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Utilization of *Citrullus lanatus* seed cake as feedstuffs: influence on broiler chicks' growth performance

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1 ABSTRACT

This work aims to evaluate the effect of the inclusion of *Citrullus lanatus* "Pistachio" seed cake (CSC) in the diet on the productivity of broiler chicks. This work has focused on 195 chicks of two (2) weeks of age. These were randomly distributed into 5 groups of 39 subjects each corresponding to 5 types of experimental diets A_0, A_1, A_2, A_3 and A_4 containing 0, 26.6, 30 and 39% seed cake of *C. lanatus* in substitution of soya seed cake (SSC). The corresponding proteins contents were as follow: 14.87, 19.63, 19.64, 20.04 and 19.61%. Fee intake was measured on daily basis and weighing on weekly basis. At the end of the study, body weights of the subjects under treatment were significantly higher (1160-1590 g). No significant adverse effects were observed in feed conversion, which increased from 0.63 to 1.71. All the results showed that incorporation of *C. lanatus* seed cake up to 26.6% in the diet could be an alternative way of improving food and income in the production of broilers.

2 INTRODUCTION

Poultry are defined as monogastric animals, which depend on highly digestible feed ingredients to improve their growth performance and health (Ayssiwede *et al.*, 2011). In developing countries, poultry production is confronted to various constraints among which food is a major challenge because of the dependency on some conventional ingredients that are imported or locally expensive (Doumbia, 2002). Indeed, the diets for poultry are composed primarily of a mixture of several feedstuffs such as cereal grains, soybean meal, animal by- product meals, fats, and vitamin and mineral premixes. These feedstuffs, together with water, provide the energy and nutrients (proteins, amino acids, carbohydrates, fats, minerals and vitamins) that are essential for the bird's growth, reproduction, and health (Rhekis, 2002). The energy for maintaining the bird's general metabolism and for producing meat and eggs is provided by the energy-yielding dietary components, primarily carbohydrates and fats, but also protein (Hofman, 2000). As concern proteins, their dietary requirements in feedstuffs are linked to the amino acids contents. Indeed, amino acids obtained from dietary proteins are used by animals to fulfil a diversity of functions as primary constituents of structural and protective tissues and precursors of many important non-protein body constituents (NRC, 1994). The recommended protein intake is in the range 180 to 240 g of total protein per kilogram of feed for

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chickens according to their stage of life (Lachapelle, 1995; Rhekis, 2002). Essential amino acids must be supplied by the diet because the chickens (Picard et al., 1993) cannot synthesize them. The most important amino acids namely lysine and methionine are often deficient in the diet and are thereby limiting amino acids (Mendonca and Jensen, 1989; Lachapelle, 1995). Moreover, the common protein ingredients (fish meal, groundnut cake and soybean) and others used in poultry feeding have become too expensive because of their excessive demand (Ayssiwede *et al*., 2011). Consequently, this fact has highly reduced access to these resources for traditional poultry compared to industrial poultry farmers. Thus, in order to contribute to the sustainable poultry livestock and to the food security, it is necessary to increase their productivity by improving strategies of feeding through unconventional and local feed resources utilization. The search of local feed resources for poultry have focused attention of several researchers on Cucurbits seeds from *Citrullus lanatus* which are considered as valuable sources of proteins (Shayo *et al*., 1997 ; Loukou *et al*., 2007 ; Ojieh *et al*., 2008 ; Ayssiwede *et al*., 2011 ; Ogbe and George 2012 ; Shazali *et al*., 2013 ; Ngoran *et al*., 2015). According to these authors, proteins contents of seeds from *Citrullus lanatus* varied from 25 to 30%. In a botanical point of view, *Citrullus lanatus* is monoecious specie, yellow flowered and creeping annual vine, presenting leaves deeply divided into 5-7 more or less subdivided lobes. The fruits are round or oval, uniformly light green or mottled light and dark green and contain a white bitter flesh embedding about 200 seeds. In Côte d'Ivoire, two cultivagroups (wlewle and bebu) of *Citrullus lanatus* (Thunberg) Matsumura & Nakai have been distinguished based on the morphology of seeds which are usually consumed as soup thickeners or cakes (Zoro Bi *et al*., 2003, 2006). In order to promote non-conventional agro-resources as potential feedstuffs for poultry, this study aimed to evaluate the effect of processed cake from *Citrullus lanatus* seeds used in feeding, on broiler chicks growth performance.

