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Use of *Manihot esculenta* leaves on physiological and production parameters of Sasso breeder hens

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Abstract

Background: The world population is increasing, leading to competition between humans and animals for the use of farm produce. The use of non-conventional resources in poultry feed is increasingly being explored. Cassava (*Manihot esculenta*) have been studied in layers and broilers feed. However, there is very little information on the impact of the leaves on breeder hens.

Objectives: This study was conducted to determine the effect of *M. esculenta* leaf meal (MELM) on breeder hen performance, hatching egg quality and blood parameters.

Methods: A total of 180 hens and 24 cocks Sasso breeders at 32 weeks of age were used and equally assigned into two dietary treatments having six replicates of 15 hens and two cocks each. The dietary treatments were basal diet supplemented with 0% MELM and basal diet supplemented with the MELM group (5% MELM). Data were collected on feed intake, egg production, feed conversion ratio as well as egg quality indices during the experiment. The blood samples were collected from 18 birds per treatment (three3 per replication) for the determination of total protein, uric acid, triglycerides and total cholesterol at 45th week of age.

Results: The results showed that there was no significant difference on the feed intake of the birds across the treatments. Average egg weight and egg production were higher with a lower ($p < 0.05$) feed conversion rate in the MELM group hens. Total protein, uric acids, total cholesterol and triglyceride level increased significantly ($p < 0.05$) in hens fed 5 % of MELM. The proportions of yolk, egg shell and Haugh unit showed no significant difference between the treatments, while the proportion of albumen and yolk colour increased significantly ($p < 0.05$) in the MELM group hens.

Conclusions: It was concluded that 5% MELM can be used as feed ingredients in formulating breeder hen diets to improve productive performance.

KEYWORDS
Manihot esculenta leaf, breeding hens, performance production, serum biochemical

1 | INTRODUCTION

The expansion of the poultry industry depends largely on the availability of good quality feed in sufficient quantities at affordable prices to both producers and consumers (Wubalem et al., 2016). This is very important, especially for breeder hens which are very sensitive to nutrition such that inadequacies in nutrient supply often lead to a drop in egg production and even cessation of lay and deterioration of hatching egg quality and an increase in embryonic mortality at hatch (Bain et al., 2016). With the present trend of rising prices of feed ingredients, there has been a search for non-conventional foodstuffs with the potentials of improving poultry performance. Among the non-conventional feed sources, leaf protein sources have been reported (Babatunde et al., 2021). One possible source of cheap protein source feed is the leaf meal of some tropical plants. According to Moyo et al. (2011), leaf meals not only provide a protein source but also are constituents of some essential vitamins and amino acids, minerals and oxycarotenoids which are generally deficient in other feeds.

Studies have shown that cassava leaves are an extremely valuable source of protein (14%–40%), dry matters, mineral, vitamins B1, B2 and C and carotenes (Fasuyi, 2005). It has been established that *Manihot esculenta* leaves can be harvested within 4–5 months of planting without adversely affecting root production (Stephen et al., 2017) and can be considered as a suitable alternative in poultry diets. Apart from the small influence of cyanuric acid (HCN), *M. esculenta* leaves do not cause digestibility disorders. Sun-drying reduces 90% of cyanide (Priya et al., 2011), and washing with water and air drying at temperatures below 28°C also reduce the cyanide content of the leaves of *M. esculenta*. With these nutritional values and availability of cassava leaves, the studies of Khieu et al. (2005) and Morgan and Choct (2016) have shown that *M. esculenta* leaves can be used in the ruminant and monogastric diet. Some promising productive performance results, which vary according to their nutritional composition and their level of incorporation in diets, have been reported. Houndonougbo et al. (2012), Galon et al. (2017) and Sumiati et al. (2020) reported that *M. esculenta* leaf improved egg production performances at 5% inclusion level in the feed. Similarly, Ngueda et al. (2020) indicated that the effect of various levels of *M. esculenta* leaf meal (MELM) in laying hens Isa Brown with inclusion of 5% MELM in diet enhanced production. Although several studies had been conducted on the effects of MELM on laying hens, there is a scarcity of data on the influence of MELM on the productive performance and egg quality of breeder hens (Tran Thi et al., 2014). The present study, therefore, was conducted to assess the effects of MELM on the productive performance of Sasso breeders hens.

