feed. This poses a major constraint on the profitability of livestock farming in general, and poultry farming in particular, as feed accounts for 80 per cent of production costs in the poultry sector [5]. It is therefore becoming urgent to find locally available and sustainable alternatives to address this situation. Among these alternatives is the cashew nut, for which Côte d'Ivoire has been the world's leading producer since 2021, with production expected to reach 1.5 million tonnes by 2025 [6]. The utilisation of sorting rejects or downgraded cashew kernels resulting from processing could provide a valuable source of protein. Indeed, cashew kernel cake is an excellent source of protein given its high protein and mineral content [7]; [8]; [9]. Its use in quail feed will help to reduce costs for farmers and make this activity more sustainable.

However, its use in quail feed has remained limited to date. A few studies have been carried out on the growth performance of meat-type quails [9] and on the carcass yield and egg quality of egg-laying quails [10]. The overall objective of this study was therefore to evaluate the use of cashew nut cake in the diet of meat-type quails. Specifically, the aim was to investigate the effect of incorporating it into the feed on laying performance, as well as on the external and internal physical characteristics of the eggs laid by meat-type quails.

2 MATERIALS AND METHODS

2.1 Experimental site and livestock building

The Peleforo GON COULYBALY University's experimental poultry farm was used as the farm throughout the experiment. The rearing programme took place in a building 14 metres long and 8 metres wide, with a corrugated iron roof and low walls 0.5 metres high. The average temperature hovered around 27°C, with relative humidity ranging between 82% and 92%.

2.2 Matériel biologique

The animal test subjects consisted of 42-day-old quails. They were selected on the basis that they had no physical and/or reproductive impairments. The plant material tested consisted of defatted cashew nut cake.

2.3 Livestock equipment and technology

Inside the rearing building, there were aviaries consisting of galvanised wire mesh cages, each measuring 1 m^2. These served as housing for the various experimental batches of quails. Each aviary was equipped with a water trough and a feed trough with capacities of 3 litres and 3 kg respectively. The technical equipment consisted of two electronic scales. One, an ECO model with a capacity of 0.5 kg and an accuracy of 0.01 g, was used to weigh the animals, eggs and small quantities of the inputs used in feed production. The second set of scales, a Jjoer model with a capacity of 3 kg and an accuracy of 1 g, was used to weigh large quantities of feed. A Dasqua vernier caliper with an accuracy of 0.01 mm was used to measure the eggs.

2.4 Preparation of experimental feed

The main ingredients used in the preparation of the various feeds were maize flour, wheat bran, soya meal and/or cashew nut cake. The control diet (CD) consisted of 100 per cent soya meal as the protein source, whilst the test diets contained 25 per cent (D25%) and 50 per cent (D50%) cashew nut cake as a substitute for soya meal. To avoid the risk of poisoning and mould infestation, the diets were prepared in sufficient quantities to feed the animals for three days and were then replenished throughout the experimental period. The centesimal and biochemical composition of the different diets is presented in Table 1.

Table 1: Percentage composition and biochemical properties of the inputs and experimental feeds

Inputs (%)	Percentage composition		
	CD	D25%	D50%
Maize	55	55	55
Soya meal	30	22.5	15
Cashew cake	0	7.5	15
Wheat bran	4	4	4
Shell flour	6	6	6
Salt	1	1	1
Mineral and vitamin supplement	4	4	4
Total	100	100	100
	Biochemical composition		
Dry matter (%)	93.83 ± 1.01	94.66 ± 1.03	94.16 ± 1.07
Mineral matter (%)	3.05 ± 0.37	3.31 ± 0.33	3.48 ± 0.32
Crude protein (%)	18.66 ± 0.12	18.83 ± 0.17	18.77 ± 0.13
Fat (%)	3.42 ± 0.7	3.36 ± 0.41	3.21 ± 0.37
Crude fibre (%)	3.17 ± 0.22	3.28 ± 0.21	3.30 ± 0.27
Metabolisable energy (kcal/kg)	2,695.7	2,690.2	2,676.3

