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Use of *Moringa oleifera* leaves in broiler production chain. 1 - Effect on *Sasso* breeder hens performances, internal quality of hatching eggs and serum lipids

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Abstract

An experiment was conducted to determine the effect of *Moringa oleifera* leaves (MOL) on breeder hen performance, hatching egg quality and blood parameters. A total of 180 *Sasso* broiler breeder hens were used for the study. They were allotted to two groups each containing 3 replicates of 30 hens of 18 weeks of age. Dietary treatments were a control diet (basal diet without moringa leaves) and a diet containing 10g of moringa leaves in 1kg of control diet (1% w/w). The experiment lasted 40 weeks. The following production parameters; feed intake, egg weight, laying rate and feed conversion ratio were measured for the whole experimental period while egg quality and blood parameters were assessed at different ages. Results showed that laying rate and hatching egg weight were improved by moringa meal diet for the whole experimental period. Feed intake and feed conversation ratio were decreased ($p < .05$) by incorporation of moringa leaves. Differences ($p < .01$) were observed in albumen and yolk ratio at 55th week of age. Yolk colour was ($p < .001$) improved by moringa meal at 31st, 43rd and 55th week of age. At the end of the experiment, serum concentrations of triglycerides, total cholesterol, low-density lipoprotein cholesterol and atherogenic index were decreased ($p < .05$) while high-density lipoprotein cholesterol was unaffected ($p > .05$) by incorporation of moringa in the diet. It was concluded that the use of moringa leaves as feed additive in *Sasso* breeders diet improved productivity and quality of hatching eggs.

KEYWORDS

breeder performances, egg quality, *Moringa oleifera*, serum lipids

1 | INTRODUCTION

Economic growth and the need for animal proteins has led to an increase in meat consumption (Popkin, Adair, & Nq, 2012). Poultry farming is one of the agricultural sectors that contributes to meeting the animal protein requirements of the human population (Delgado, Rosegrant, & Wada, 2003). To continue playing this role, it is necessary to produce more day-old chicks. This can only be achieved by nutritional improvement that facilitates increased egg production, adequate incubation procedures and production of good quality day-old chicks. Management during incubation of hatching eggs (Decuypere & Michels, 1992; Meir & Nir, 1984) has played some role in partially achieving this goal.

Several studies have shown that egg quality and hatchability are influenced by the nutritional composition of feed consumed by breeders (Adesola, Ng'ambi, & Norris, 2012; Edge, McGarvey, & Truscott, 1997). In fact, improving quality of breeder feeds leads to increasing hatching egg quality (Aydin, Pariza, & Cook, 2001; Novo, Gama, & Soares, 1997). Natural feed additives derived from herbs, spices or other plants are widely used to improve the productivity of animals through their positive actions on digestibility, nutrient absorption and control of parasites in the digestive tract (Athanasiadou, Githiori, & Kyriazakis, 2007; Windisch, Schedle, Plitzner, & Kroismayr, 2008). The use of feed additives, especially in hot climates where heat stress prevents animals from achieving optimal productivity can also contribute to improving their performance (Khan et al., 2012). El-Shafei, Hassan, Al-Gamal, and El-Sayed (2012) have reported an increase of total egg number, daily egg mass and egg quality traits such as eggshell weight, albumen, eggshell thickness and specific gravity compared with the control group when laying quails were supplemented with 1% of fenugreek seed meal. In laying hens, fenugreek seed meal in feed led to an improvement of production parameters (Abdul-Rahman, Sultan, & Taha, 2010). Abdul-Rahman et al. (2010) observed a reduction in plasma total lipids, total cholesterol and improved antioxidant status when broiler chicks are supplemented with 0.5% fenugreek.

Moringa oleifera (*M. oleifera*) is another pythogenic feed additive. It is a leguminous plant used by both humans and animals (Moyo, Masika, Hugo, & Muchenje, 2011; Sultana et al., 2015; Tété-Bénissan, Quashie, Lawson-Evi, Kokou, & Gbeassor, 2012; Tiamiyu, Okomoda, & Aende, 2016). *M. oleifera* is known to have antioxidant, anti-inflammatory, hypoglycemic, hypolipidemic, cholesterol-reducing and hepatoprotective properties (Ghasi, Nwobodo, & Ofili, 2000; Chumark et al. 2008; Singh et al., 2009; Leone et al., 2015). Its leaves are rich in proteins, minerals, salts and vitamins (Makkar & Becker, 1997; Moyo et al., 2011). They also contain antinutritional substances that limit their use at will (Aye & Adegun, 2013; Worku, 2016). Work conducted by Teteh, Gbeassor, Decuypere, and Tona (2016) showed an increase in the production and weight of eggs when moringa leaves are incorporated into the diet of *Isa brown* laying hens. Similar tendencies have been observed on the internal quality of eggs, especially on yolk coloration (Tesfaye, Animut, Urge, & Dessie, 2014). In addition, the use as food additives leads to changes in serum parameters. Despite their nutritional qualities, there is no research that has evaluated the potential of moringa leaves in *Sasso* breeders diets. Therefore, the aim of the current study was to assess the effect of *M. oleifera* leaf on *Sasso* breeder performances, hatching egg traits and serum biochemical parameters.