2 | MATERIALS AND METHODS

2.1 | Preparation of test ingredients

The study was conducted on Sasso breeder birds of 32 weeks of age. These birds were fed basal diet, diet without MELM and another diet with the MELM at the inclusion level of 5%. After harvest, *M. esculenta* leaves were washed and dried for 4 days in dark in an air-conditioned chamber at 17°C and ground by hand before incorporation into the diets.

TABLE 1 Composition of experimental diets (%)

Feed stuffs	Control diet	MELM diet
Maize	55	53
Wheat bran	8	4
Soybean meal	3	4
Fish meal 40%	3.2	3.2
Soya seed	14	16
Laying concentrate 5%	5	5
Oyster shell	7.5	7.5
Methionine	0.1	0.1
Lysine	0.2	0.2
Dares of beer	4	2
Manihot esculenta leaf	0	5
Total	100	100
Calculated values		
Crude proteins	18.20	18.23
Metabolizable energy (kcal/kg)	2810	2806
Lysine (%)	1.05	1.29
Methionine (%)	0.48	0.48
Methionine + cysteine (%)	0.70	0.67
Calcium (%)	3.36	3.42
Phosphorus (%)	0.58	0.55
Crude fibre (%)	3.34	3.70

Abbreviation: MELM, *Manihot esculenta* leaf meal.

2.2 | Management of experimental hens

One hundred and eighty (180) hens and 24 cocks of Sasso breeders both at 32 weeks of age were assigned into two treatment groups according to the rate of incorporation of *M. esculenta* leaf in the diet. These treatment groups were control (basal diet without *M. esculenta* leaf meal) and the MELM group (diet with 5% leaves of *M. esculenta*). Five percent leaves of *M. esculenta* inclusion level was arrived at based on our previous study (Ngueda et al., 2020). Within each treatment group, six replicates of 15 hens and two cocks were reared for 14 weeks. The birds were fed according to the company's recommendations throughout the experimental period. All the diets were isocaloric and isonitrogenous and met the requirement of the birds (Table 1). During the rearing period, hens were fed the experimental diets, and the cocks received non-experimental ration. Feed intake, body weights and egg component weights were recorded weekly. At 45 weeks of age, blood samples were collected from the wing vein of 18 birds per treatment (three per replication). Blood samples were collected into a blood storage tube without anticoagulant to determine

protein total, uric acid, triglyceride and total cholesterol concentrations.

2.3 | Data collection

2.3.1 | Breeder hens performance

Throughout the experiment, a measured amount of feed was offered to hens each day. Weekly feed refusals in each group were collected, weighed and recorded before feed was offered. Feed provided and refusals were used to evaluate feed intake (g/hen/day). Eggs were collected and weighed daily. The average egg laying rate, egg weight and feed intake were used to calculate feed conversion ratio as grams of egg mass per gram of feed consumed.

2.3.2 | Egg quality characteristics of breeder hens

Eggs laid at the end of weeks 35, 40 and 45 were sampled for measurement of egg components and yolk colour. At each age, eggs were weighed with a scale with an accuracy of 0.01 g before cracking. Yolk and eggshell were separated manually and weighed. Haugh unit values were measured using Egg Multi Tester Haugh. All egg components were expressed as percentages of egg weight [(component weight/absolute egg weight) × 100]. Yolk colour was assessed using a colorimetric range with values ranging from 6 (light yellow) to 13 (yellow-orange).

2.3.3 | Serum biochemical measurement

Blood samples were collected from five randomly selected hens from each replicate at the end of the experiment for biochemical analyses. Blood was sampled from the wing vein using a sterile needle fitted with a dry tube without anticoagulant. The collected blood was centrifuged at 3000 rpm for the collection of sera for the determination of biochemical indices, viz. total proteins, uric acids, triglycerides and total cholesterol. The analyses of the parameters were performed with the use of commercial kits (Cypress Diagnostic). The parameters were as described by the manufacturer. Assays were colorimetric and absorbance readings were taken using an EPOCH2 brand spectrophotometer.