CD: Control diet; D25%: Diet containing 25% cashew nut cake; D50%: Diet containing 50% cashew nut cake.
Mineral and vitamin supplement: Vitamin A 199,500 IU/kg, Vitamin D3 59,800 IU/kg, Vitamin E (totally racemic alpha-tocopheryl acetate) 300 mg/kg, Iron (II) sulphate monohydrate 798 mg/kg, Copper (II) sulphate pentahydrate 299 mg/kg, Zinc sulphate monohydrate 1,097 mg/kg, Manganous oxide 1,396 mg/kg, Calcium iodate 20.0 mg/kg, Sodium selenite 4.00 mg/kg, L-lysine sulphate 424.30 mg/kg

2.5 Livestock management

The experimental groups each consisted of 90 quails. These quails came from a breeding farm where they were fed three types of diet formulated according to the animals' physiological stage. These were a control diet, an D25% diet and an D50% diet. Each group was divided into three batches of 30 quails. Each group was assigned an egg-laying diet comprising the control feed, the D25% feed and the D50% feed. The quails were housed at a density of 30 per m^2 and fed *ad libitum*. Food rations were divided into two meals to prevent waste. The first meal was served in the morning and the second in the evening. Water from the mains supply was used to water the animals at all times. Every day before feeding, the water troughs and feed troughs were washed with soapy water and disinfected with bleach. The used poultry litter was changed every five days.

2.6 Assessment of the laying rate and external physical characteristics of the eggs

The eggs were collected early in the morning before feeding and the first portion of the ration. They were placed in trays labelled according to the diet and then counted. The recorded values were used to determine the daily egg-laying rates (LR) for each group using the following formula:

$$\text{LR} = \frac{\textit{Number of eggs}}{\textit{Number of quails}} \boldsymbol{X\ 100}$$

Once transferred to the laboratory, external physical parameters such as the weight, length and diameter of the eggs were assessed. These measurements were carried out on a sample of 30 eggs per diet. The weight of each shell was also measured individually after the eggs had been carefully cracked and their contents emptied into a Petri dish. The shells were then carefully washed with water to remove any remaining albumen. They were left to dry at room temperature for 24 hours and subsequently weighed. These measurements were used to calculate the egg shape index (SI) and the shell indexe (SP) according to the formulae established by [11]:

$$\text{SI} = \frac{\text{Diameter of the egg}}{\text{Length of the egg}} \text{ X } 100$$

$$SP = \frac{\text{Weight of the eggshell}}{\text{Weight of the egg}} \text{ X } 100$$

The shape index (SI) is useful for measuring the mechanical strength of an eggshell [12]. According to [11], the SI of a normal egg lies between 70 and 77 per cent.

2.7 Assessment of the internal physical parameters of eggs

The weight of the egg's contents was measured using an electronic balance. This had been previously tared using a Petri dish into which the edible material (the combined yolk and albumen) had been emptied. The length and thickness of the albumen were then determined. Similarly, the diameter and thickness of the yolk were measured using a vernier caliper after it had been separated from the albumen using a teaspoon. To measure the thickness of the yolk and the albumen, the thin metal rod of the vernier caliper was used. The rod was inserted vertically into the albumen or yolk until it touched the bottom of the Petri dish. The height was read as the distance from the rod to the edge formed by the bevel of the albumen or yolk. The values obtained were used to calculate the yolk index (YI) and the Haugh unit (HU), also known as the Haugh index, using the formulae below.

$$\textbf{HU} = 100 * \text{Log}\,(h + 7.57 - 1.7 * W^{0,37}) \text{ [13]}$$

Where h: albumen height (mm) ; W: egg weight (g) ; 7.57: correction factor for albumen height ; 1.7: correction factor for egg weight

The Haugh unit, created by Haugh in 1937, is a measure of the quality of egg proteins. According to [14] and [13]

- HU ≈ 99.6 (excellent quality)
- 90 : Quality (excellent)
- 75 - 90 : Quality (good)
- 60 - 75 : Quality (average)
- < 60 : Quality (poor)

$$YI = \frac{\text{Thickness of yolk}}{\text{Diameter of yolk}} \text{ X } 100 \text{ [15]}$$

2.8 Statistical analyses

The normality and homogeneity of the data were assessed using the Shapiro test, whilst the equality of variances was assessed using Levene's test. Where variances were found to be equal, the means were compared using one-way ANOVA followed by Tukey's post-hoc test. With regard to egg-laying rates, the G-test was used. The significance level was set at 5%. All statistical analyses were carried out using R software version 4.3.0.

