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Growth Performance and Carcass Quality Characteristics of Cobb 500 Broiler Chicken Fed Rations with Different Levels of Water Lily *(Nymphae lotus)* Seed Meal

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Abstract

Effect of feeding different levels of Water lily seed meal (WLSM) on broilers performance, carcass characteristics and meat quality traits was studied for six weeks. Four levels of WLSM (T_1 = 0%; T_2 = 3%; T_3 = 6% and T_4 = 9%) were compared using 120 Cobb 500 chicks; 3 pens/treatment and 10 chicks/pens. Measured parameters were feed intake and body weights. On day 49, two broilers from each pen were slaughtered for carcass evaluation. Broilers performance in terms of daily feed intake, average daily gain and feed conversion ratio (FCR) were calculated for each treatment diet. Daily feed intake of 105.9 g, 106.7 g, 107.9 g and 109.9 g were recorded for T_1, T_2, T_3 and T_4, respectively. Average daily gains (g) were 69.28 (T_1), 70.75 (T_2), 70.80 (T_3) and 71.31(T_4). The FCR rested in the range of 1.51-1.54. No difference ($P>0.05$) was observed in the growth performance of the birds among the inclusion spectrum used, however, the best overall performance was attained at 9% incorporation of WLSM (T_4). Moreover, the highest mean weight of edible carcass like drumstick and thigh were obtained for birds fed on diet having the highest level of WLSM (T_4). Breast from broilers fed the commercial diets containing WLSM contained less fat and more protein than the control group ($P<0.05$), which confirmed the highest carcass quality. Conclusively, the inclusion of different levels of WLSM in the commercial ration of Cob-500 broilers is successful without compromising their performance and the carcass parameters.

Keywords: Carcass; Cobb 500 broilers; Feed intake; Growth performance; Water lily seed meal

Introduction

Poultry production supplies the rapidly growing human population with high value animal proteins through production of safe, high-quality food within a comparably short period (Yitbarek *et al.*, 2016). However, shortages of raw materials and consequent hikes in the price of commercial feeds are ruining its prospects. Feed consumption accounts for the major cost of poultry production which is responsible for more than 70% of the total cost (Medina *et al.*, 2020). Conventional feeds are not enough to mitigate the escalating feed shortage and price to make poultry production viable in Ethiopia. A key to sustainable poultry development is enlargement of the feed base through a quest for novel resources, particularly those not competing with human food. Aquatic plants like Water lily can offer alternative feed materials where availability of good quality commercial feeds are sparse or cost-prohibitive.

Nymphaea lotus (Water lily) is a flowering plant of the family *Nymphaeaceae*. It grows naturally as weed in water logged areas with wide distribution in the tropical and subtropical world (Abarike *et al.,* 2015). Personal observation affirmed that Water lily is one of the aquatic plants found year round in most fresh water bodies of Gambella region of Ethiopia. Water lilies have an exceptional ability to persist through the dry season with rhizomes. On the other hand, it was accepted that harvesting and processing water plants would result in a reduction of weeds in waterways besides providing a resource that could be used as animal feed.

Considerable efforts have been made over the last decade to explore the nutritional composition of Water lily seed for a probable use as an alternative feed for livestock (Muhammad *et al.,* 2012; Abarike *et al.,* 2015; Wasagu *et al.,* 2015). Water lily seed appears to be a potential source of nutrients. The work of Muhammad *et al.* (2012) revealed that Water lily seed contained 16.3% crude protein and 10% ether extract. The crude fiber content of the seed was in the range of 1.6 – 6.17% (Musa *et al.,* 2012; Wasagu *et al.,* 2015). Other constituents of Water lily seed are minerals and vitamins. Water lily seed contains essential elements such as Na, K, Mg, Mn, Ca, Fe and Zn in addition to antioxidant vitamins A, C and E (Musa *et al.,* 2012; Wasagu *et al.,* 2015). Furthermore, the concentrations of hazardous anti-nutritional factors including Oxalate and Tannins are essentially low in Water lily seed (Wasagu *et al.,* 2015). Rather the seeds have been suggested to possess antimicrobial properties, and can potentially help in reducing infections (Abarike *et al.,* 2015).

