Effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania

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Abstract

An experiment was carried out to investigate the effect of substituting *Moringa oleifera* leaf meal (MOLM) for sunflower seed meal (SSM) as a protein source of egg strain commercial chickens. The effects of substitution on feed intake (FI), dry matter intake (DMI), egg weight (EWT), Laying percentage (LP), egg mass production (EMP), and feed conversion ratio (KG FEED/KG EGGS) were investigated.

Four dietary treatments based on MOLM and SSM as plant protein sources were formulated such that MOLM reciprocally replaced SSM at levels of 20, 15, 10 and 0% giving the dietary treatments containing 0, 5, 10 and 20% MOLM levels for MOLM-0 MOLM-10, MOLM-15 and MOLM-20 respectively. A total of 96 twenty-one weeks of age pullets were allocated to the dietary treatments in a randomised design. Each treatment consisted of three replicates and eight birds per replicate.

The EWT was significantly highest in MOLM-0 and lowest in MOLM-10. LP showed a significant progressive decreasing trend as MOLM proportion increased in the diet. Further, EMP showed a significant progressive decrease at 10 and 20% MOLM levels. DMI and DFI significantly increased progressively at 10 and 20% MOLM levels. Also, Kg feed/Kg eggs (g feed intake/g egg mass) were significantly highest in birds fed 20% MOLM levels.

The results, therefore, suggest that MOLM could completely replace SSM up to 20% without any detrimental effect in laying chickens. However, for better efficiency 10% inclusion level is optimal and an addition of MOLM above 10% high energy based feeds are required for better utilization.

Keywords: chicken, layer, leaf meal, Moringa oleifera, nutrition, substitution, sunflower seed meal

Introduction

*Moringa oleifera* Lam (syns. Moringa pterygosperm, family Moringaceae) is a multipurpose tree, which was thought, could substitute *Leucaena leucocephala* as it possesses useful characteristics as multipurpose tree species. Its leaves and green fresh pods are used as vegetables by humans and are rich in carotene and ascorbic acid with a good profile of amino acids (Makkar and Becker 1996). It is also used as livestock feed and its twigs are reported to be very palatable to ruminants and have appreciable crude protein levels (Sutherland et al 1990, Sarwatt et al 2002, Kimoro 2002).

*Moringa oleifera* is native in Himalaya but is currently spread almost world-wide. However, there is scanty information worldwide on its potential as an animal feed. Studies by Sarwatt et al (2002) on supplementation of *Moringa oleifera* to poor quality hay fed to growing Small East African Goats (SEAG) showed the existence of a negative nitrogen balance to goats supplemented with 25 and 50% *Moringa oleifera* leaf meal (MOLM). The preliminary results of effect of supplementing crop leftovers with equal amount of *Leucaena* leaf meal (LLM), *Grilicidia* leaf meal (GLM) and *Moringa oleifera* leaf meal (MOLM) showed that goats fed on MOLM were outperformed in terms of growth rate by those fed on the other multipurpose trees. This is perplexing because MOLM has relatively higher crude protein (Sutherland et al 1990, Makkar and Becker, 1997, Sarwatt et al 2002) and low anti-nutritional factors (Makkar and Becker, 1997) yields low animal performance? Kakengi et al (2003) evaluated and compared nutritive value of different morphological components of *Moringa oleifera* with *Leucaena leucocephala* leaf meal in Tanzania. They observed high pepsin and total soluble protein in *Moringa oleifera* leaf meal (MOLM) than other parts of the plant. The high pepsin and total soluble protein makes MOLM more suitable to monogastric animals.

The objective of this study was to determine the effects of substituting different levels of sunflower seed meal with MOLM on egg production performance. Then, establish the optimal substitution level for the optimal performance of laying chickens. It was hypothesized that MOLM could substitute sunflower seed cake, which is used as the main plant protein source for poultry nutrition.
Material and methods

Experimental birds and their management

A total of 96-egg White leghorn pullets at 20 weeks of age were used. Before commencement of the experiment all birds were dewormed, vaccinated against Newcastle and weighed individually. Thereafter, birds were randomly distributed into four groups of 24 birds per treatment. The 24 birds in each treatment were further subdivided into 3 groups of 8 birds each as replicates. In each treatment, replicate birds were assigned identification numbers and wing banded with tags. A group of 8 birds was placed in separate pen of approximately 4m x 4m x 1.5m. Sunlight was used as a source of light during the day and fluorescent tubes were used to illuminate the pens at night.