3 MATERIAL AND METHODS

3.1 Experimental location and duration: The experiment was conducted in experimental open henhouse of 78 m^2, partitioned into five breeding box of 12 m^2 each and an extra box of about 18 m^2 serving as storage place for food and livestock machinery. This henhouse was located at Bingerville (5°21' North and 3°54' West) in the District of Abidjan, Côte d'Ivoire. The experiment lasted for eight (13) weeks, from 2nd October 2014 to 17th January 2015.

3.2 Collection and processing of *Citrullus lanatus* seeds: Dried *Citrullus lanatus* seeds were collected from the rural women of Manfla village (City of Bouaflé, Côte d'Ivoire). These women process melon seeds called also "wlewle" for commercial purpose. The collected seeds were cleaned to remove dirt and were milled onto a laboratory crusher (Cullati, France). Prior to the extraction, the seed meal was packed in jute mallow bags with sides 30 cm x 10 cm and preheated at 50°C in an oven (Memmert, Germany) for 10 minutes to facilitate the extraction process. The sacks containing the meal were packed in batches into a press, which had a screw rod on top. The screw rod was used to squeeze the meal in the tub until a greater percentage of the oil was removed. The *Citrullus lanatus* seed cake (CSC) obtained after the oil extraction was weighed, sun-dried for four days and hammer milled. These were then incorporated into the various treatment diets of the broilers.

3.3 Experimental diets: Five (5) diets (starter-finition) were formulated (Table 1). Diets A_0 and A_1 contained 0% CSC (controls) had no CSC inclusions. The control diet A_0 was provided by MARIDAV Enterprise (Abidjan, Côte d'Ivoire) while control diet A_1 was formulated using 0% CSC and 20.6% soya seed cake (SSC). Diets A_2, A_3 and A_4 contained CSC at 26.6, 30 and 39% level. These diets had no SSC inclusions. Additionally, diets A_0-A_4 contained

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maize, palm kernel cake (PKC), wheat bran meal (WBM), cotton seed cake (CTSC) dicalcium phosphate, shellfish, common salt, L-Lysine (98%) and L-Methionine (99%). All the experimental diets were isonitrogenous. The maize, soya seed cake (SSC), palm kernel cake (PKC), wheat bran meal (WBM) used for the experiment was purchased from the collection of INRA (France) with respectively numbers INRA 82, INRA 190, INRA 182 and INRA 104. The standards L-Lysine and L-Methionine were provided from Sigma-Aldrich (USA).

Table 1. Composition of formulated diets for broiler chicks

	Diets				
Ingredients (%)	A0	A1	A2	A3	A4
Maize	-	60.00	54.00	42.00	50.00
SSC	-	20.60	0.00	0.00	0.00
CSC	-	0.00	26.60	30.00	39.00
PKC	-	2.50	2.50	2.50	2.50
WBM	-	11.00	11.00	11.00	11.10
CTSC	-	2.50	2.50	2.50	3.00
Salt (NaCl)	-	0.25	0.25	0.25	0.25
Shellfish	-	2.25	2.25	2.25	2.25
Dicalcium phosphate	-	0.50	0.50	0.50	0.50
L-Lysine	-	0.20	0.20	0.20	0.20
L-Methionine	-	0.20	0.20	0.20	0.20

SSC : soya seed cake ; CSC : *Citrullus lanatus* seed cake, PKC : palm kernel cake, WBM : wheat bran meal ; CTSC : cotton seed cake. A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake)

3.4 chicks and management: A total of 195-day-old Cobb 500 broiler chicks (*Gallus domesticus*) from FACI Enterprise (Abidjan, Côte d'Ivoire) were used in this work. All birds were feeding from 1 to 14 days of age with same commercial start diet (MARIDAV Enterprise) *ad libitum*. At 14th days of age, broilers chicks were allocated to five (5) groups (A_0, A_1, A_2, A_3 and A_4) with 39 birds each. The design used for the experiment was completely randomized (CRD). The birds were placed in a brooder house with wood shavings as litter after initial weight determination (mean weight per group). Light was supplied using 100W bulbs to provide the heat needed to maintain the optimum temperature range for the birds during the brooding period. Fifteen flat feeders (10 L) and 10 drinking bowls (5 L each) were used to supply feed and water respectively to the birds. Feeding was carried out twice daily at 07.00 and 16.00 GMT hours. Feed and birds were weighed with a 20 kg top pan scale during the experiment. Feed and water were given *ad libitum* from the brooding to the finishing stage.

