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Effect of Replacing *Moringa Olifera* Leaf Meal for Soybean Meal on the production performance of commercial laying hens

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Abstract
The present study was undertaken to study the effect of *Moringa oleifera* on commercial Laying Hens production performance in which soybean meal was gradually substituted at 0, 5, 10 and 15% of *Moringa oleifera* leaf meal (MOLM). Two hundred and sixteen healthy commercial laying hens of age 25with uniform body weight were divided in a complete randomized design with four treatments and 6 replications. Each treatment consisted of six replication with 9 birds randomly assigned to each treatment. Laying hens were randomly divided into four groups; T1: diets without *Moringa oleifera* leaf meal, T2: diets with 5% *Moringa oleifera* leaf meal; T3: diets with *Moringa oleifera* leaf meal 10% and T4: diets with 15% *Moringa oleifera* leaf meal, respectively. Present study showed that addition of the *Moringa oleifera* leaf meal powder significantly increased egg production, feed intake, feed efficiency and egg weight. It was concluded that supplementation of 10% *Moringa oleifera* leaf meal in diets, increased egg production, feed intake, feed efficiency and egg weight in laying hens.

Keywords: laying hens, *Moringa olifera*, Egg production, soyabean meal

1. Introduction
Poultry industry is one of the fastest growing segments of the agricultural sector in India. Compared to Agriculture sector (1.5-2% per year) the production of eggs and broilers has been rising at 5 to 10 per cent per annum.Feed represents the greatest single expenditure in poultry production. The feed cost alone accounts for about 75 to 80 per cent of cost of production. The major constraints that tend to restrict growth of poultry industry are availability of ingredients and rising cost of feed. Feed production and availability of feed ingredients are limited to meet the demand of poultry industry. In intensive commercial layer farming, feed remain the major challenge where the price of the conventional feed resources increase continuously. Because of the increasingly cost of common protein ingredient (soybean meal, groundnut cake, and fish meal), stockholders have little access to such resources. With the present trend of rising prices of feedstuffs, alternative locally available and cheap non-conventional feedstuffs like leguminous trees are increasingly being used as a substitute of conventional resources in the formulation of poultry diets. Soyabean meal, a major source of protein in poultry feeding is getting more expensive due to increased demand resulting from expansion in livestock industry and ethanol production worldwide (Ayssiwede *et al.*, 2011) [2]. Replacing cereals and expensive less available agro-industrial by-products by unconventional source of raw materials, is one of the solutions to reduce cost of production. Therefore, *Moringa olifera* leaf meal (MOLM) is of special importance and can be a solution to reduce cost of production. High consumer awareness for food safety, such as eggs with the chances of antibiotic residues, has made poultry researchers look for other ways to replace antibiotics by formulating poultry feed that not only provides for the nutritional needs of poultry (energy, amino acids, vitamins, and minerals) but also safe for consumers. Antibiotic growth promoters (AGP) have been used by the feed industry for decades, but have allegedly caused antibiotic resistance both in animals and humans beings, becoming a public health hazard (WHO, 2017) [18]. This was the basis for the ban on all types of AGPs in animal feeds in Europe and developed countries (Cogliani *et al.*, 2011) [4] and motivating the search for alternative growth promoters, such as phytogenic feed additives (Windisch *et al.*, 2008) [19].
Feed additives are non-nutritive substances used in poultry feed, including antibiotics, enzymes, antioxidants, pellet-binders, antifungals, coloured pigments and flavouring agents

agents (Elagib *et al*., 2013) [6]. They have been widely used in the poultry industry to improve growth, feed efficiency and layer performance. However, the use of organic additives has gained acceptance worldwide. *M. Oleifera* which is an organic additive has antioxidant property due to its high.amount of polyphenols (Sreelatha and Padma, 2009) [17]. *M.oleifera* leaf meal can be included in the feed to promote certain qualities in pullets. Moringa leaves contain vitamins, flavonoids, and carotenoids, which not only serve as essential nutrients, but also enrich poultry meat and eggs, and intensify the pigmentation of the shanks and egg yolk (Melesse *et al.*, 2011; Fasuyi *et al.*, 2005) [11, 8]. Considering the contents of bioactive compounds and essential nutrientsin *M. oleifera* leaves, they can be used both as a feed ingredient and asphytogenic feed additive to promote layer performance and to enrich the egg yolk with carotenoids, flavonoids, and selenium (Melesse *et al.*, 2011; Fasuyi *et al.*, 2005) [11, 8]. Therefore, the objective of the present study was to analyze the effect of different levels of dried *M. oleifera* leaves powder on the laying hen performance.