3 RESULTS

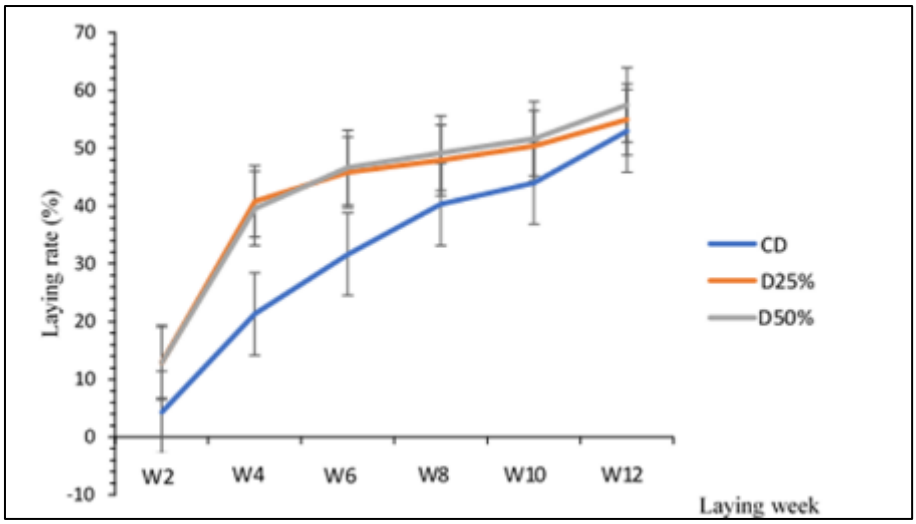
3.1 Effect of diets on the age at first egg-laying and the egg-laying rate

In this study, the quails on the control diet (CD) and the D25% diet began laying at 48 days (Table 2). Those on the D50% diet began laying at 50 days, two days later than the CD and D25% groups. The egg-laying rate of the quails in each dietary treatment group during the experiment is shown in Figure 1. The lowest egg-laying rate (21.33%) during week 4 was recorded in the animals on the CD diet, and the highest (40.83%) in those on the D50% diet. After three months of laying, the rates reached 53 per cent, 55 per cent and 57.5 per cent respectively for the birds on the CD, D25% and D50% diets. However, analysis of these values using the chi-squared test revealed no significant differences (P > 0.05).

Table 2: Effect of diet on the age (in days) at first laying

Diets		
Control diet	D25%	D50%
48	48	50

D25%: Diet containing 25 per cent cashew nut cake; D50%: Diet containing 50 per cent cashew nut cake and internal physical characteristics of the eggs laid by meat-type quails.



CD: Control diet; D25%: Diet containing 25 per cent cashew nut cake; D50%: Diet containing 50 per cent cashew nut cake. W: Laying week

Figure 1: Effect of diet on laying rate

3.2 Effect of diet on the external physical characteristics of eggs

3.2.1 Effect of diet on egg weight

The results relating to egg weight are set out in Table 3. Statistical tests applied to these values show that the quails on the control diet and those on the D25% diet produced eggs with statistically similar weights, regardless of laying age. Nevertheless, the egg weight of quails fed the D25% diet was higher throughout the entire experimental period. The mean egg weights were 12.29 ± 1.24 g and 12.69 ± 1.19 g for the control and D25% diets, respectively. Furthermore, the eggs from these two groups of quails were significantly ($P < 0.05$) heavier than those laid by quails in the D50% group, regardless of the quails' laying age.

Table 3: Effect of diet on egg weight

Settings		Diets			P value
		CD	D25%	D50%	
Weight of eggs (g)	W1	11.23 ± 1.40 ^{a}	11.50 ± 1.14 ^{a}	12.39 ± 1.65 ^{b}	5.5 x 10^{-3}
	W2	12.14 ± 1.26 ^{ab}	12.92 ± 1.30 ^{a}	11.63 ± 1.26 ^{b}	7.6 x 10^{-4}
	W3	12.35 ± 0.82 ^{a}	12.68 ± 1.08 ^{a}	12.21 ± 1.01 ^{a}	0.172
	W4	12.80± 1.46 ^{a}	12.88 ± 1.47 ^{a}	11.79 ± 1.05 ^{b}	3 x 10^{-3}
	W5	12.54 ± 1.32 ^{ab}	12.88 ± 1.01 ^{a}	12.01 ± 1.40 ^{b}	0.031
	W6	12.67 ± 1.17 ^{a}	13.27 ± 1.08 ^{a}	11.69 ± 0.97 ^{b}	8.2 x 10^{-7}