2.4 | Statistical analysis

Statistical analysis was performed by using Graph Pad Prism 5. Student's *t*-test was used to analyze the effects of *M. esculenta* leaf meal on egg production, egg weights, egg components, feed intake and conversion ratio. Data obtained were expressed as mean ± SEM. The results were considered to be statistically significant at $p < 0.05$.

TABLE 2 Effects of *M. esculenta* leaf meal on production performance (mean ± SE) of Sasso breeder hens

	Treatments		
Parameters	Control group	MELM group	*p*-Value
Daily feed intake (g)	125.5 ± 2.06	127.0 ± 1.96	0.30
Laying rate (%)	73.99 ± 0.68[b]	76.01 ± 0.91[a]	0.02
Egg weight (g)	53.61 ± 0.25[b]	54.32 ± 0.26[a]	0.01
Feed conversion ratio (g)	3.46 ± 0.13[a]	3.05 ± 0.13[b]	0.01

Note: Mean values with different letters in the same row are significantly different at $p < 0.05$.
Abbreviation: MELM, *Manihot esculenta* leaf meal.

3 | RESULTS

3.1 | Effects of *M. esculenta* leaves on breeder hens performance

The effect of MELM on feed intake, laying rate, egg weight and feed conversion ratio of breeder hens is presented in Table 2. The laying rate and egg weight were higher for hens in the MELM group with a feed conversion ratio lower ($p < 0.05$) compared to the hens in the control group. The feed intake shows no significant difference between treatments.

3.2 | Effects of *M. esculenta* leave meal on eggs quality of breeder hens

Egg quality parameters of breeder hens at 35, 40 and 45 weeks of age fed with 5% of *M. esculenta* leaves are presented in Table 3. Egg yolk colour and Albumen ratio at 35, 40 and 45 weeks of age were higher ($p < 0.05$) for hens in the MELM group than hens in the control group. Yolk ratio was higher ($p < 0.05$) at 40 and 45 weeks of age than ($p > 0.05$) at 35 weeks in the MELM group, whereas the same parameter was higher at 35 and 40 weeks in the control group. Haugh unit was higher in the MELM group than in the control group at 40 weeks of age, whereas the Haugh unit was similar at 35 and 45 weeks in both groups. However, the egg shell ratio did not differ between treatments.

3.3 | Serum biochemical

Table 4 presents the effect of MELM on the blood serum: total protein, uric acids, total cholesterol and triglyceride concentration in Sasso breeder hens at the end of the experiment. All the biochemical parameters recorded were significantly higher ($p < 0.05$) for the MELM group compared to the control group.

4 | DISCUSSION

The aim of the present study was to evaluate of effect of MELM on biochemical parameters and productive performance of Sasso breeder

TABLE 3 Effects of *M. esculenta leaf* meal on eggs quality (mean ± SE) of Sasso breeder hens at different ages

	Treatments					
	Control group			MELM group		
Parameter	35th week	40th week	45th week	35th week	40th week	45th week
Yolk colour	3.88 ± 0. 66^{b}	5.31 ± 0. 35^{b}	5.98 ± 0. 11^{b}	6.30 ± 0.38^{a}	8.61 ± 0.23^{a}	9.96 ± 0.16^{a}
Albumen ratio (%)	31.45 ± 0. 03^{b}	31.60 ± 0.41^{b}	32.47 ± 0.26^{b}	33.32 ± 0.32^{a}	32.64 ± 0.20^{a}	32.88 ± 0.24^{a}
Yolk ratio (%)	13.41 ± 0.15^{a}	13.73 ± 0.24^{a}	14.23 ± 0.09^{b}	13.04 ± 0.09^{b}	13.99 ± 0.12^{a}	14.80 ± 0.08^{a}
Egg shell ratio (%)	11.10 ± 0.19	11.67 ± 0.20	11.22 ± 0.20	10.87 ± 0.29	11.66 ± 0.15	11.17 ± 0.07
Haugh unit (%)	84.12 ± 0.70	80.90 ± 0.92^{b}	84.75 ± 1.36	84.83 ± 1.05	82.93 ± 0.25^{a}	84.64 ± 1.10

Note: Mean values with different letters in the same row are significantly different at $p < 0.05$.
Abbreviation: MELM, *Manihot esculenta* leaf meal.