3.5 Data collection: Body weights (BW) of the birds per pen were recorded weekly, every Monday morning, and an average was taken as weight per pen using the formula:

$$BW = \frac{Total\ weight\ per\ pen}{Number\ of\ birds\ per\ pen}$$

The body weight gain (BWG) was taken at the beginning of each weighing week. This was recorded as the initial body weight. The body weight for the week was recorded as the final body weight. The initial body weight was deducted from the final body weight to obtain the body weight gained for the week and the body weight gain was calculated using the formula:

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$$BWG = \frac{Final\ weight - Initial\ weight}{Number\ of\ days}$$

Feed intake ratio (FCR) was recorded every Monday morning on a weekly basis. Diets were offered per replicates during the week and leftovers at the end of the week were weighed. Feed intake, on a dry matter basis, was calculated by subtracting feed leftovers from total feed offered. The feed conversion ratio of the birds was calculated as the ratio between feed intake and body weight as indicated by the formula:

$$FCR = \frac{Feed\ intake}{Body\ weight}$$

Mortalities (M) were recorded throughout the experimental period. Percentage mortality was calculated as:

$$M = \frac{Number\ of\ dead\ birds}{Number\ of\ birds\ per\ treatment} \times 100$$

Chemicals analysis: The formulated broiler diets used in this study were analysed using the methods of the Association of Official Analytical Chemists (AOAC, 1990). All determinations were done in triplicate. Total carbohydrate was determined by the difference of the sum of all the proximate composition from 100%.

Statistical analysis: Analysis was conducted in triplicate and results were expressed as means ± standard deviation. Effect of the diets on broilers BW, BWG and FCR were test using one-way analysis of variance (ANOVA 1). Significance differences between means were determined using Newman-Keuls test at significance level of 5%. STATISTICA.7.1. software was used. Effect of the diets on broilers mortality was tested using a Khi-deux test with EXCEL.2010 software.

RESULTS AND DISCUSSION

Physicochemical parameters of *Citrullus lanatus* seed cake are given in Table 2. The results of analysis indicated that the proteins content of diet A0 (14.87%) is 4.8% lower than those of diets A_1, A_2 and A_3 and 5.2% than A_4 ($p < 0.05$). The proteins contents of diets A_1, A_2, A_3 and A_4 were in accordance with the protein requirements of broiler chickens estimated to 18-24%, depending of their stage of life (Lachapelle, 1995; Rhekis, 2002). Dietary proteins are used by poultry to fulfil a diversity of functions as primary constituents of structural and protective tissues and precursors of many important non-protein body constituents (NRC, 1994). The evolution of body weight of broiler chicks during dietary treatment is depicted in Figure 1. From the beginning to the end of the experiment, incorporation of *C. lanatus* seeds cake was conducted to the increase of body weight. From the 14^{h} day to 42 days of age, the weight gain of the animals was significantly different ($p < 0.05$) with each type of diet. At 42 days of age, an average weights of 1730, 1590, 1420, 1260 and 1160 g were respectively recorded for diets A_0, A_1, A_2, A_3 and A_4. The highest body weight observed for the diet A0 could be explained by the lower content (5.43%) of crude fibres contrary to other diets. Indeed, fibres include other carbohydrates such as cellulose, hemicellulose, pentosans, all of which are poorly digested by poultry. Thus, these dietary carbohydrates often contribute little to meeting the energy requirement of poultry, and some adversely affect the digestive processes of poultry when present in sufficient dietary concentrations (Bedford *et al.*, 1991). It was also observed that increasing the rate of incorporation of *C. lanatus* seed cake had decrease the body weight. This result is similar to that obtained by Arbouche *et al.* (2012). Indeed, these authors indicated that the higher rate of incorporation of almond apricot cake is linked to the decrease in body weight of broilers chicks. This fact could be explained by the presence of condensed tannins in the husks of *C. lanatus* seeds. These components decrease protein digestibility by making them unavailable (Larbier and Leclercq,

