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Research Article
Financial Implication of *Moringa oleifera* Leaf Incorporation into Layer-type Chickens' Feed

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Abstract

Background and Objective: The use of antibiotics is associated with problems such as the presence of residues in eggs and meat and the development of bacterial resistance. These concerns have resulted in the search for phytochemical from plants such as *Moringa oleifera* leaf. The leaves of *Moringa oleifera* have been regularly incorporated into feed to improve poultry production but the profitability of this, in modern poultry production, has not been evaluated. This study, therefore, evaluated the financial implications of the use of *Moringa oleifera* leaves in poultry feed. **Materials and Methods:** A total of 600 day-old Isa brown chicks were assigned to 3 dietary treatment groups of M_0 (0% of *Moringa oleifera* leaves), M_1 (1% of *Moringa oleifera* leaves) and M_2 (2% of *Moringa oleifera* leaves) from day-old to 280 day of age. Production and financial data were subjected to financial analyses using feed conversion ratio, margin approach, return on investment and break-even yield methods. **Results:** The study showed that there was a better profitability in the birds fed with the diet containing 1% leaves having 11.04% more income and 14% return on investment than those of M_0. This improved performance was associated to the better feed conversion ratio and high egg production of the birds fed diet containing 1% leaves when compared with those fed 2% Moringa leaves. **Conclusion:** It was concluded that the use of *Moringa oleifera* leaf as a prebiotic in a poultry diet improved production performance and profit margin of hens.

Key words: *Moringa oleifera* leaf, feed conversion ratio, chicken, financial implication

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The main objective of any poultry enterprise is to ensure poultry welfare, structure viability, job security and consumers' food safety. Therefore, poultry industries have been concerned with improvement and optimum profitability. In developing countries, economic conditions and the quest for profit maximization have led farmers to compromise the use of most factors of production, especially poultry feed. The importance of poultry feed is based on the fact that it accounts for approximately 60-70% cost of egg production. It also contributes largely to ensure birds' welfare and improves animal performances. In this regard, North[1] pointed out that every 10% reduction in feed costs, is associated with increasing productivity, net margin from 15-21% and gross margin by 40%. Hence, poultry farmers can formulate ration in such a way to fit animal nutritional requirements and improve performance while minimizing costs.

Previously, to achieve such results, farmers used to incorporate Antibiotic Growth Factors (AGF) into poultry feed. However, the main concern attributed to thisis that its inclusion results in the accumulation of residues in eggs and meat and also the development of resistance of bacteria. Consequently, this practice was banned in 2006 in Europe and USA[2]. As a result, there has been a growing search for a safe and efficient alternative to the use of AGF. Among the alternatives, prebiotics from plants such as *Moringa oleifera* are the most useful because of their carbohydrate content. Studies have shown that these carbohydrates confer antimicrobial effects and production enhancing properties[3,4]. However, plant production, processing and use incur some expenses to the extent that this may affect the production costs and farm net earnings.

Moringa oleifera is a leguminous plant widely available in the tropical zone and it is used in feeding livestock. Leaves of this plant are known to contain 26% of crude protein, 9.5 MJ kg^{-1} of metabolizable energy, high quantities of saponins, carotene, ascorbic acid, iron, methionine and cystine[5,6]. Moreover, Teteh *et al.*[7], reported that *Moringa oleifera* leaves contained flavonoïds, total phenols, tannin and polysaccharides at 0.2, 4.2, 2.38 and 21.1% respectively. Studies on the use of *Moringa oleifera* leaf in poultry feed have explored two methods of incorporation: substitution and supplementation methods. The substitution technique is based on the replacement of a conventional feedstuff partially or totally by *Moringa oleifera* leaf. This has been studied by Kakenji *et al.*[8]; Gadzirayi *et al.*[9]; Ayssiwede *et al.*[10] and Adeniji and Lawal[11], who demonstrated that substitution of sunflower flour by 20%, soya flour by 25% and groundnut cake by 8, 16 and 100% with *Moringa oleifera* leaf improved broiler growth and egg production of hens. The supplementation method makes use of *Moringa oleifera* leaf as a conventional feedstuff and is used without replacing any ingredients. For example, Teteh *et al.*[7], Banjo[12] and Teteh *et al.*[13] used the supplementation method and reported that *Moringa oleifera* leaf improved growth and egg production performances at the rate of 1% incorporation into feed. In addition, studies conducted by Ayssiwede *et al.*[10] and Adeniji and Lawal[11] revealed that the substitution method could lead to significant financial profitability of poultry farming. To our knowledge, the supplementation method has not been subjected to any financial study which may persuade farmers that, even at a low rate, *Moringa oleifera* leaves can increase profit. The present study, therefore, was undertaken to evaluate the financial impact of low rate incorporation of *Moringa oleifera* leaves into poultry feed.