Material and Methods

Mature leaves of *Moringa oleifera* plants were collected, dried under a shade up to a moisture level of ≤ 12%, then ground, and stored in polythene bags in a cool and dry place until further proximate analysis and feed formulation. The leaf meal was submitted to chemical analysis (macro nutrients) (Table.1).

Table 1: Proximate composition of *Moringa oleifera* leaf meal

Proximate composition	**Unit** (g/100g)
Moisture	7.60
Crude Protein	24.91
Ether Extract	6.52
Ash	11.08
Minerals	**Unit** (mg/100g)
Calcium	2462
Phosphorus	252

Two hundred sixteen healthy commercial layers of age 25 weeks having 89-92 % egg production, were reared in cages on poultry experimentation facility of department of Livestock Farm Complex, Veterinary College, Shivamogga of Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar (KVAFSU). Birds were randomly distributed into four treatments with six replicates of 9 birds each. The treatments consisted of diets supplemented with 0, 5, 10 and 15% (w/w) of *Moringa oleifera* leaf meal (MOLM) as a replacement for soya bean meal, for a period of sixteen weeks. The four experimental diets (MOLM-0%, MOLM 5%, MOLM-10%, and MOLM-15%) were formulated to contain proportionately equal crude protein (17%) and metabolizable energy (2600 kcal/kg) levels (Table. 2).

Data collection

Throughout the experiment, the following parameters were evaluated: feed intake (g/bird/day), egg production (%/hen-day), egg weight (g), egg mass (g/hen/day), and feed conversion ratio (kg feed/12 eggs). The data on Egg production, feed consumption, feed efficiency and egg weight characteristics was subjected to statistical analysis under completely randomized block design and Analysis of variance.

Table 2: Ingredient Composition of Experimental Diets

Ingredients	**T1** (0 % MOLM)	**T2** (5 % MOLM	**T3** (10 % MOLM)	**T4 (**15 % MOLM)
Moringa leaf meal (MOLM)	**0**	**1.05**	**2.1**	**3.15**
Maize	53	53	54	55
Deoiled rice bran	9.5	8.5	7	5
Sunflower meal	5	6	7	8
Soybean meal	21	20	19	18
Limestone powder	2	2	2	2
Shell grit	8	8	8	7.5
Dicalcium phosphate	0.7	0.7	0.7	0.7
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100
AB_2D_3K[1]	10	10	10	10
B-complex[2]	20	20	20	20
Trace mineral[3]	100	100	100	100
Lysine	40	40	40	40
Methionine	100	100	100	100
Nutrients (%)				
CP	17	17	17	17
ME(Kcal/kg)*	2600	2600	2600	2600
Calcium	3.75	3.77	3.79	3.81
Total phosphorus	0.51	0.63	0.75	0.62
Methionine*	0.4	0.4	0.4	0.4
Lysine*	0.97	0.97	0.97	0.97

* - Calculated values

1. One gram of Vitamin AB_2D_3K supplement contained 82500 IU of Vitamin-A, 50 mg of Vitamin-B_2, 12000 IU of Vitamin-D_3 and 10 mg of Vitamin-K.

2. One gram of B-Complex supplement contained 8 mg of Vitamin-B_1, 16 mg of Vitamin-B_6, 80 mcg of Vitamin B_{12}, 80 mg of Vitamin-E, 120

mg of Niacin, 8 mg of Folic acid, 80 mg of Calcium pantothenate, 120 mg of Calcium and 300 mg of Phosphate.
3. One gram of Trace Minerals contained 54 mg of manganese, 52 mg of zinc, 20 mg of iron, 2 mg of iodine and 1 mg of cobalt.