The birds were kept under deep litter management system and rice husks were used as litter materials to cover the floor. At the beginning of the study period, there was a preliminary period of 14 days before data collection to allow acclimatization of birds with experimental diets and data were collected for 13 weeks. Birds in each replicate were group fed and water was provided daily ad libitum. Birds were provided with ration once daily in the morning. The amount provided in each pen was weighed an allowance of about 20-25% above the expected daily requirements was given. The refusals were weighed the next day, just before provision of another ration.

Treatments and experimental diets

The study had four dietary treatments containing varying combinations of *Moringa oleifera* leaf meal (MOLM) and sunflower seed meal (SSM) levels. MOLM reciprocally replaced SSM at levels of 20, 15, 10 and 0% giving the dietary treatments containing 0, 5, 10 and 20% MOLM levels for MOLM-0, MOLM-10, MOLM-15, and MOLM-20 respectively. Maize meal (MM), hominy meal (HM) and rice polish (RP) were used as a source of energy in the experimental diets. Other ingredients used were fishmeal (FM), cotton seed cake (CSC), mineral and vitamin premixes, limestone and salt (Table 1).

<table>
<thead>
<tr>
<th>Component</th>
<th>MOLM-0</th>
<th>MOLM-10</th>
<th>MOLM-15</th>
<th>MOLM-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOLM</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Maize meal</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Hominy meal</td>
<td>5.25</td>
<td>5.25</td>
<td>5.25</td>
<td>5.25</td>
</tr>
<tr>
<td>Fish meal</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>SSM</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Limestone</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Salt</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Bone meal</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>RP</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cotton seed cake</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>*Mineral/Vitamin premix</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

*Mineral/Vitamin premix

<table>
<thead>
<tr>
<th>Treatment</th>
</tr>
</thead>
</table>
| T1 = 0% MOLM and 20% SSM, T2 = 5%MOLM and 15% SSM, T3 = 10% MOLM and 10 SSM, T4 = 20% MOLM and 0% SSM

*Moringa oleifera* leaves (MOL) were harvested from an orchard at early flowering stage. Branches were cut from the Moringa trees, spread out and dried under the shade for a period of 3 to 4 days. Thereafter, branches were threshed carefully to separate leaves from twigs before milling. The dried leaves were ground with hammer mill to make a leaf meal. The leaf meals were stored in the nylon bags during entire period of the study.

Chemical analysis of the ingredients and diets

Proximate analysis procedure was used in determining the percent dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and ash contents of the ingredients and diets. Likewise, calcium and phosphorus were determined in the ingredients and diets (Table 1 and 2).
Table 2. Chemical composition (g/kg DM) of feed ingredients used to formulate experimental diets for layer chickens in Tanzania