TABLE 4 Effects of *Manihot esculenta* leaf meal on biochemical parameters (mean ± SE) of Sasso breeder hens

	Treatments		
Parameters	Control group	MELM group	*p*-Value
Total protein (g/dl)	5.81 ± 0.13^{b}	7.37 ± 0.57^{a}	0.0001
Uric acids (mg/dl)	10.29 ± 1.18^{b}	15.63 ± 2.50^{a}	0.03
Triglyceride (mg/dl)	30.96 ± 2.14^{b}	35.53 ± 1.37^{a}	0.04
Total Cholesterol (mg/dl)	23.62 ± 2.75^{b}	35.53 ± 4.37^{a}	0.02

Note: Mean values with different letters in the same row are significantly different at $p < 0.05$.
Abbreviation: MELM, *Manihot esculenta* leaf meal.

hens. Overall, there was no significant difference on the feed intake. Average egg weight and egg production were higher with a lower feed conversion rate ($p < 0.05$) in hens fed with 5% of MELM. The similarity in the feed intake of the hens in the present study implies that there was no adverse effect of *M. esculenta* leaves on the palatability of the breeder hens. These results are consistent with the study of Houndonougbo et al. (2012) who did not observe any significant differences regarding the effects of *M. esculenta* leaves on feed intake in layers. The decrease in feed conversion ratio in the present study may be due to the improvement of the nutritional quality of the diets, particularly in amino acids, following the incorporation of cassava leaves. According to Richards et al. (2010), higher amino acid in the diet in breeder hens translated to a better feed efficiency.

Among all egg quality parameters measured in the present study, only yolk colour and albumen ratio of eggs from the birds in the MELM group sampled at weeks 35, 40 and 45 were significantly improved. The increase in egg yolk colour score for MELM-supplemented diet may be attributed to the high content of carotenoids in MELM, which is an indication of an efficient absorption and utilization of the pigments present in *M. esculenta* leaves (Fasuyi et al., 2005). In contrast to our findings, Tran Thi et al. (2014) noted non-significant results on egg weight and egg production when breeder hens were fed *M. esculenta* leaf at different levels ranging from 4% to 6%. The observation in the current study is in line with Galon et al. (2017) and Houndonougbo et al. (2012) who reported similar results in response to various levels of MELM in the diets of laying chickens. Novak et al. (2006) indicated that albumen weight correlates with average egg weight, and its deposition in egg depends largely on the amount of nutrients received by hens. Thus, the increase in egg weight due to an increase in ratios of albumen to yolk for the MELM group by age may be explained by the better utilization of crude protein content of MELM brought about by the inclusion of MELM supplementation. The significant effect of MELM on egg weight and egg production in the present study might be due to the presence of lysine and methionine in *M. esculenta* as reported by (Fasuyi, 2005). Increased methionine and lysine in the feed improves egg production and increases egg weight (Fakhraei et al., 2010).

Furthermore, the results show a significant increase ($p < 0.05$) in the values of total proteins, uric acid, triglyceride and total cholesterol in breeder hens fed MELM-containing diet. It is well documented that uric acid is the main degradation product of amino acids and nucleic acids in birds and plays a major role in the body, as an energy source for cellular reactions (adenosine triphosphate) (Akifumi et al., 2016). Increase of its rate during the period of laying, implies the depletion of the stored lipids and consequently increase in gluconeogenesis from proteins (Hochleithner, 1994). The result of the current study is also consistent with the findings of Ngueda et al. (2020) who reported that layer hens supplemented with 5% MELM showed significantly higher total protein and uric acid concentration compared to the birds fed diet without MELM. Triglycerides and total cholesterol are part of the body fats, which can be metabolized for providing energy and constitute the major part of dietary lipids stored in adipose tissue (Dallongeville et al., 2006). The higher value suggests a better intestinal absorption of the lipids contained in the diet. Thus, hens in this treatment had more nutrient reserves for the constitution of cell membranes and the synthesis of large amounts of energy to be deployed in the reproductive mechanisms (Horton et al., 1994).