The values for the indexed rows with the same letters are not significantly different at $P > 0.05$. CD: Control diet; D25 %: Diet containing 25% cashew nut cake; D50 %: Diet containing 50% cashew nut cake. W: Laying week

3.2.2 Effect of diet on the egg shape index

The values shown in Table 4 highlight the shape index (SI) of the eggs from the different diets. Analysis of these values reveals that all categories of eggs exhibited essentially the same physical strength regardless of the laying period and the quails' diet, apart from week 3, when it was higher (80.64 ± 3.10) for eggs from the D25% diet.

Table 4: Effect of diet on the shape index (SI)

Settings		Diets			P value
		CD	D25%	D50 %	
SI (%)	W1	79.55 ± 5.36 ^{a}	80.30 ± 2.40 ^{a}	78.87 ± 1.72 ^{a}	0.066
	W2	78.05 ± 3.70 ^{a}	79.73 ± 2.42 ^{a}	79.09 ± 2.29 ^{a}	0.161

	W3	78.19 ± 3.31 [b]	80.64 ± 3.10 [a]	78.70 ± 2.41 [b]	4.6×10^{-3}
	W4	77.29 ± 3.45 [b]	79.91 ± 2.07 [a]	78.75 ± 1.55 [ab]	1.9×10^{-3}
	W5	77.90 ± 5.11 [a]	79.24 ± 1.98 [a]	79.65 ± 6.74 [a]	0.373
	W6	77.76 ± 2.93 [a]	78.80 ± 2.71 [a]	78.74 ± 2.06 [a]	0.220

The values for the indexed rows with the same letters are not significantly different at P > 0.05. CD: Control diet; D25 %: Diet containing 25 per cent cashew nut cake; 50 %: Diet containing 50 per cent cashew nut cake. W: Laying week

3.2.3 Effect of diet on the shell index

The results relating to shell indices as a function of diet are presented in Table 5. An examination of the values shows that the highest values alternated between diets over time. However, the mean shell index over the entire experimental period for quail eggs from birds fed diet D50% was statistically lower, with a mean of 12.23 ± 2.04% (P < 0.05). It was, however, statistically similar for the control diet and D25% diets, with values of 14.33 ± 1.45% and 13.2 ± 2.13% respectively.

Table 5: Effect of diet on the shell index

Settings		**Diets**			**P value**
		CD	D25%	D50%	
Shell index (%)	W1	14.91 ± 0.78[a]	13.47 ± 0.65[b]	14.16 ± 0.74[a]	0.032
	W2	14.57 ± 0.76[a]	14.68 ± 0.82[a]	12.41 ± 0.76[b]	0.004
	W3	12.64 ± 0.75[a]	15.96 ± 0.73[b]	14.81 ± 0.78[b]	0.011
	W4	15 ± 0.78[a]	15.2 ± 0.8[a]	10.7 ± 0.77[b]	0.000
	W5	14.09 ± 0.75[a]	13.6 ± 0.76[a]	11.08 ± 0.74[b]	0.020
	W6	14.8 ± 0.77[a]	14.6 ± 0.78[a]	10.6 ± 0.73[b]	0.010

The values for the indexed rows with the same letters are not significantly different at P > 0.05. CD: Control diet; D25 %: Diet containing 25 per cent cashew nut cake; D50 %: Diet containing 50 per cent cashew nut cake. *W: Laying week*

3.3 Effect of diet on the internal physical characteristics of eggs

3.3.1 Effect of diet on the yolk index (YI)

An examination of Table 6 reveals that the yolk index (YI) vary significantly between diets throughout the experimental period. However, in the second week of laying, no significant difference was observed between the diets (P = 0.776). It is also noted that in the first week (W1) and the third week (W3), for the D50% diet, the YI increased significantly compared with the control, whilst for weeks W4, W5 and W6, the opposite effect was observed, with a significant decrease in the YI at 50%.