The high protein and mineral levels in Water lily seeds combined with the associated medicinal properties indicate that these materials could be used in poultry diets (Mohammed *et al.,* 2012; Abarike *et al.,* 2015). Despite various uses of Water lily seed as a potential feed resource, the feeding value of Water lily seed has not been fully investigated and pertinent data for poultry are lacking. This experiment was thus conducted to investigate the effect of different levels of Water lily seed meal, in broiler ration, on the growth performance, carcass characteristics and meat composition of Cobb 500 broiler chicken fed commercial diets.

Materials and Methods

Study site

The experiment was conducted in the poultry house of the School of Animal and Range Sciences, Hawassa University (Ethiopia). It is located at 7°4'N latitude and 38°31'E longitude.

Water lily seed meal preparation

The whole fruits of Water lily plant were collected from Jekow flood plain which is found at Nuer Zone of Gambella Regional State, Ethiopia. The fruits were harvested manually, and seeds were separated from the enveloping pods. After separation, the seeds undergo a process of sun drying, grinding and sieving to produce which is referred hereafter as Water Lily Seed Meal (WLSM). Adequate quantity of WLSM was produced in Gambella and transported to Hawassa University prior to the feeding experiment. The processes involved in turning seeds into meals are pictorially summarized below.

Photo 1. Collection of Water lily fruits from the Jekow flooded plain, Gambella region

Photo 2. Separation of seeds from the pods

Photo 3. The seed drying process (seeds spread thinly on silpauline sheet)

Photo 4. Seed sieving to get rid of unwanted materials

Broilers management and treatment diets

Day-old unsexed Cobb 500 broiler chicks (n = 120) were procured from Alema Farms PLC, and transported to Hawassa University. The chicks were reared together from 1 to 7 d of age, and maintained on a commercial crumble starter diet (CP = 20.5%, ME = 3050 kcal/kg DM). On the 8^{th} day of arrival, they were weighed and assigned to one of the four treatment diets in a completely randomized design (3 pens/treatment and 10 birds/pen). Each group of the 30 chicks was reared in separate, clean and disinfected deep litter pens (1.5 m x 1.5 m). Each pen had a watering and feeding troughs. The concrete floors were covered by saw-dust litter. Vaccinations against Newcastle and Gumboro diseases, and medications (Coccidiostat and vita-chick) were given as recommended. Mortality and any ill health signs were monitored each day.

Commercial grower and finisher broiler diets were purchased from Alema Farms PLC, Debre Zeit, Ethiopia. Then, Water lily seed meal was added on top of the commercial diets at 0, 3, 6 and 9% levels in the control (T_1), T_2, T_3 and T_4 groups, respectively. In each treatment group, the diets were split into two phases: grower (8–27 d) and finisher (28–49 d). The daily feed offer was divided into two equal portions and provided at 08:30 and 16:30 hours regularly. Daily feed refusals in each pen were weighed and recorded every next morning. Clean and fresh water was available at all times. All essential sanitary requirements were performed in the poultry raising units.

Chemical composition of feeds

Representative feed samples were taken from commercial diets (grower and finisher), Water lily seed meal and their mix (treatment diets) and analyzed in triplicates for nutrient content at animal nutrition laboratory of Hawassa University. Dry matter (DM), crude protein (CP), crude fiber (CF), ether extracts (EE) and total ash contents were determined according to AOAC (2005). Nitrogen was determined by Kjeldhal procedure and CP was computed as N*6.25. Besides, calcium and phosphorus contents were determined using atomic absorption spectrophotometer (AOAC, 2005). The metabolisable energy (ME) was estimated by the formula given by Wiseman (1987): ME (Kcal/ kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 Ash. The chemical composition and energy values of Water lily seed meal and commercial rations are presented in Table 1. The nutritional values of the experimental diets are presented in Table 2.

Table 1. Chemical composition and metabolizable energy of WLSM and commercial diets

Feed	Nutritional composition, % DM (unless specified)							
	DM	CP	EE	CF	Ash	Ca	P	ME, (kcal/kg DM)
Growers' diet	91.2	19.0	5.27	5.51	5.50	0.78	0.52	3524.55
Finishers' diet	88.2	18.0	6.03	7.44	6.50	0.67	0.57	3353.90
WLSM	89.3	18.72	1.19	4.92	2.85	0.45	0.36	3457.91

WLSM = Water lily seed meal; DM = Dry matter; CP = Crude protein; EE = Ether extract; CF = Crude fiber; ME = Metabolizable energy; Ca = Calcium; P = Phosphorus