5 | CONCLUSION

It was therefore concluded that the incorporation of MELM at 5% of the diet of breeder hens improved production performance, and the egg quality increased in some of the serum lipids. From the point of view of egg production, the use of *M. esculenta* leaves in the diet of breeder hens up to 5% should be encouraged. Since quality of the

hatching egg partly determines hatching performance, the next step would be to study the effect of *Manihot esculenta* on hatchability.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS STATEMENT

Regarding animal care, the guidelines recommended by the Animal Ethics Committee of University of Lome in Togo were followed (ref: 008/2021/BC-BPA/FDS-UL).

AUTHOR CONTRIBUTIONS

Formal analysis, *investigation*, *methodology*, *resources*, *visualization*, *writing-original draft and writing-review and editing* : Ngueda Djeuta Odile Raphaëlle. *Formal analysis*, *investigation*, *methodology*, *resources and visualization*: Tona Kwassi. *Investigation*, *methodology*, *visualization and validation*: Adjei Mensah Benjamin. *Investigation*, *methodology*, *visualization and writing-review and editing*: Oyegunle Oke. *Investigation*, *methodology*, *validation*, *visualization and writing-review and editing*: Okalanwon Onagbessan. *Formal analysis*, *investigation*, *methodology*, *project administration*, *resources*, *supervision*, *validation*, *visualization and writing-review and editing*: Tona kokou.

DATA AVAILABILITY STATEMENT

The leaves were harvested fresh from farmer's field in Togo.

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1002/vms3.797.

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REFERENCES

Akifumi, K., Yusuke, N., Yasuka, M., Takeshi, Y., Keiichi, M., Koji, U., Yuki, I., Hideyuki, S., Midori, F., Hiraku, O., & Tomoichiro, A. (2016). Role of uric acid metabolism-related inflammation in the pathogenesis of metabolic syndrome components such as atherosclerosis and nonalcoholic steatohepatitis. *Mediators of Inflammation*, *2016*, 8603164. https://doi.org/10.1155/2016/8603164

Bain, M. M., Nys, Y., & Dunn, I. C. (2016). Increasing persistency in lay and stabilising egg quality in longer laying cycles. What are the challenges. *British Poultry Science*, *57*, 330–338. https://doi.org/10.1080/00071668.2016.1161727

Babatunde, O. O., Park, C. S., & Adeola, O. (2021). Nutritional potentials of ingredients for broiler and pigs. *Journal of Animal Science*, *11*, 1196. https://doi.org/10.3390/ani11051196

Dallongeville, J., Grupposo, M. C., Cottel, D., Ferrières, J., Arveiler, D., Bingham, A., & Amouyel, P. (2006). Association the metabolic syndrome and parental of cardiovascular disease. *European Heart Journal*, *27*, 722–728. https://doi.org/10.1093/eurheartj/ehi717

Fasuyi, A. O., Fajemilehin, S. O. K., & Omojola, A. B. (2005). The egg quality Characteristics of layers fed Varying Dietary Inclusions of Siam Weed (*Chromolaena odorata*) Leaf Meal (SWLM). *International Journal of Poultry Science*, *4*, 752–757. https://doi.org/10.3923/ijps.2005.752.757

Fasuyi, A. O. (2005). Nutrient composition and processing effects on cassava leaf (*Manihot esculenta*, Crantz) antinutrients. *Pakistan Journal of Nutrition*, *4*, 37–42. https://doi.org/10.3923/pjn.2005.37.42

Fakhraei, J., Loutfollahian, H., Shivazad, M., Chamani, M., & Hoseini, S. A. (2010). Reevaluation of lysine requirement based on performance responses in broiler breeder hens. *African Journal of Agricultural Research*, *5*, 2137–2142. https://doi.org/10.5897/AJAR10.161

Galon, D., Lorenzo, Eloiza M., & Florencia, C. (2017). Growth and egg production performance of dekalb layers (*Gallus gallus domesticus*) supplemented with cassava leaf meal (*Manihot esculenta* Crantz). *Asian Journal of Agriculture and Biology*, *5*, 83–87.