MATERIALS AND METHODS

Experimental design: The experiment was carried out at the experimental unit of the Regional Centre of Excellence in Poultry Sciences (Centre d'Excellence Regional des Sciences Aviaires or CERSA) of the University of Lomé (Togo). *Moringa oleifera* leaves were collected from the rural area of Togo, rinsed and disinfected with Virocid® and then dried under an air conditioning system. They were, thereafter, pulverized and incorporated into diets.

A total of 600 day-old Isa brown chicks produced by CERSA hatchery were assigned to one of 3 treatment groups (M_0, M_1 and M_2) with 4 replicates of 50 chicks each. The birds were fed diets of: 0% (M_0), 1% (M_1) and 2% (M_2) *Moringa oleifera* leaves from day-old to day 280 as shown in Table 1. The rearing period was partitioned into 3 phases. The first phase lasted from day-old to 8th week, the second phase was from week 9-20 and the last phase was from week 21-40. During the 3 phases, the birds were fed successively, with starter mash, grower mash and layer mash. In order to comply with animal welfare, the study was conducted in a way that avoided unnecessary discomfort to the birds by the use of proper management.

Total feed intake and total water intake during starter, growth and egg production periods were recorded. From 20 weeks, eggs were collected and sold. Moreover, the total number of eggs and the mean egg weights during the production period were recorded. Data obtained were used to determine the feed conversion ratio (total feed intake during laying period/weight of total eggs collected) and the income obtained from the sale of eggs for each group.

Table 1: Gross composition of experimental diets (%)

	Feed composition according to age and group								
	Starter mash			Grower mash			Layer mash		
Feedstuff	M_0	M_1	M_2	M_0	M_1	M_2	M_0	M_1	M_2
Maize	58.00	57.420	56.840	52.000	51.480	50.960	58.00	57.420	56.840
Wheat bran	9.00	8.910	8.820	25.000	24.750	24.500	9.00	8.910	8.820
Cotton cake	4.00	3.960	3.920	0.000	0.000	0.000	0.00	0.000	0.000
Fish meal	10.00	9.900	9.800	8.000	7.920	7.840	9.00	8.910	8.820
Soya seed	15.00	14.850	14.700	10.000	9.900	9.800	15.00	14.850	14.700
Broiler concentrate	3.00	2.970	2.940	3.000	2.970	2.930	0.00	0.000	0.000
Layer concentrate	0.00	0.000	0.000	0.000	0.000	0.000	3.00	2.970	2.940
Oyster shell	0.75	0.743	0.735	1.750	1.733	1.720	5.75	5.693	5.635
Salt	0.25	0.247	0.245	0.250	0.247	0.250	0.25	0.247	0.245
Moringa leaf (%)	0.00	1.000	2.000	0.000	1.000	2.000	0.00	1.000	2.000
Total	100.00	100.000	100.000	100.000	100.000	100.000	100.00	100.000	100.000
Calculated analysis									
CP (%)	19.71	19.730	19.750	17.100	17.120	17.140	17.89	17.920	17.930
ME (MJ kg^{-1})	12.18	12.200	12.300	11.300	11.300	11.400	11.90	11.900	11.900
CF (%)	4.88	5.690	5.850	5.600	5.760	5.910	4.58	4.750	4.910

CP: Crude protein, ME: Metabolizable energy, CF: Crude fiber

Financial data collection: Farmers engaged in *Moringa oleifera* leaves production as well as those outlets engaged in the collection and sales of the leaves to users were consulted to determine the price of a kilogram of *Moringa oleifera* leaves. Poultry feed producers were also consulted to obtain prices of other feedstuffs. Prices of *Moringa oleifera* leaves and other ingredients were used to calculate the cost of a kilogram of feed according to the growth stage. In addition, the prices of a litre of water, day-old chicks and spent layers as well as investment and overhead costs of the farm were collected from CERSA administration. These data were used to assess the total cost and income in this study.