2 | MATERIALS AND METHODS

2.1 | Experimental site, animals and preparation of test material

This study was conducted at the Centre d'Excellence Régional sur les Sciences Aviaires (CERSA) poultry farm unit, University of Lomé, Togo. During a 40-week study, 180 *Sasso* breeder hens were fed with diets with or without *Moringa oleifera* leaves (MOL). These leaves were collected from rural areas of Togo and air dried using air conditioning at 18°C and milled to be incorporated in poultry feed. Birds were reared on a deep litter system with laying nests.

2.2 | Management of experimental hens

One hundred and eighty (180) *Sasso* breeders (18 weeks of age with initial BW of 1.31 ± 0.008 kg; mean ± *SEM*) and 18 males were equally divided into 2 dietary treatments. Ninety hens and 9 cocks were used in each dietary treatment of 3 replicates of 30 hens and 3 cocks. Hens of the first group (control) were fed basal diet without MOL while the second group received the same diet containing 1% MOL. All diets were iso-nitrogenous and iso-energetic. The birds were fed according to the company's recommendations throughout the experimental period. Water was offered ad libitum

TABLE 1 Composition of experimental diets (%)

Feed stuffs	Control diet	MOL diet
Maize	58	57.42
Wheat bran	8	7.92
Soya seed	17	16.83
Fish meal 40%	8	7.92
Moringa leaf	0	1
Concentrate	2	1.98
Oyster shell	7	6.93
Total	100	100
Calculated analysis		
ME (kcal/kg)	2,822.22	2,833.32
CP (%)	17.433	17.556
Calcium (%)	2.659	2.660
Phosphorus (%)	0.650	0.646
Lysine (%)	0.936	0.953
Methionine (%)	0.388	0.393
Methionine + Cysteine (%)	0.594	0.602

Abbreviations: CP, Crude protein; ME, Metabolizable energy; MOL, *Moringa oleifera* leaves.

throughout the experiment. Natural light was used as a source of lighting. The compositions of the experimental diets are shown in Table 1.

2.3 | Data collection

2.3.1 | Breeder hens' performances

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 evaluated 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 | Determination of internal hatching egg qualities

Eggs laid at the end of weeks 31, 43 and 55 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 open. Yolk and eggshell were separated manually and weighed. Albumen weight was calculated by removal of eggshell and yolk weight to whole egg weight. All egg components were expressed as percentages of egg weight [(component weight/ absolute egg weight) × 100]. Yolk color was measured using a Roche yolk colour fan (Hartmann, Paris, France).

2.3.3 | Determination of blood parameters concentration

Blood samples were taken from five randomly selected hens from each replicate at the end of the experiment for blood serum lipid determination. Blood samples were collected by inserting a sterile needle into the wing vein of the birds and extracting approximately 2 ml of blood. Samples were immediately centrifuged at 3,000 rpm and serum was collected for total cholesterol, high-density lipoprotein cholesterol (HDL-cholesterol) and triglycerides assays. Blood parameters were determined by colorimetric method using SELECTRA PRO M spectrophotometer. All serum parameters were measured using a commercial kit manufactured by ELITechGroup. Low-density lipoprotein cholesterol (LDL-cholesterol) concentrations and atherogenicity index were determined by calculation according to methods described by Jenkins et al. (1987) and Tété-Bénissan et al. (2013).

2.4 | Statistical analysis

Data collected were analysed using Student's *T*-tests with GraphPad Prism 5.00 software. When data were percentages they were transformed by arc sin square root prior to analysis. Results were considered to be statistically significant when $p < .05$. Data obtained were expressed as mean ± standard error of mean.

3 | RESULTS

3.1 | Effects of *Moringa oleifera* leaves on breeder hens performances

The effect *Moringa oleifera* leaves on *Sasso* breeder hens performances is presented in Table 2. Feed consumption was ($p = .038$) reduced in moringa dietary group. Overall mean of egg production percentage and egg weight were ($p = .0098$ and $p < .001$, respectively) increased for hens fed on MOL compared with the control group. Feed conversion ratio for the whole experimental period was ($p = .042$) reduced with 1% of MOL in diet.