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>DM (%)</th>
<th>CP</th>
<th>CF</th>
<th>Ash</th>
<th>EE</th>
<th>Ca</th>
<th>P</th>
<th>NFE</th>
<th>ME MJ/kg DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSM</td>
<td>900</td>
<td>249</td>
<td>421</td>
<td>51.7</td>
<td>147</td>
<td>7.4</td>
<td>4.1</td>
<td>121</td>
<td>4.90</td>
</tr>
<tr>
<td>MOLM</td>
<td>860</td>
<td>297</td>
<td>225</td>
<td>147.7</td>
<td>43.8</td>
<td>27.9</td>
<td>2.6</td>
<td>106</td>
<td>7.86</td>
</tr>
<tr>
<td>Fish meal</td>
<td>879</td>
<td>566</td>
<td>14.0</td>
<td>303.0</td>
<td>99.5</td>
<td>10.8</td>
<td>35.6</td>
<td>19.2</td>
<td>6.09</td>
</tr>
<tr>
<td>Hominy meal</td>
<td>849</td>
<td>111</td>
<td>89.5</td>
<td>46.2</td>
<td>116</td>
<td>1.2</td>
<td>5.4</td>
<td>617</td>
<td>7.57</td>
</tr>
<tr>
<td>Maize meal</td>
<td>851</td>
<td>117</td>
<td>17.5</td>
<td>17.9</td>
<td>32.2</td>
<td>0.6</td>
<td>2.1</td>
<td>815</td>
<td>9.5</td>
</tr>
<tr>
<td>Rice polish</td>
<td>862</td>
<td>120</td>
<td>167</td>
<td>136.9</td>
<td>130</td>
<td>1.4</td>
<td>9.4</td>
<td>446</td>
<td>3.54</td>
</tr>
<tr>
<td>Bone meal</td>
<td>983</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>710</td>
<td>208</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Limestone</td>
<td>982</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>44.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cotton seed meal</td>
<td>945</td>
<td>339</td>
<td>276</td>
<td>79.8</td>
<td>97.8</td>
<td>6.2</td>
<td>6.2</td>
<td>208</td>
<td>6.12</td>
</tr>
</tbody>
</table>

CP = Crude protein  
CF = Crude fibre  
Ash = Ether extract  
NFE = Nitrogen free extract  
ME = Metabolizable energy

The chemical analysis was carried out according to the AOAC (1990) procedure. Energy values of feeds were calculated using the prediction equation cited in NRC (1994).

**Design**

Completely randomised design was employed in this experiment. Birds were randomly allocated to four dietary treatments. Each treatment had 3 replicates. In each replicate, there were 8 birds.

**Data collection procedure**

During the entire study period, feeds provided and refusals were recorded daily in each treatment replicate using a Mettler DT 150 electronic balance with an in-built weighing programme accurate to ±20 g. The differences between feed given and left over were used to calculate feed intake (FI) (grams). Then, calculated daily intakes in each treatment replicate were used to calculate daily and weekly intake per bird in each dietary treatment.

Eggs were collected daily three times a day at 9h, 13h and 16h. All the eggs and their weights in each treatment replicate were recorded daily. Daily egg productions in each treatment replicate were used to calculate weekly and daily laying percentage (LP) in each dietary treatment. Moreover, daily egg weight (EWT) records in each treatment replicate were used to calculate weekly and daily egg weight per bird in each dietary treatment. Egg mass production (EMP) was calculated as a factor of egg weight and egg production (g/ hen/day). Feed conversion ratio (Kg feed/Kg eggs) was calculated by dividing total FI (g) by total EMP (g).

**Statistical analysis**

The data for FI, DMI and Kg feed/kg eggs, LP, EWT and EMP were subjected to Analysis of variance (ANOVA) according to Snedecor and Cochran (1992) using general linear model (GLM) procedures of Statistical Analysis System (SAS) Inc, (1998). Values were considered significant at P<0.05. The data for Kg feed/Kg eggs, LP, EWT and EMP egg production were analysed using Model 1, whereas for FI and DMI were analysed using Model 2.

Model 1:

\[ Y_{ijk} = U + A_i + T_j + (AT)_{ij} + E_{ijk} \]

Where:

- \( U \) = overall mean  
- \( Y_{ij} \) = Observations of k\textsuperscript{th} bird assigned to i\textsuperscript{th} level of MOLM taken at j\textsuperscript{th} weeks of age  
- \( A_i \) = Effect associated with the i\textsuperscript{th} level of MOLM  
- \( T_j \) = Effect associated with j\textsuperscript{th} weeks of age  
- \( (AT)_{ij} \) = Interaction between MOLM levels and age (weeks)  
- \( E_{ijk} \) = Random error

Model 2:

\[ Y_{ijk} = U + A_i + T_j + (AT)_{ij} + B(x_{ijk} - x) + E_{ijk} \]

Where:

- \( x_{ijk} \) = Mean of k\textsuperscript{th} bird assigned to i\textsuperscript{th} level of MOLM taken at j\textsuperscript{th} weeks of age
Where:

- \( U \) = Overall mean
- \( Y_{ijk} \) = Observations of the \( k \)th bird assigned to the \( i \)th level of MOLM taken at the \( j \)th weeks of age
- \( A_i \) = Effect associated with the \( i \)th level of MOLM
- \( T_j \) = Effect associated with the \( j \)th weeks of age
- \( (AT)_{ij} \) = Effect associated with interaction between MOLM levels and age (weeks)
- \( X_{ijk} \) = Initial body weight of the individual
- \( X \) = Overall mean for initial body weight
- \( b \) = Regression coefficient of \( Y_{ijk} \) on \( X_{ijk} \)
- \( E_i \) = Random error

**Results**

**Condition of experimental birds**

Generally all birds remained healthy for the entire experimental duration. Yellowing around the shanks was a prominent feature in birds fed MOLM based diets. Though, colour intensity became lighter as laying period progressed.

**Chemical composition of ingredients and experimental diets**

The chemical composition of different ingredients used in the formulation of dietary treatments is shown in Table 2. The CP, metabolizable energy (\( \text{Me}_n \)), Ca and ash contents of MOLM were substantially higher than that of the SSM in the present study. However, Crude fibre, ether extract and phosphorous contents were relatively higher in SSM than that found in MOLM. Other ingredients did not vary in dietary treatments. Table 3 shows the chemical composition and metabolizable energy of experimental diets.

### Table 3. Chemical composition (g/kg DM) and metabolizable energy of treatment diets used as a layer feed supplement in Tanzania

<table>
<thead>
<tr>
<th>Diet Component</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MOLM-0</td>
</tr>
<tr>
<td>Dry matter, DM</td>
<td>920</td>
</tr>
<tr>
<td>Crude protein, CP</td>
<td>177</td>
</tr>
<tr>
<td>Crude fibre, CF</td>
<td>154</td>
</tr>
<tr>
<td>Ether extract, EE</td>
<td>58.5</td>
</tr>
<tr>
<td>Ash</td>
<td>134</td>
</tr>
<tr>
<td>Nitrogen free extract, NFE</td>
<td>405</td>
</tr>
<tr>
<td>Calcium</td>
<td>68.6</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>6.2</td>
</tr>
<tr>
<td>Me(_n), MJ/kg DM</td>
<td>11.3</td>
</tr>
</tbody>
</table>

The diets showed a decreasing trend of CF and EE with an increase of MOLM proportions. The CP and ME contents for all diets were almost similar (18% and 11 MJ/kg DM respectively).

**Feed and Dry matter intake**

Dietary treatments did not show any significant effect on FI and DMI up to 5% MOLM levels in the diet. However, significant and progressive increases in feed intake were observed on birds fed 10 and 20% MOLM levels in the diet (Table 4).
Discussion

Good healthy status of experimental birds observed during the entire period of the present study, suggest use of MOLM have negligible amount of toxic materials already reported in other leaf meals.

The results were in contrast with various reports on fodder tree and shrub leaves. Though, Makkar and Becker (1997) observed some traces of anti-nutritional factors in *Moringa oleifera* but had no influence in this study. On the other hand, yellow coloration of body parts observed was mainly attributed to the presence of xanthophylls and carotenoid pigments in MOLM as in other tree and shrub leaf meals (Austic and Neisheim 1990). Mellau (1999) reported similar observations when egg-strain pullets fed *Leucaena leucocephala* leaf meal. However, the decreasing trend of yellow colour intensity on body parts with time probably partly was associated with the gradual losses of xanthophylls and carotenoids in MOLM during storage and or partly by the transfer of pigmenting agents for production of egg yolk pigments (North 1990).