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1992). The body weight gain registered during this study is shown in Table 3. At 21 days of age, the best weight gain was observed with diet A_0 (50.71 ± 0.06 g) followed by the diet A_1 (36.61 ± 0.18 g). At the same time, the lower body weight gain was observed with the diet A_4 (27.50 ± 0.50 g). However, the diets A_2 and A_3 presented a similar effect (35.00 ± 1.05 and 34.64 ± 0.62 g). At 28 days of age, the diets A_3 and A_4 were more productive than the control diet A_0 and this result corroborates those of Shazali *et al.* (2013) who revealed higher body weight gain in subjects fed the diet containing the highest percentage of *C. lanatus* seed meal. The diet A_2 induced a greater effect than the control diet A_1 at 35 days of age (52.14 ± 0.79 g). The body weight gain induced by the same diet was higher than that of the control diet A_0 at 42 days of age. The effect of *C. lanatus* seed cake incorporation on feed conversion ratio is presented in figure 2. Consumption indices increase while considering all the 5 diets during the experiment. The diet A_2 was characterized by the highest value (1.30 ± 0.11) of feed conversion ratio at 28 days of age while the best value (1.71 ± 0.05) was observed for diet A_4 at 42 days of age. With reference to INRA (1989) feed conversion ratios (1.47; 1.64; 1.76; 1.97 at 21, 28, 35, 42 days of age, respectively) for broiler mixed sexes, the diets A_2, A_3, A_4 could be suitable for poultry. Nevertheless, the feed conversion ratio obtained in this study were below those (1.8 to 2.72) recorded by several authors Ayssiwèdé *et al.* (2009); Tendonkeng *et al.* (2009); Diaw *et al.* (2010). This result may be due the different conditions broiler chicks feeding. The values of the mortality for different treatment groups are presented in Table 4. Mortality in all the groups varied from with a level of from 2.56% (B_2) to 17.95% (B_3). Furthermore, the starting phase gave a mortality rate of 2.99 %. The first mortality occurred at age day 21 in the control groups B_0 and B_1. No death was observed at 28 days of age. At 42 days, a high mortality rate was recorded in the group B_3 (12.82 %). Mortality was more pronounced at this time in all groups, except the control group B_0. The registered mortality at 21 days of age is above the admitted standards (5%) for poultry in the tropics. The group B_4 receiving a high protein diet (20.04%) with 39% of cucurbit meal (with husks) and 19.46% fibres, highlighted more cases of mortality especially at 42 days of age. This mortality may be due to significant presence of anti-nutritional factors such as condensed tannins, which induce the slowdown in the synthesis of immune proteins (Larbier and Leclercq, 1992).

Table 2: Chemical composition of diets for broiler chicks

Parameters (%)	Diets				
	A0	A1	A2	A3	A4
Moisture	12.14± 0.10	12.19± 0.15	11.74± 0.10	11.29± 0.15	11.70± 0.20
Ash	4.04± 0.20	5.43± 0.10	4.45± 0.11	6.84± 0.15	5.77± 0.15
Proteins	14.87± 0.15	19.63± 0.01	19.64± 0.10	19.61± 0.02	20.04±0.00
Lipids	9.14± 0.10	10.87± 0.20	12.20± 0.00	10.76± 0.30	11.69± 0.10
Crude fibres	5.43± 0.00	9.39± 0.20	15.67± 0.05	19.30± 0.25	19.46± 0.05
Carbohydrates	66.52± 0.30	54.67± 0.12	48.03± 0.10	42.88± 0.20	43.61± 0.02

Values are given as mean ± SD for triplicate. A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake)