Table 2. Nutritional composition of experimental diets with and without WLSM

Nutrients (% unless specified)	Growers' diet (8-27d)				Finishers' diet (28-49d)			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Dry matter	91.2	91.0	90.7	90.3	88.24	88.53	88.55	89.10
Ash	5.50	5.42	5.35	5.32	6.50	6.35	6.22	6.05
Ether extract	5.27	5.11	5.06	5.05	6.03	5.89	5.83	5.72
Crude fiber	5.51	5.35	5.32	5.28	7.44	7.38	7.33	7.29
Crude protein	19.0	19.08	19.25	19.56	18.0	18.19	18.45	18.66
Calcium	0.78	0.70	0.65	0.64	0.67	0.63	0.62	0.58
Phosphorous	0.52	0.48	0.45	0.44	0.57	0.54	0.52	0.49
ME	3524.6	3533.3	3537.1	3540.3	3353.9	3357.7	3364.2	3368.7

WLSM = Water lily seed meal; T_1 = Commercial diet containing 0% WLSM; T_2 = Commercial diet containing 3% WLSM; T_3 = Commercial diet containing 6% WLSM; T_4 = Commercial diet containing 9% WLSM; ME = Metabolizable energy (kcal/kg DM).

Data on broilers performance

The feed offered and refusals were weighted and recorded daily for each pen during the entire period (8 – 49 d). Feed intake was calculated as the difference between amount offered and amount refused. The difference was divided by the number of birds to determine the mean daily feed intake per chick/pen. The body weight of broilers was recorded on a pen basis at the beginning of the trial (8 d) and subsequently on a weekly interval. Body weight change per bird was determined by the difference between the final and initial body weight divided by the number of birds. Average daily gain per bird was computed by dividing body weight change for the number of experimental days. Feed conversion ratio (FCR) was calculated by dividing the feed consumed for the weight gained.

Data on carcass characteristics

After the last weight control (49 d), two broilers were randomly selected from each pen. Following a 12-hour period of feed deprivation, the birds were weighed immediately before slaughtering (considered as pre-slaughter weight). The weights of the carcass and their offal were assessed after dry de-feathered by hand plucking. The carcasses were sectioned into wing, back, breast, thighs, neck and drumstick portions. Weights of edible offals (skin, heart, gizzard and liver) and non-edible offal components (blood, spleen, intestine, lung, and urogenital tract) were recorded. The carcass dressing percentage was calculated as weight of dressed carcass without offals divided by pre-slaughter weight and multiplied by 100 (Yitbarek *et al.,* 2016).

Carcass quality parameters

Breast meat quality in terms of proximate composition, water holding capacity, cooking loss and pH were compared for each diet group. Similar to feed samples, the moisture, crude protein, fat, crude fiber, and total ash composition of meat samples were analyzed using standard methods (AOAC, 2005). Water holding capacity (WHC) was determined according to the method described by Hamm (1960) and the cooking loss according to the methodology proposed by Cason *et al.* (1997). The pH was measured by inserting the electrodes into the meat samples using a pH meter (Model 205, Testo AG, Lenzkirch, Germany). The pH meter was calibrated with standard buffers of pH 4.0 and 7.0 at 25ºC. A sample homogenized in distilled water (90 ml) was transferred into the beaker and electrode along with a temperature probe. The constant reading appearing on the pH meter base was noted and recorded as pH value.

Statistical analysis

The data were subjected to statistical analysis using SAS version 9.2 with one-way ANOVA. Means were separated using Duncan's multiple range test at 5% probability level. The statistical model used was: $Yij = \mu + Ti + Eij$.
Where, Yij = Dependent variable; μ = Overall mean; Ti = Effect of the i^{th} treatment diet; Eij = Effect of the random error.

Results and Discussion

Chemical composition of WLSM

The chemical analysis revealed that Water lily seed meal appears to be a potential source of nutrients (Table 1). The crude protein content (18.72%) of Water lily seed in the current study is higher than the values of 16.3% and 3.09% reported by Muhammad *et al.* (2012) and Musa *et al.* (2012), respectively. Ash content of WLSM (2.85%) was higher than the value (2.33%) reported by Musa *et al.* (2012) and Aliyu *et al.* (2017). Similar to the present figure (2.85%), the seed of *Nymphaea lotus* contains ash of 2.67% (Wasagu *et al.,* 2015). Ash content in a feed item gives an indication of its mineral content (Abarike *et al.,* 2015). The crude fiber content of WLSM observed in the current study (4.95%) was within the range of 1.6% - 6.17% reported by other studies (Musa *et al.,* 2012; Wasagu *et al.,* 2015). Slightly higher percentage of crude fiberwas reported in the *Nymphaea pubescens* seed (4.14%). The ether extract content obtained in this study was lower than the values of 9.95% which is reported by Mohammed (2012). Variations in nutritional compositions are generally attributed to multiple factors including seed maturity, intra species variations, drying mechanism and climatic condition of the respective locations (Aliyu *et al.*, 2017). Overall, the optimum metabolizable energy value (3457.91 kcal/kg DM) and high CP (18.72%) content of WLSM in the present study indicated that Water lily seed can better replace the energy source ingredients in poultry diets with small inclusion of protein supplements.