Horton, H. R., Moran, L. A., Ochs, R. S., Rawn, J. D., & Scrimgeour, K. G. (1994). *Principes de biochimie*. De Boeck-Wesmael.

Houndonougbo, M. F., Chrysostome, V. P., & Houndonougbo, C. A. A. M. (2012). Performances de ponte et qualité des œufs des poules pondeuses ISA brown alimentées avec des rations à base de feuilles séchées de manioc (*Manihot esculenta* Crantz). *International Journal of Biological and Chemical Sciences*, *6*, 1950–1959. https://doi.org/10.4314/ijbcs.v6i5.5

Hochleithner. (1994). Biochemistries. In B. W.Ritchie, G. J.Harrison, & L. R.Harrison (Eds.), *Avian medicine: Principles and application* (pp. 223–245). Wingers Publishing. Inc.

Khieu, B., Chhay, T., Ogle, R. B., & Preston, T. R. (2005). The use of cassava roots and leaves for on-farm animal feeding. Proceeding of the Regional Workshop, Hue city, Thua Thien province, Vietnam.

Morgan, N. K., & Choct, M. (2016). Cassava nutrient composition and nutritive value in poultry diets. *Journal of Animal Nutrition*, *2*, 253–261. https://doi.org/10.1016/j.aninu.2016.08.010

Moyo, B., Masika, P. J., Hugo, A., & Muchenje, V. (2011). Nutritional characterization of Moringa *oleifera* Leaves. *African Journal of Biotechnology*, *60*, 12925–12933. https://doi.org/10.5897/AJB10.1599

Ngueda, D. O. R., Voemesse, K., Teteh, A., Gbeassor, M., Decuypere, E., & Tona, K. (2020). Nutritional effects of dietary of *Manihot esculenta* leaf on isa brown older layers performance. *International Journal of Poultry Science*, *19*, 142–146. https://doi.org/10.3923/ijps.2020.142.146

Novak, C., Yakout, H. M., & Scheideler, S. E. (2006). Inra productions animales, 2010, *numéro* sulfur amino acid: Lysine ratio on egg production parameters and egg yield in Hy-Line W-98 hens. *The Journal of Poultry Science*, *85*, 2195–2206. https://doi.org/10.1093/ps/85.12.2195

Priya, K. D., Pachiappan, C., Sylvia, J., & Aruna, R. M. (2011). Study of the effects of hydrogen cyanide exposure in Cassava workers. *Indian Journal of Occupational and Environmental Medicine*, *15*, 133–136. https://doi.org/10.4103/0019-5278.93204

Richards, M. P., Rosebrough, R. W., Coon, C. N., & Mc Murtry, J. P. (2010). Feed intake regulation for the female broiler breeder: In theory and practice. *Journal of Applied Poultry Research*, *19*, 182–193. https://doi.org/10.3382/japr.2010-00167

Stephen, P. L., De Souza, A. P., Massenburg, L. N., Jaiswal, D., Cheng, S., & Shekar, R. (2017). Rooting for cassava: Insights into photosynthesis and associated physiology as a route to improve yield potential. *The New Phytologist*, *213*, 50–65. https://doi.org/10.1111/nph.14250

Sumiati, S., Darmawan, A., & Hermana, W. (2020). Performance and egg quality of laying ducks fed diets containing cassava (*Manihot esculenta* Crantz) leaf meal and golden snail. *Tropical Animal Science Journal*, *43*, 227–232. https://doi.org/10.5398/tasj.2020.43.3.22

Tran, T., Hoan Quang, H. T. U., & Trung Kein, T. U. (2014). Effect of different levels of cassava leaf meal in the diet on productivity and quality of luongphuong hen eggs. *Bulgarian Journal of Animal Husbandry*, *139*, 1–2.

Wubalem, A., Etalem, T., & Berhan, T. (2016). Effects of feeding different dietary levels of *Moringa oleifera* leaf meal on egg production, fertility and hatchability of dual purpose koekoek hens. Middle-East. *International Journal of Science and Research*, *24*, 2909–2920. https://doi.org/10.5829/idosi.mejsr.2016.24.09.23907

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