Determination of farm financial situation: To calculate profitability generated by the experiment and income statement, the following parameters were taking into account:

- 40 weeks of rearing
- 30,000 CFA Franc as construction cost of one square meter of bird room
- Sale of reformed layers to consumers and the use of this revenue to purchase day-old chicks
- 1,000 birds (600 for the experiment and 400 for commercial production) over which the farmer has charge

The financial analysis was based on feed conversion ratio, margin approach, return on investment and the break-even point.

Feed conversion ratio: Feed conversion ratio is defined as the quantity of feed to produce 1 kg of egg. The feed conversion ratio helps to evaluate feed efficiency and gives indications about rearing management and profit margin per kg of feed intake.

Margin approach: Taking fixed and variable costs into account, the method of margin approach was used to determine gross and net margins. Gross margin is the difference between sale of various products and variable costs, while net margin is the difference between sales and all operational charges (variable and fixed costs).

Return on investment: The gross margin does not allow detailed account of the management system of enterprises operating in the poultry sector. So, Keiser[14] proposed the return on investment method. This method was used to calculate the yield of investment or gain on sale of each CFA Franc invested according to the following equation:

$$\text{Return on investment (ROI)} = \frac{\text{Net profit}}{\text{Investment}}$$

Break-even point: For a thorough evaluation, Brossier *et al.*[15] proposed the use of the break-even point to plan and adopt a new method of management such as the use of *Moringa oleifera* leaf in poultry feeding. The break-even method determines sales volume or the production levels that enable the farm to cover all of its charges (variable and fixed

costs); hence, the poultry farm realized an equilibrium between its sales and charges[16]. It was calculated with the following formula:

$$\text{Break}-\text{even point} = \frac{\text{Total costs}}{\text{Unit price}}$$

Statistical analysis: Production parameters such as feed conversion ratio and egg weight were expressed as the mean±standard error (SE) of mean and analysed with a statistical software package, Systat 11. One-Way ANOVA was used to analyse the effects of experimental diets on feed conversion ratio and egg weight. If the overall F-value was not statistically significant ($p>0.05$), no further comparison among groups was done.

RESULTS

Results of production parameters are presented in Table 2. Egg weights were similar among the 3 treatment groups while feed conversion ratio in M_2 was higher than that of M_1 ($p<0.05$). In addition, group M_1 showed numerically lowest total feed intake and highest number of eggs produced.

Table 3 shows prices of one kg of *Moringa oleifera* leaf, one kg of each ingredient and one liter of drinking water. The price of each feed is shown in Table 4. Regardless of the treatment groups, grower feed was cheaper than the others. Table 5 shows fixed and variable costs and revenue from poultry products sold. Group M_2 showed the highest total cost. In contrast, sales for group M_1 yielded the highest value.

Table 2: Feed intake, water consumption, total egg produced, egg weight and feed conversion ratio according to the group

	Group		
Parameters	M_0	M_1	M_2
Feed intake			
Starter mash (kg)	337.58	308.23	329.39
Grower mash (kg)	913.14	918.80	885.28
Layer mash (kg)	2,988.15	2,957.02	3,023.56
Total (kg)	4,238.87	4,184.05	4,238.23
Total eggs produced	18,323	20,596	17,794
Egg weight (g)*	54±1.05	55±1.11	53±2.93
Feed conversion ratio**	3.02±0.01^{ab}	2.61±0.44^{bc}	3.21±0.02^{a}
Water intake (L)	15,430	15,427	15,428

*Values are Means±SEM and are not significantly different, **Values are Means±SEM. ^{abc}Within row, values sharing the same letter are similar

Table 3: Prices (CFA Franc***) of drinking water, feedstuffs and other services

Feedstuffs	Price (CFA Franc) kg^{-1} or L
Dried leaf of *Moringa oleifera*	410.36
Drinking water	0.26
Maize	167.00
Wheat bran	80.00
Fish meal	250.00
Cotton cake	240.00
Soya seed	356.00
Layer concentrate	700.00
Broiler concentrate	850.00
Oyster shell	60.00
Salt	1,000.00
Processing	07.00
Transport	08.00

***1 dollar: 587.20 CFA Franc

Table 4: Price of kg of complete feed (CFA Franc*** kg^{-1} of feed)

	Group		
Type of complete feed	M_0	M_1	M_2
Starter mash	223.13	231.10	233.06
Grower mash	200.12	202.37	204.62
Layer mash	220.04	222.09	224.14