Performance of broilers

The growth performance of Cobb 500 chicken is presented in Table 3. The broilers fed on diets with different levels of Water lily seed meal were not significantly (P>0.05) different from those on control diet for all performance parameters (Table 3). The daily feed intakes of chicken grouped in T_1, T_2, T_3 and T_4 were 105.9, 106.7, 107.9 and 109.9 g, respectively. The present study reflected that addition of WLSM did not depress the palatability of feed. It seems probable that the attractive aroma and flavor resulting from the WLSM might have encouraged the chickens to take optimum feed. Requirement for the broiler grower and finisher phases was calculated at 4.52 kg of feed per chick.

Table 3. Performance of Cobb 500 broiler chicken fed on different levels of WLSM

Parameters	Treatments					
	T_1	T_2	T_3	T_4	SEM	Significance
Daily feed intake, g	105.9	106.7	107.9	109.9	2.7	NS
Initial body weight, g	180.8	181.4	181.5	181.2	0.13	NS
Final body weight, g	3090.7	3152.7	3154.7	3176.1	21.1	NS
Body weight gain, g	2909.9	2971.3	2973.2	2994.9	21.1	NS
Average daily gain, g	69.28	70.75	70.80	71.31	1.73	NS
FCR (g feed/g gain)	1.53	1.51	1.52	1.54	0.06	NS
Mortality	0.00	0.00	0.00	0.00	0.00	NS

Means in the same row without common letter are statically different at P<0.05; WLSM = Water lily seed meal; T_1 = Commercial diet containing 0% WLSM; T_2 = Commercial diet containing 3% WLSM; T_3 = Commercial diet containing 6% WLSM; T_4 = Commercial diet containing 9% WLSM; FCR = Feed conversion ratio; SEM = Polled standard error of mean; NS = Not significant (P>0.05).

There are no published studies investigating growth performance, carcass components and meat quality in broiler chickens or other poultry species fed diets containing Water lily seed meal, and therefore the discussion of the present finding is quite limited. Addition of WLSM did not affect (P>0.05) the growth performances of chickens. The final body weights of chickens were 3090.7 g (T_1), 3152.7 g (T_2), 3154.7 g (T_3) and 3176.1 g (T_4). Feed conversion ratio of chicken in T_1, T_2, T_3 and T_4 was 1.53, 1.51, 1.52 and 1.54, respectively; indicating an almost similar amount of feed is consumed to produce the same amount of body mass each day. Nevertheless, small changes in FCR at any given feed price will have a substantial impact on financial margins. At the same time, neither ill health signs nor mortality occurred throughout the study period. The zero mortality recorded for all the treatment groups suggests that feeding WLSM at various levels did not adversely affect the performance of the broiler chickens. Generally, the consistency in broilers performance might indicate optimum balance of available nutrients including protein across the treatment groups.

Carcass characteristics

The carcass characteristic of broiler chicken is presented in Table 4. Slaughter weight, dressed carcass, dressing percentage, breast, back and wings as well as total edible and non-edible offal components were similar among treatment groups. The weight of drumsticks was improved when broilers were fed diets containing WLSM at various levels. The drumstick for T_4 was higher than T_1 while T_3 and T_2 had intermediate value. There was no consistent trend in thigh weight but the weight for T_4 and T_2 was greater than T_1 and T_3. Total edible carcass was greater for T_4 compared with T_3 while T_2 and T_1 had an intermediate value.