3.2 | Effects of *Moringa oleifera* leaves on internal qualities of hatching eggs

Table 3 shows the effect of MOL on internal qualities on hatching eggs. Within the control group, the albumen ratio in the eggs of the birds sampled at 31, 42 or 55 weeks decreased with increasing age. For the MOL group, the albumen ratio also decreased at 42 weeks but was higher at 55 weeks. Between the two diets, the albumen ratio week by week, did not differ at 31 or 42 weeks but was higher in the MOL eggs of birds at 55 weeks compared with the control ($p < .01$).

The egg shell ratio within groups, also decreased between 31 and 42 weeks, but no further change was observed at 55 weeks. Between treatments, egg shell ratio did not differ between different periods of sampling.

Yolk ratio in the control group increased with age throughout the sampling period. In the MOL group, yolk ratio also increased at 42 weeks and declined at 55 weeks. Between treatments, yolk ratios were similar at 31 and at 42 weeks for the control and MOL groups. At 55 weeks, yolk ratio was ($p < .01$) higher in the controls eggs compared with the MOL group. Yolk colour in both groups decreased throughout

TABLE 2 Effect on moringa leaves on breeder hens performances

Parameters	Control group	MOL group	*p*-value
Feed intake (g/day/hen)	113.9 ± 0.830	111.9 ± 0.847	.038
Egg weight (g)	52.5 ± 0.056	53.2 ± 0.058	***
Laying rate (%)	61.4 ± 0.560	63.37 ± 0.520	.0098
FCR	3.65 ± 0.132	3.33 ± 0.076	.042

Note: Significant differences between groups were determined by *t* test.

Abbreviations: FCR, Feed conversion ratio; MOL, *Moringa oleifera* leaves.

***$p < .001$.

TABLE 3 Effect on moringa leaves on internal traits of hatching eggs

	Control group			MOL group		
Parameters	**31st week**	**42rd week**	**55th week**	**31 st week**	**42 rd week**	**55 th week**
Albumen ratio (%)	63.4 ± 0.736	60.8 ± 0.809	60.0 ± 0.688	63.5 ± 0.600	61.4 ± 0.743	64.0 ± 0.923**
Eggshell ratio (%)	11.6 ± 0.373	10.3 ± 0.354	10.9 ± 0.368	11.6 ± 0.372	10.3 ± 0.205	10.6 ± 0.322
Yolk ratio (%)	25.1 ± 0.607	28.9 ± 0.678	29.1 ± 0.598**	24.9 ± 0.540	28.3 ± 0.701	25.4 ± 0.867
Yolk colour	4.27 ± 0.358	3.80 ± 0.175	1.43 ± 0.228	7.67 ± 0.485***	8.00 ± 0.239***	4.67 ± 0.232***

Note: At each age, significant differences between groups were determined by *t* test.
Abbreviation: MOL, *Moringa oleifera* leaves.
**$p < .01$.
***$p < .001$.

the sampling period. However, means obtained at 31 and 43 weeks were similar. When considering diet, yolk colour was higher at all ages for the MOL group when compared to the control group ($p < .001$).

3.3 | Effects of *Moringa oleifera* leaves on serum parameters

Blood parameters are summarized in Table 4. No ($p = .648$) difference was observed in the HDL cholesterol values. However, serum total cholesterol, LDL cholesterol and triglyceride concentrations were reduced ($p < .05$) at the end of experimentation in the MOL group. Atherogenicity index was also ($p = .018$) lower for hens fed with MOL.

4 | DISCUSSION

A number of feed additives are available for inclusion in poultry diets in order to improve their performance. This is the first investigation on the effect of *Moringa oleifera* leaf as a feed additive on *Sasso* broiler breeder hen performances, internal traits of hatching eggs and blood parameters. We have previously reported beneficial effects of moringa leaves inclusion in the feed of a layer strain of chickens (Isa Brown) on egg performance.

TABLE 4 Effect of moringa leaves on serum lipids parameters

Parameters	Control group	MOL group	*p*-value
Triglycerides concentration (g/L)	18.6 ± 1.64	13.5 ± 1.56	.030
Total cholesterol concentration (g/L)	2.17 ± 0.195	1.72 ± 0.158	.044
HDL-Cholesterol concentration (g/L)	0.468 ± 0.021	0.455 ± 0.017	.648
LDL-Cholestérol concentration (g/L)	2.34 ± 0.217	1.89 ± 0.213	.036
Atherogenicity index	5.10 ± 0.441	4.04 ± 0.414	.018

Note: Significant differences between groups were determined by *t* test.
Abbreviations: HDL, High-density lipoprotein; LDL, Low-density lipoprotein; MOL, *Moringa oleifera* leaves.