Table 6: Effect of diet on the yolk index

Settings		**Diets**			**P value**
		CD	D25%	D50%	
YI (%)	W1	33.12 ± 8.17[b]	36.61 ± 7.88 [b]	42.37 ± 6.10 [a]	2.8×10^{-5}
	W2	47.03 ± 12.4 [a]	43.13 ± 7.28 [a]	42.45 ± 4.80 [a]	0.776
	W3	44.40 ± 3.59 [a]	48.05 ± 6.85 [b]	42.54 ± 5.70 [a]	8.7×10^{-4}
	W4	43.88 ± 2.80 [ab]	45.81 ± 2.94 [a]	40.72 ± 5.13 [b]	5.4×10^{-4}
	W5	43.80 ± 9.14 [b]	49.03 ± 7.22 [a]	41.28 ± 4.00 [b]	2.2×10^{-4}
	W6	49.85 ± 3.84 [a]	50.23 ± 5.96 [a]	40.45 ± 2.53 [b]	9.9×10^{-16}

The values for the indexed rows with the same letters are not significantly different at P > 0.05. CD: Control diet; D25%: Diet containing 25% cashew nut cake; D50%: Diet containing 50% cashew nut cake. W: Laying week

3.3.2 Effect of diet on the Haugh unit

An analysis of the Haugh unit (HU) data reveals differing values across the different diets (Table 7). Eggs from quails on the D25% diet showed a significantly higher HU compared with those from the control group and the D50% diet group ($P < 0.05$) throughout the experimental period. Furthermore, the D50% diet showed no significant effect during the study, with values that were statistically identical to those of the control group ($P > 0.05$).

Table 7: Effect of diet on the Haugh unit

Settings		Diets			P value
		CD	D25%	D50%	
Haugh unit	W1	82.24 ± 1.34 [a]	92.4 ± 1.00 [a]	84.13 ± 1.09 [a]	5.6×10^{-10}
	W2	79.89 ± 1.13 [b]	86.41 ± 1.06 [a]	77.2 ± 1.53 [b]	2.7×10^{-13}
	W3	79.71 ± 1.04 [b]	80.42 ± 0.98 [a]	77.11 ± 1.03 [b]	4.1×10^{-5}
	W4	78.91 ± 1.02 [b]	87.35 ± 1.02 [a]	76.64 ± 1.02 [b]	2.5×10^{-8}
	W5	78.69 ± 1.13 [b]	84.72 ± 1.21 [a]	77.82 ± 1.08 [a]	1.6×10^{-10}
	W6	79.67 ± 1.08 [b]	86.79 ± 1.10 [a]	77.01 ± 0.95 [a]	7.5×10^{-15}

The values for the indexed rows with the same letters are not significantly different at $P > 0.05$; CD: Control diet; D25%: Diet containing 25 per cent cashew nut cake; D50%: Diet containing 50 per cent cashew nut cake. W: Laying week

4 DISCUSSION

Tests carried out on production parameters revealed that quails fed a diet containing 25 per cent cashew nut cake began laying eggs sooner than those on the 50 per cent diet. This may be due to the birds' body weight. Previous studies on laying pullets have shown that incorporating 50 per cent of this ingredient into the feed enabled the birds to achieve a live weight comparable to that achieved on a soya meal-based diet [16]. This could enable the birds to reach sexual maturity and lay eggs at an early age. However, research carried out by [17] produces results that contradict our analysis. They found that the live weights of broiler chickens were significantly higher in animals fed soya meal (1322.67 ± 168.33 g) as a protein source than in those fed a diet containing 2.5 per cent cashew nut cake (1235.46 ± 171.00 g).

Research into the effect of incorporating cashew nut cake into the diet of laying quails revealed similar egg-laying rates at the end of the experiment for all three diets. This similarity in laying rates could be due to the fat content, which was not only low but also broadly similar across the three diets in our study, at 3.42 ± 0.7% (CD), 3.36 ± 0.41% (D25%) and 21 ± 0.37% (D50%). Indeed, a high fat content in the feed could affect egg production rates. Thus, in the study by [18], hens fed the diet with the highest fat content amongst the three diets tested showed a decline in egg production rates. The same findings were reported by [19]. These authors observed a significant drop in egg production rates in laying hens when the diet contained more than 5 per cent un-de-oiled cashew nut flour, alongside a gradual increase in the fat content of the birds' feed.