The chemical composition of MOLM observed in the present study compare well with the values reported by (Marker and Becker 1997). The similarities in chemical composition with other studies indicate that environmental factors such as season, geographical location and stage of maturity play a minor role in determining nutritive value of MOLM. Further, values of chemical composition were close to those reported in other leaf meals such as *Leucaena leucocephala*, *Sesbania sesban* and *Glicidictia sepium*. This suggests the potential of MOLM as animal feed agree with other leaf meals from nutritional point of view. On the other hand, SSM chemical composition values were similar to those reported by Mellau (1999). The CF and EE values were higher than those reported by NRC (1994). Also, energy values were slightly lower than reported by NRC (1994). The variability of nutritive value of sunflower between different workers, indicate that its nutritive value probably is due to method of oil extraction, variety, soil fertility and analytical procedure used. The chemical compositions of other feed ingredients used in the formulation of experimental diets were within the ranges reported by (NRC 1994; McDonald et al 1995 and Mellau 1999).

Results obtained in this study in feed and dry matter intake demonstrate that MOLM is palatable and highly preferred by chickens. These findings were inconsistent with those reported in other leaf meals by (Vohra 1972; Ravindran et al 1986; Osei et. al 1990 and Bhatnagar et. al 1996) who observed a depression in intake when laying chickens were fed diets containing various levels of *Leucaena leucocephala*(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, lower energy associated with lower digestibility of energy in CF component of MOLM as in other plant leaves (Tangendjaja et al 1990) could be a contributing factor to higher intake observed when MOLM was higher in the diet. The increase in feed intake is usually associated with compensatory mechanism to energy demand (Smith 1999). This suggests substitution of sunflower with MOLM at higher proportions in the diet should be accompanied with high-energy materials for better utilization.

From the results obtained in the present study, it was also evident that substitution of sunflower with MOLM moderately influenced negatively EMP and LP. Nevertheless, the EMP and LP values remained above the optimal recommended levels (Austic and Neisheim 1990). Similar patterns have been reported in other conventional leaf meals whereby egg productions in laying hens are adversely affected by dietary inclusion of Leucaena leaf meal (Maleo et. al 1970, Vohra et al 1972; Bhatnagar et al 1996 and Mellau 1999). The rate of depression of MOLM on egg mass and laying percent observed in this study, most probably was associated to low digestibility of energy and CP and bulkiness when MOLM was higher in the diet that contributed to low energy and CP availability to layers. However, progressive increase of egg mass and laying percentages with age observed in this study was expected because the birds were still at the initial phase of laying (North 1990). However, in a situation where by MOLM is obtained free of charge the potential of MOLM as animal feed demonstrate that MOLM is palatable and highly preferred by chickens. These findings were inconsistent with those reported in other leaf meals by (Vohra 1972; Ravindran et al 1986; Osei et. al 1990 and Bhatnagar et. al 1996) who observed a depression in intake when laying chickens were fed diets containing various levels of *Leucaena leucocephala*(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, lower energy associated with lower digestibility of energy in CF component of MOLM as in other plant leaves (Tangendjaja et al 1990) could be a contributing factor to higher intake observed when MOLM was higher in the diet. The increase in feed intake is usually associated with compensatory mechanism to energy demand (Smith 1999). This suggests substitution of sunflower with MOLM at higher proportions in the diet should be accompanied with high-energy materials for better utilization.

In the present study, it was observed that feed utilization was low in birds fed 20% in the diet. Though, sunflower seed meal substitution with MOLM maintained better Kg feed/Kg eggs up to 10%. Similar results were reported by (Bhatnagar et al 1996) when chickens fed LLM. This might be contributed to low available energy and CP when MOLM was high in the diets, which were probably due to low digestibility of CF component of leaves. Energy and CP content have an influence on intake, EMP, LP and eventually Kg feed/Kg eggs. However, the decreasing trend of Kg feed/Kg eggs with an increase of age observed in all dietary treatments was expected.