The similarity in the results obtained on feed intake suggest that the inclusion of moringa leaf at 1% would not influence feed intake detrimentally or increase dietary fibre which may cause poor performance in monogastrics such as birds (Agbede & Aletor., 2003). Our findings show effectively that MOL improved breeder hens' performances. The egg production percentage for whole experimental period was increased by MOL. This improvement in egg performance may have been due to several factors, one of which is the presence of selenium in moringa leaves (Moyo et al., 2011). According to Cantor and Scott (1974), egg production increased when the feed of laying hens was supplemented with selenium. This observation is in agreement with that of Teteh et al. (2016) who reported higher egg production when Isa brown hens feed was included at 1% of moringa leaves. However, the magnitude of increase obtained by the authors was approximately five times higher than in the current study. This difference could be attributed to strain difference or the fact that MOL was offered to the Isa Brown hens diet included 1% moringa leaves from starter phase. Renema (2004) and Attia et al. (2010) indicated that the use of organic selenium source improves not only egg production but also egg weight in agreement with the findings from this study and those of Teteh et al. (2016).

Another factor that may have influenced egg production is the known amino acid content of *Moringa olifera* leaves. This might have influenced both production and egg weight. The improvement in egg weight and egg number may be linked to the amino acids' profile of MOL notably the sulfurous amino acids. In fact, methionine and cysteine have been shown to have a positive influence on egg weight and number because these sulfurous amino acids are essential for protein synthesis (Bunshasak, 2009). Even though there was no change in feed intake, breeder hens fed with MOL exhibited improved feed conversion ratios as evidenced by increases in egg weight and production.

The influence of MOL on egg quality in this study seemed most prominent as hens become older. Albumen ratio and yolk colour were enhanced at 55 weeks, when the parameters were naturally declining. The role of MOL in enhancing yolk colour at all ages was very impressive. Silversides (1994), Suarez, Wilson, Mather, Wilcox, and McPherson (1997), Vieira and Moran (1998) and Silversides and Scott (2001) have reported (a) albumen ratio and hens'age are negatively correlated, (b) albumen and shell ratio have similar evolution and (c) hatching eggs of older hens have a higher yolk ratio than those of younger hens. Our data from control hens are in agreement with those of these authors. The addition of moringa in the feed ameliorated or reduced the reduction in albumen ratio but decreased the yolk ratio in the 55 weeks old birds. Yolk colour was increased at all ages. Even though the characteristic decline of the yolk colour was observed at 55 weeks, MOL reduced the precipitous characteristic decline. Teteh et al. (2016) previously reported this phenomenon in Isa Brown layers where MOL influenced egg weight, albumen and yolk ratios and yolk colour. The increase in yolk colour may be due to the high level of beta-carotene present in MOL (Joshi & Mehta, 2010; Makkar & Becker, 1996).

The results show a general decrease in the blood serum parameters measured in the birds fed MOL except for HDL-Cholesterol concentrations. The decrease in serum triglycerides mimic the decline in yolk ratio as the triglycerides are the main components of yolk. Apart from triglycerides, serum cholesterol and HDL-cholesterol were also reduced by MOL. Cholesterol concentration reduction has been previously reported in laboratory animals when fed on MOL (Ghasi et al., 2000). Foidl, Makkar, and Becker (2001) have also reported the chelating effects of saponins on triglycerides in the presence of MOL, as MOL contains high concentrations of saponins.

The decreased total cholesterol concentration may be due to reduction of LDL-cholesterol. Lower concentrations of serum LDL-cholesterol in breeder hens fed with MOL could be attributed to beta-sitosterol, a vegetable sterol presents in MOL whose structure is similar to cholesterol. This bioactive phytoconstituent induces decreased LDL concentrations in rats (Ara, Rashid, & Amran, 2008). Triglycerides and LDL cholesterol are atherogenic lipids. The decrease of artherogenic index in MOL group confirms that moringa leaves possess a potential hypolipidemic and hypocholesterolemic effect which induced a reduction in the atherogenic index (Chumark et al., 2008; Tété-Benissan et al., 2013). Our findings on serum lipids are in agreement with the general observations made by Dey and De (2013) that inclusion of moringa leaves in broilers diet at 0.25 and 0.4% decreased triglycerides, total cholesterol and LDL cholesterol.

In conclusion, this study reveals that the incorporation of *Moringa oleifera* leaves into *Sasso* breeder hens' feed improved performance of *Sasso* breeder hens and had a positive impact on the internal quality of their hatching eggs and decreased some of the serum lipids measured. Since quality of the hatching egg partly determines hatching performance, the next step would be to study effect of *Moringa oleifera* on hatchability.

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