Results and Discussion

Egg production

The results of egg production, feed consumption, feed efficiency and egg weight in groups fed with the experimental diets are shown in Table 3. The laying hens fed with *M. oleifera* leaf meal exhibited significantly higher (P<0.05) egg production during 37 to 40 weeks among the experimental groups. Laying hens in T3 and T4 groups corresponded with higher egg production when compare to Control and T2 groups. This Increased egg production may be due to the role of Moringa in the digestive tract of chickens which can increase feed digestibility and is caused by the presence of phytochemical compounds in Moringa leaves. Moringa leaves are also a source of vitamin A, riboflavin, nicotinic acid, folic acid, pyridoxine, ascorbic acid, β-carotene, calcium, iron, and α-tocopherol as reported by (Prasad and Ganguly, 2012) [14]. The higher egg production in layers fed with the diet containing MOLM could be due to the improvement in balanced nutrient supply by MOLM in the diet. *M. oleifera* leaf meal contains lysine, methionine and a combination of other amino acids, which might supply the required amount of essential nutrients for better production (Sohail *et al.,* 2003) [16]. In accordance with the present finding, Uma (2000) reported that the methionine and lysine levels in poultry diets have positive correlation with egg production. Egg production increased significantly as dietary levels of lysine increased from 0.50 to 0.64 % (Fakhraei *et al.,* 2010) [7].

Feed consumption

The results showed significant differences (P<0.05) in the feed consumption among the experimental groups. There was no significant difference in feed consumption between treatments upto 36 weeks. The feed consumption was significantly increased in all the treatments when compared to control during 37 to 40 weeks of age. The same was reported by Ekayuni *et al.,* 2017) [5] which shows that *M. oleifera* does not have a toxic effect or contains factors that limit the absorption of nutrients. However, Ayssiwede *et al.,* 2011 [2] reported that the use of 24% Moringa leaves in the ration decrease feed intake in the birds. As a supplement for sunflower seed meal, the addition of 10 percent and 20 percent *M. oleifera* leaf meal to the laying hen diet significantly ($p < 0.05$) increased feed intake and dry matter feed intake. Results obtained in this study in feed and dry matter intake demonstrate that the MOLM is palatable and highly preferred by chickens. These findings were inconsistent with those reported in other leaf meals by (Ravindran *et al.,* 1986 and Bhatnagar *et. al.,* 1996) [15, 3] who observed a depression in intake when laying chickens were fed diets containing various levels of *Leucaena leucocephala meal* (LLM.). These variations probably suggest lower anti-nutritional factors and toxic materials in MOLM (Makker and Backer 1997) than in other leaf meals. On the other hand, Kakengi *et al,* (2007) [9] observed an increase in feed intake in layers when 15% or 20% of dehulled sunflower seed meal was replaced by MOLM. The discrepancy in feed intake could be further explained by the lower or higher energy content of MOLM relative to the dietary components it replaced in different studies. The current results suggested that a supplementation level of MOLM up to 15% did not have negative effect on feed intake.

Feed efficiency

The results of this study showed that the FCR of laying hens improved in response to the increase of dietary MOLM supplementation. The treated laying hens exhibited higher significantly different (P<0.05) on feed efficiencies (feed consumption/egg mass) than the control group. Laying hens in T3 and T4 groups recorded better feed efficiencies. Moringa leaf extract can be useful to be used as an effective feed supplement in poultry to improve feed efficiency in poultry (Akhouri *et al* 2013) [1]. The main way of action of this active ingredient is the inhibition of microbial pathogens and endotoxins in the intestine and increased pancreatic activity, resulting in better metabolism and utilization of nutrients (Windisch *et al*., 2008) [19]. Improved feed efficiency due to the role of Moringa in the digestive tract of chickens can increase feed digestibility as reported by (Nkukwana *et al.,* 2014) [12], that plant extract supplements can increase the digestibility of nutrients in the digestive tract of poultry. *Moringa oleifera* leaves are known to be very poor in anti-nutritional content and have been used in ruminant rations and other poultry or monogastric. This result was in contrary with Teteh *et al.,* 2013, who reported that the high use of Moringa leaves in feed can cause increased levels of saponin which can reduce digestion and absorption of nutrients, especially lipids.