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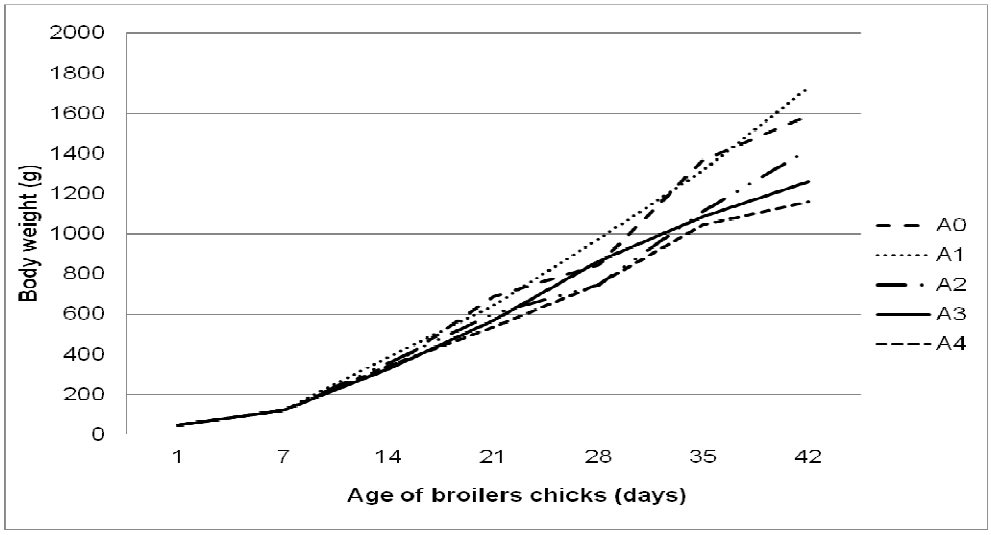

Figure 1: Evolution of body weight during feeding of broiler chicks. A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake).

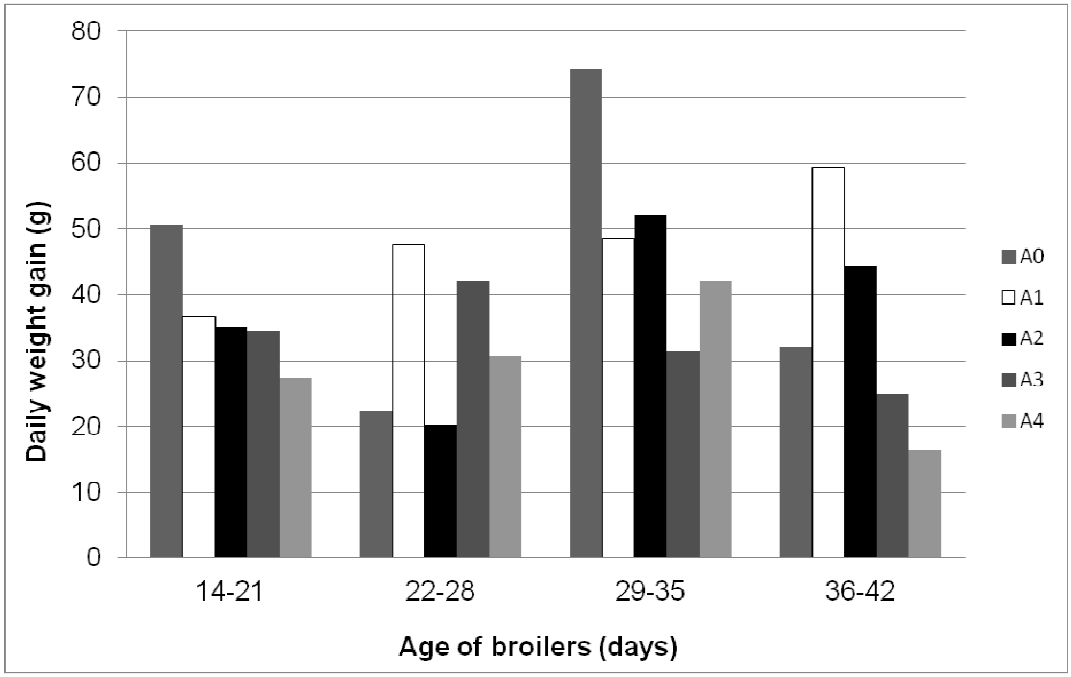

Figure 2: Evolution of body weight during feeding of broiler chicks. A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake)