Table 4. Effect of inclusion of Water lily seed meal on carcass characteristics of Cobb 500 broiler chicken

Parameters (g)	**Treatments**					
	T_1 (n = 6)	**T_2 (n = 6)**	**T_3 (n = 6)**	**T_4 (n = 6)**	**SEM**	**P-value**
Slaughter weight	2921.6	2993.3	2843.8	3019.8	43.11	0.46
Breast muscle	742.5	700.0	690.8	660.8	20.62	0.60
Thighs	285.8^{b}	326.7^{a}	278.3^{b}	319.0^{a}	7.95	0.04
Drumsticks	211.3^{b}	254.2^{ab}	240^{ab}	271.0^{a}	8.51	0.03
Back	303.3	312.5	271.7	314.0	7.80	0.15
Wings	247.2	270	275.8	294.0	13.40	0.93
Neck	102.8^{a}	75^{b}	93.2^{ab}	89.8^{ab}	3.18	0.01
Dressed carcass	1892.9	1938.4	1849.8	1948.6	21.85	0.42
Dressing, %	64.79	64.76	65.05	64.53	1.68	0.77
Edible offals						
Skin	130.0	133.8	152.2	284.0	10.95	0.52
Gizzard	57.8	62.3	48.5	48.8	1.91	0.08
Liver	47.7	49.7	43.7	47.4	1.15	0.32
Heart	13.7	13.3	14.8	13.8	0.46	0.71
TEOC	249.2	259.2	259.2	393.7	40.83	0.57
Total edible carcass	2142.1^{b}	2197.6^{ab}	2109.0^{b}	2342.3^{a}	44.32	0.03

Means in the same row without common letter are statically different at $P<0.05$; WLSM = Water lily seed meal; T_1 = Commercial diet containing 0% WLSM; T_2 = Commercial diet containing 3% WLSM; T_3 = Commercial diet containing 6% WLSM; T_4 = Commercial diet containing 9% WLSM; TEOC = Total edible offal component.

Information on the effect of WLSM supplementation on carcass components of broiler chicken is quite limited. According to Adeyemi *et al.* (2008) dressed weight is more important to poultry meat consumers than the live weight because feathers add more to live weight and the dressed weight represents the absolute value of saleable meat. The similarity in dressed weight in this study shows that up to 9% level of the WLSM can be included in the diet of broiler chickens without having any adverse effect. However, a numerical assessment of the dressed weight shows that the T_4 (9% WLSM) diet performed better than the rest of the diet groups. The highest weight for edible carcass, drumsticks and thighs was observed for broilers fed the diet containing the highest level of WLSM (T_4). This finding conforms to the report of Adeyemi *et al.* (2008), who stated that thigh, drumstick and breast cut are prime cuts of chicken, which gives a picture of the carcass meatiness and eventually revenue yield.

Table 5. Effect of inclusion of Water lily seed meal on non-edible offals of Cobb 500 broiler chicken

Parameters (g)	Treatments					
	T_1 (n = 6)	T_2 (n = 6)	T_3 (n = 6)	T_4 (n = 6)	SEM	P-value
Blood	66.8	59.2	46.3	59.2	4.14	0.39
Lungs	12.3	14	15	13.2	0.57	0.45
Kidney	14.7	13.2	13.8	13.2	0.33	0.33
Thorax	249.2	259.2	259.2	249.0	7.48	0.91
Head	75	75.0	75.8	70.0	2.16	0.51
Shank	88.5	88.5	84.5	78.6	2.36	0.44
Intestine	91.3	83.2	79.2	88.8	2.02	0.16
Proventriculus	14.8	13.3	14	13.8	0.43	0.62
Feather	105.3	101.2	99.2	100.4	2.29	0.82
TNEOC	714.9	706.8	687.0	676.2	20.32	0.61

^{ab} Means in the same row without common letter are different at $P<0.05$; SEM= standard error of mean; WLSM = Water lily seed meal; T_1 = Commercial diet containing 0% WLSM; T_2 = Commercial diet containing 3% WLSM; T_3 = Commercial diet containing 6% WLSM; T_4 = Commercial diet containing 9% WLSM; TNEOC = Total non-edible offal component.

Weight of edible and non-edible offals were unaffected by the treatment diets ($P>0.05$). Weight of edible offals was not different among the treatments which were consistent with the report of Medina *et al.* (2020) who observed similar weights in these organs when broilers were supplemented with fenugreek seed meal. Generally, the result of the current study implies that inclusion of WLSM up to 9% did not affect the normal function of liver in broiler chickens.