### Table 4. Daily laying percentage, feed intake, egg mass, weight and feed conversion ratio of the laying chickens fed with different levels of MOLM as a supplement in Tanzania

<table>
<thead>
<tr>
<th>Treatments</th>
<th>MOLM-0</th>
<th>MOLM-10</th>
<th>MOLM-15</th>
<th>MOLM-20</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily laying percentage, %</td>
<td>80.4a</td>
<td>79.3ab</td>
<td>77.3ac</td>
<td>75.4bc</td>
<td>1.43</td>
</tr>
<tr>
<td>Daily egg mass, g/bird</td>
<td>43.2a</td>
<td>43.5a</td>
<td>42.1ab</td>
<td>40.5b</td>
<td>0.71</td>
</tr>
<tr>
<td>Daily feed intake, g/bird</td>
<td>109a</td>
<td>108a</td>
<td>112b</td>
<td>115c</td>
<td>0.89</td>
</tr>
<tr>
<td>Daily DM intake, g/bird</td>
<td>100a</td>
<td>99.5a</td>
<td>103b</td>
<td>105c</td>
<td>0.82</td>
</tr>
<tr>
<td>Egg weight, gm</td>
<td>53.2b</td>
<td>54.2a</td>
<td>53.5bc</td>
<td>52.5c</td>
<td>0.3</td>
</tr>
<tr>
<td>Feed conversion ratio, kg feed/kg eggs</td>
<td>2.71a</td>
<td>2.64a</td>
<td>2.90a</td>
<td>3.29b</td>
<td>0.09</td>
</tr>
</tbody>
</table>

a, b, c Means within each row bearing same letter are not significantly different at (P<0.05)
This was because the laying chickens were still on the 1\textsuperscript{st} phase of egg production where by egg mass was still increasing with an increase in weeks of age (NRC 1994). These findings suggest that substitution of sunflower with MOLM up to 10\% have no any influence on Kg feed/Kg eggs. But, provision of MOLM in the layer diet at 20\% or more levels more energy is required for better utilization.

Moringa leaf meal inclusion levels influenced egg weight at different magnitude in the present study. On the other hand, the egg weights with a range of 52.5±0.1 to 54.2±0.1g were observed. These values were within the values reported by Shenstone (1968) from artificially selected chickens. Also agree with a range egg weight values observed by Mellau (1999) when LLM was fed to laying chickens. However, mean egg weight values were slightly lower compared with standard egg weight (58g) reported by Shenstone (1968) and Katule (1989). Also were lower than egg weight value of 57g reported by McDonald et al (1995). The reason for the lower egg weight values could have been fact that laying chickens used in the present study were within the first phase of egg production. Eggs in first phase are usually smaller than in 2\textsuperscript{nd} and 3\textsuperscript{rd} phase (North 1990). The variability suggests that EWT is influenced by more other factors than nutrition such as genotype, stage of laying and climate.

Moringa inclusion levels influenced egg weight at different magnitude in the present study. 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 might be associated with higher sulphur containing amino acids reported in Moringa leaves. North (1990) reported a positive influence of sulphur containing amino acids on egg weight. However, the substitution of sunflower seed meal with MOLM at 10 and 20\% levels in the diet showed a moderate progressive depression of egg weight. The results were in contrast with the results from other leaf meals. Mellau (1999) observed an increase in egg weight values with an increase of LLM in the diet up to 15\% inclusion levels. Also, Bhatnagar et al (1996) found non-significant effect on egg weights at 0, 5 and 10\% levels of LLM but weight was lowest at 20\% level. The decrease in weight at higher levels of MOLM was also not clear but probably was due lower energy and CP availability and also associated with lower digestibility of CF component reported in various other leaf meals. However, variability of egg weights and weeks of age in birds fed different levels of MOLM observed in this study was not clear but differences in the initial egg weights probably attributed to this trend (North 1990).

Conclusions

- The study showed that obtained responses due to substitution of sunflower seed meal with \textit{Moringa oleifera} suggest the shrub to have a potential in poultry feeding. This is exhibited through its protein content, relatively low fibre and higher mineral contents.

- The study using layers showed that MOLM could be used as a source of plant protein since it was highly accepted even at high inclusion levels in the diet. Further, LP, EMP and EWT remained within the recommended level even when given as a sole plant source. Also, showed highest performance in egg production in comparison with other leaf meals already studied. However, for optimum utilization 10\% inclusion is recommended.

- In areas where MOLM can be obtained for free and quality of eggs fetch higher premium complete substitution (20\%) with MOLM is highly recommended.

Acknowledgements

The authors gratefully acknowledge financial support from the Norwegian Agency for Development Cooperation (NORAD).

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