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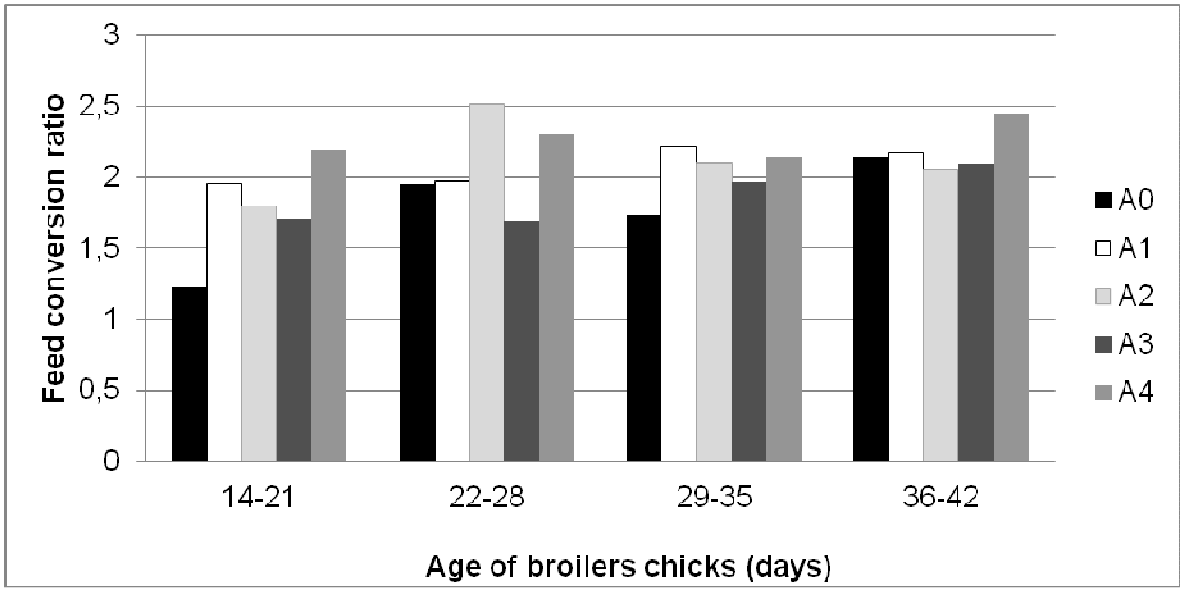

Figure 3: Evolution of feed conversion ratios of broilers chicks. A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake)

Table 3: Body weight gain of broiler chicks

Age (days)	Diets					Statistics	
	A0	A1	A2	A3	A4	F	P
14 to 21	50.71 ± 0.06^{a}	36.61 ± 0.18^{b}	35.00 ±1.05^{c}	34.64 ± 0.62^{c}	27.50 ± 0.50^{d}	603.06	<0.001
22 to 28	22.33 ± 0.57^{d}	47.50 ± 0.50^{a}	20.36 ± 0.72^{e}	42.14 ±0.79^{b}	30.71 ± 0.61^{c}	1009.93	<0.001
29 to 35	74.29 ± 0.61^{a}	48.57 ± 1.40^{c}	52.14 ± 0.79^{b}	31.43 ±0.44^{e}	42.14 ±0.79^{d}	981.05	<0.001
36 to 42	32.14 ± 0.79^{c}	59.29 ± 1.23^{a}	44.29 ± 1.11^{b}	25.00 ± 1.00^{d}	16.43 ± 1.50^{e}	634.50	<0.001

Values are given as mean ± SD for triplicate. Differences between means are indicated by letters. $P < 0.05$. A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake)

Table 4: Mortality of broiler chicks during experiment (khi-2 test)

Age (days)	Mortality (%)					Khi2
	A0	A1	A2	A3	A4	
14 to 28	3 (39)	1 (39)	0 (39)	0 (39)	0 (39)	0.07
29 to 42	0 (36)	1 (38)	3 (39)	5 (39)	2 (39)	0.15
14 to 42	3 (39)	2 (39)	3 (39)	5 (39)	2 (39)	0.70

A0: trade feed (reference), and formulated feed substituted with 0% (A1), 26,60% (A2), 30% (A3) and 39% (A4) of cucurbit (*Citrullus lanatus* seed cake)

CONCLUSION

The aim of this study was to evaluate the effect of *Citrullus lanatus* seed cake on broiler chicks' growth performance. This work revealed that cake from cucurbits seeds are a good source of proteins and could be used in poultry feed. The experimental diet A_2 was better appreciated by the chickens compared to diets A_3 and A_4, respectively. These experimental diets have shown a considerable body weight gain. In addition, consumption indices changed with the age of the animals. The incorporation of *Citrullus lanatus* seed cake at 26.6% level, promotes zoo-technical performance by 14 to 42 days of age. To contribute to the promotion of cake from *C. lanatus*, seeds must be hulled before using them as feed for poultry. In this way, a study must be undertaken for better reproducible feed formulation.

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