Meat quality traits

The effect of Water lily seed meal inclusion on carcass quality parameters of broilers is presented in Table 6. Breast meat quality in terms of proximate composition, water holding capacity, cooking loss and pH was compared for each treatment diet group. Significant differences were found in moisture, protein and fat content of meat from different diet groups. Meat samples from the WLSM added groups had the highest protein value, but the lowest fat deposition. The control diet (T_1) had the highest body fat. The level of fat percentage in the current study is lower than the values (2.3% and 6.0%) reported by Culioli *et al.* (2003). This finding suggested that feeding WLSM might have human health implications. The observed lower fat accumulation in the broiler meat due to Water lily seed meal might be associated with various factors, such as level of CP in the diet. It has been reported that increasing dietary protein content caused a significant reduction in fatty acid synthase mRNA expression in the livers of broiler chickens compared with the control group (Choi *et al.*, 2006). Behrooj *et al.* (2012) also stated that high level of CP in broilers diets suppressed the mRNA expression of hepatic malic enzyme, acetyl coenzyme carboxylase (ACC), and fatty acid synthase in a comparison of low-protein diets of broilers. The same authors suggested that increasing dietary protein content improves the carcass quality by increasing protein content while reducing body fat deposition.

Table 6. Effect of inclusion of Water lily seed meal on meat quality attributes of Cobb 500 broilers

Parameters (%)	**Treatments**					
	T_1	**T_2**	**T_3**	**T_4**	**SEM**	**P-value**
Moisture	84.3[a]	84.9[a]	79.4[b]	80.9[ab]	6.61	0.02
Ash	1.38	1.44	1.47	1.57	0.03	0.47
Crude fiber	15.10	14.75	14.46	15.16	0.71	1.40
Protein	22.67[c]	23.66[b]	25.52[a]	25.30[a]	0.28	<.0001
Fat	1.75[a]	1.73[a]	1.54[b]	1.46[b]	0.03	0.03
WHC	33.1	33.2	32.4	33.1	6.70	4.30
Cooking loss	34.3	34.2	34.4	33.9	1.81	2.20
pH	5.80	5.50	5.90	5.80	0.14	0.60

[abc] Means in the same row without common letter are statically different at P<0.05; SEM= standard error of mean; WLSM = Water lily seed meal; T_1 = Commercial diet containing 0% WLSM; T_2 = Commercial diet containing 3% WLSM; T_3 = Commercial diet containing 6% WLSM; T_4 = Commercial diet containing 9% WLSM; WHC = Water Holding Capacity.

Compared with the control group, the addition of WLSM at 6% (T_3) reduced moisture content of meat (P >0.05), but had no effect at 3% (T_2) and 9% levels (T_4). The high moisture content of the broiler meat increases softness in the meat which in turn raises its acceptability in the market, as suggested by Ali and Zahran (2010). The observed lower moisture content of meat from broilers fed WLSM in the diet indicates that the shelf life will be longer and also implies a great economic importance since moisture content is associated with an increase in microbial activities during storage.

The meat quality evaluation revealed that water holding capacity, cooking loss and pH were unaffected by the dietary treatments. The pH value of meat is in the range of 5.50 to 5.90. This finding corroborates with the reports of Liu *et al.* (2012) who suggested that the pH value between 4.5 and 6.5 favors the formation of nitrogen-containing compounds which in turn contribute towards attractive flavors. On the contrary, Anadon (2002) stated that muscles at pH ≤ 6.0 undergo greater protein denaturation, causing increased light scattering and opaqueness. Water holding capacity, having direct influence on the color and tenderness of meat, is among the most functional properties of raw meat (Warner, 2014). It has been shown that less percentage of cooking loss might be due to high concentration of protein as reported by Petracci and Cavani (2012). In the present study, the lack of differences in water holding capacity could be explained by similarity in muscle pH values among carcass treatments which is consistent with the finding of Musa *et al.* (2006). The visual appearance and water holding capacity of meat are very important, as both contribute to the overall quality (Warner, 2014).

Conclusion

This study shows that inclusion of Water lily seed meal in the commercial diets of Cobb 500 broiler chickens did not affect feed intake, body weight gain, feed conversion ratio, and most of the carcass parameters studied which suggests that it can replace parts of concentrate. The carcasses of chickens from the supplemental groups contained more protein and less fat than the control group. Thus, this study highlights the positive potential of Water lily seed meal to improve meat quality parameters in broiler chickens. Generally, Water lily seeds are high in crude protein and ether extract, and low in fiber, indicating appreciated energy value. Nevertheless, more experiments should be directed toward defining the utilization of protein and energy in Water lily seed in poultry production.

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