Egg weight

Moringa inclusion levels influenced egg weight at different magnitude in the present study. Similar findings were reported by North (1990) where the substitution of sunflower with MOLM at 5 % levels in the diet showed a positive effect on egg weight but the reason of this could not be explained although probably it might be associated with higher sulphur containing amino acids reported in Moringa leaves. He also reported a positive influence of sulphur containing amino acids on egg weight. Increased egg production and egg weight in chickens fed with diet containing Moringa leaf is caused by the presence of phytochemical compounds in Moringa leaves, as reported by Prasad and Ganguly, 2012 [14]. Moringa leaves are also a source of vitamin A, riboflavin, nicotinic acid, folic acid, pyridoxine, ascorbic acid, β-carotene, calcium, iron, and α-tocopherol. Improvement of egg weight in the current study was similar with Kakengi *et al.* (2007) [9] where substitution of sunflower with MOLM at 5 % levels in the diet showed a positive effect on egg weight.

Table 3: Effect of dietary supplementation of Moringa oleifera leaf (MOLM) on performance of laying hens

Parameters	Weeks	T1 (0 % MOLM)	T2 (5 % MOLM)	T3 (10 % MOLM)	T4 (15 % MOLM)	SEM	P value
Egg production (%)	25-28	93.05	94.44	96.30	95.84	0.52	0.100
	29-32	91.20	93.52	93.98	93.98	0.50	0.141
	33-36	88.43	90.74	91.20	94.44	1.02	0.226

	37-40	89.35^{c}	90.74^{bc}	93.98^{ab}	94.91^{a}	0.81	0.027
Feed intake, g/ hen	25-28	101.60	101.52	101.37	103.05	0.31	0.189
	29-32	103.97	103.83	105.32	104.92	0.31	0.244
	33-36	100.83	101.15	101.85	102.23	0.26	0.223
	37-40	103.84^{b}	104.18^{ab}	104.45^{a}	104.15^{ab}	0.08	0.045
FCR, kg of feed/Dozen of eggs	25-28	1.40	1.34	1.35	1.30	0.03	0.718
	29-32	1.39	1.35	1.30	1.27	0.02	0.262
	33-36	1.43	1.39	1.32	1.33	0.03	0.396
	37-40	1.54^{a}	1.56^{a}	1.40^{b}	1.24^{c}	0.04	0.001
Egg weight, g/egg	25-28	55.13	56.06	55.13	55.54	0.86	0.883
	29-32	56.87	56.06	56.13	56.13	0.52	0.951
	33-36	56.59	58.46	56.75	58.09	0.44	0.345
	37-40	56.52^{b}	57.47^{ab}	59.07^{a}	58.97^{a}	0.39	0.036

1. T1: The diet without *Moringa olifera* leaf meal powder (control); T2: The diet with 5% *Moringa olifera* leaf meal powder T3: The diet with 10% *Moringa olifera* leaf meal powder; and T4: The diet with 15% Moringa olifera leaf meal powder respectively.
2. SEM: standard error of treatment means 3 Means with different superscripts within row values are significantly different (P<0.05)

Conclusion

This present study provides credible information on the performance of layer birds fed at different levels of MOLM. The results showed a net body weight gain, feed intake and feed conversion ratio of birds at 5%, 10% and 15 % of MOLM. It is herby concluded that the *M. oleifera* leaf meal could be included in the diet of layers up to a level of 15% by replacing soyabean meal for better egg production, egg weight, feed intake and feed efficiency without any adverse effect on production performance. The results of the present study showed that the *Moringa oleifera* used as a feed ingredient improves the production performance and the health status of commercial layers.

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