***1 dollar: 587.20 CFA Franc

Table 5: Income statement according to treatment

Items	Group M_0	M_1	M_2
Fixed costs (CFA Franc*)**			
Depreciation building	120,000	120,000	120,000
Depreciation machinery and equipment	37,000	37,000	37,000
Total fixed costs (CFA Franc***)	157,000	157,000	157,000
Variable costs (CFA Franc*)**			
Starter mash	77,348.64	71,229.58	76,768.26
Grower mash	182,738.21	185,936.82	181,146.38
Layer mash	657,513.44	656,723.73	677,701.12
Veterinary expenses	65,542.88	65,542.88	65,542.88
Heating	12,000	12,000	12,000
Water	3,980.90	3,980.90	3,980.90
Electricity	2,785.10	2,785.10	2,785.10
Labour	54,000	54,000	54,000
Total variable costs (CFA Franc***)	1,055,909.18	1,052,199.02	1,073,923.65
Total costs (CFA Franc***)	1,212,909.18	1,209,199.02	1,230,924.65
Cash or sale receipts			
Total eggs produced	18,323	20,596	17.794
Egg unit price (CFA Franc***)	66.67	66.67	66.67
Gross sales (CFA Franc)	1,221,570.41	1,373,104.65	1,186,316.65
Total receipts(CFA Franc***)	1,221,570	1,373,104.65	1,186,316.65
Gross Margin (CFA Franc***)	165,661.23	320,905	112,392

***1 dollar: 587.20 CFA Franc

Table 6: Break-even point and Return on Investment

Parameters	Group M_0	M_1	M_2
Break-even point (number of eggs)	18,192.73	18,137.08	20,148.74
Net margin (CFA Franc***)	8,685.23	163,936.30	-44,597.67
Return on investment (%)	1.00	14.00	-4

***1 dollar: 587.20 CFA Franc

Results concerning the break-even point and the return on investment are summarized in Table 6. Group M_2 yielded a higher break-even point than those of M_0 and M_1. Return on investment for M_1 showed the highest value.

DISCUSSION

The main aim of poultry farmers is to minimize production costs and to increase farm profits. The present study has shown the effect of dried *Moringa oleifera* leaf incorporation into layer-type chickens' feed at different levels. It was observed that revenues increased by 11.04% more in the group offered 1% of *Moringa oleifera* leaves than that of the control group. This revenue trend seemed to be positively correlated with capital yield given that the money spent in purchasing Moringa leaf led to a profit of 14 and -4% respectively, in group M_1 and M_2. Differences observed in revenue and yield can be due to differences in egg production. These differences in egg production can be explained by the effect of *Moringa oleifera* leaf on feed conversion ratio. Feed efficiency is known to be the key element in livestock production and it is preferred to be as low as possible by every farmer. Concerning revenue and profit maximization, our results revealed that birds in group M_1, showed the best feed conversion ratio, which resulted in low feed intake when compared with the birds in M_2. *Moringa oleifera* leaf incorporation into feed at 2% resulted in impaired feed efficiency. This adverse effect can be attributed to the high content of antinutritional factors such as tannins, nonstarch polysaccharides, saponins, oxalates, glucosinolates and phytic acid in the diet containing 2% of Moringa leaves (M_2)[17-19]. Study conducted by Teteh *et al.*[20] confirmed this adverse effect where hens of M_2 had the higher feed transit due to the relative high amount of antinutritional factors in its diet. Furthermore, the economic performance of group M_1 was also observed through the break-even point. Indeed, taking the total number of eggs into account, group M_1 required 18,137 eggs to cover total farm expenses whereas M_0 and M_2

needed 18,193 and 20,148 eggs respectively. Laying curve examination reported by Teteh *et al.*[13] showed that this threshold was reached at the 39th, 40th week and beyond the 40th week of age in M_1, M_0 and M_2 respectively. Results of the current study are similar to Ayssiwede *et al.*[10] and Adeniji and Lawal[11], with the exception that their studies showed the beneficial effect of substituting soya cake and groundnut cake with *Moringa oleifera* leaf on growth performance of local chickens and rabbits. Moreover, the 1% return on investment obtained in the group M_0 was low for sustainable egg production in developing countries where some people consider poultry farming as unprofitable business. The better return obtained from Moringa fed hens in this study can be explained by the better feed conversion ratio of the birds in M_1.

CONCLUSION

Dried *Moringa oleifera* leaf incorporated at 1% into poultry feed is a means of boosting profitability of poultry farming. Accordingly, as a result of the findings obtained in this study, researchers should focus on further studies on the economic aspect of poultry nutrition.

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