Statistical tests applied to the values obtained during the study of the effect of cashew nut cake on the egg shape index showed that all eggs collected, regardless of diet, had good shell strength, with an egg shape index ranging from 78.74 ± 2.06% to 80.30 ± 2.40%. These values are above those defined by [12] for a normal egg (70–77 per cent). It can therefore be concluded that the inclusion of cashew nut cake in quail feed has no negative effect on the egg shape index; on the contrary, it improves this parameter. These observations could be explained by the protein content of 18 per cent, which would have been sufficient to meet the requirements of laying quails. Indeed, [20] obtained an egg shape index of 78 per cent in laying quails with a crude protein content of 18 per cent in their feed. Furthermore, the egg shape index of the eggs obtained in their studies from quails fed diets containing 20% and 22% crude protein did not differ statistically from those of eggs from birds fed a diet containing 18% crude protein. However, [21] state in their work that, to achieve optimal performance, laying quails require a metabolisable energy intake of 2,900 kcal/kg and a crude protein content of 21%. [22] obtained egg shape index ranging from 77% to 78% with crude protein levels of 18%, 20% and 22% in laying quails.

With regard to the shell index, its value decreases as the amount of cashew nut cake in the feed increases, indicating reduced mechanical strength of the eggs. These observations corroborate those of [18]. Indeed, these authors observed a significant decrease in the weight of chicken egg shells, from 7.13 g for a diet without cashew nut cake to 6.21 g for a diet containing cashew nut cake. They attributed this to the high phosphorus content in the feed tested, due to the high concentration of this mineral in cashew nut cake, which is thought to have impaired the quality of the shell. Similarly, [23] observed in their study a significant reduction in the mechanical strength of hen's eggs from 4,540 kgf to 4,220 kgf

when they incorporated 2.2 g and 3.6 g of non-phytic phosphorus per kg of feed, respectively, in hens aged between 66 and 81 weeks. Although the chemical analysis of the feed did not cover phosphorus, studies on the replacement of soya meal with 100 per cent cashew nut cake in the feed showed a very high phosphorus content (1.45 mg per 100 g of DM) compared with less than 0.1 mg per 100 g of DM in the feed using soya as the source of vegetable protein. However, it is difficult at this stage to attribute these values observed in our research to the latter.

In poultry farming, the freshness of eggs is an important factor. One of the methods used to quantify this is the yolk index. According to [24], this index for a fresh egg range between 0.30 and 0.50 (30 per cent and 50 per cent), with an average value of 0.42, or 42 per cent. In our study, the eggs from the R25 per cent and R50 per cent groups recorded values ranging between 30 per cent and 50 per cent. We conclude from these results that cashew nut almond meal did not reduce the YI of the eggs under the conditions tested. These favourable values could also be explained by the storage duration of the eggs in our study, which did not exceed 7 days. According to the study in [25], the YI of quail eggs deteriorates as storage time increases. Indeed, the authors obtained average YI values of 0.44 ± 0.04 (44%) and 0.11 ± 0.01 (11%) for eggs stored for zero to 60 days, respectively.

The change in HU observed in our study suggests that cashew nut cake, when incorporated at a moderate rate, has a positive effect on egg quality. This could be explained by an increase in the thickness and viscosity of the albumen. A similar conclusion was reached by [26]. According to the authors, this characteristic is particularly attributable to the content and quality of proteins, such as ovalbumin and lysozyme, as well as to the acid-base balance of the albumen. However, this increase falls slightly, without falling below the minimum value (70) for an egg of excellent quality. [27] obtained UH values of 84.23 and 86.78 for eggs from laying hens fed diets containing 25 per cent and 50 per cent cashew nut cake respectively, thereby confirming the beneficial effect of cashew nut cake on egg quality.

5 CONCLUSION

The external physical quality of the eggs, in particular their weight and shape index, was generally good with the diets tested. However, the control group and the 25% group produced significantly better eggs than the 50% group. The diets tested yielded shape indices similar to those of the control group and eggs of good protein quality, as indicated by the UH, which ranged between 75 and 90. Thus, cashew nut cake can replace soya meal by up to 50 per cent without significantly affecting laying performance or the overall quality of the eggs, apart from their weight and shell index. A technical and economic analysis would be required to determine the profitability of these diets.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

We would like to thank the manager of the botanical garden for agreeing to host the experimental farm in part of the garden.

Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

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