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(Original Article)

Effect of Partial Substitution of the Crude Protein of the Concentrated Feed Mixture with *Moringa oleifera* Leaves on Growth Performance and Some Blood Constituents of Growing Lambs

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Abstract

This study was conducted to investigate the effect of partial replacement of the crud protein of the concentrated feed mixture by *Moringa oleifera* leaves (MOL) on growth performance, hematological profile, and some blood plasma constituents of growing lambs. Twenty-four healthy male Farafra lambs (5 and 6 months old and 30 ± 0.50 kg body weight) were randomly divided into four groups. The first group was fed on 60% of the concentrated feed mixture (CFM) and 40% wheat straw as DM and served as a control. The other 3 treatment groups (10 MOL, 20 MOL, and 30 MOL), partially substituted the crud protein of the CFM at rates 10, 20, and 30% with *Moringa oleifera* leaves protein, respectively. The results revealed that dietary MOL had no significant effect on body weight gain, however they may adversely be affected by increasing the levels of MOL. The inclusion MOL at 20% in the diet of lambs increased ($P < 0.05$) WBC's count particularly neutrophils as compared with other groups. Also, MOL groups tended to be higher in RBC's count and percentages of HG and HCT than control one. The plasma albumin was decreased ($P<0.05$) with increasing levels of MOL in the diets of lambs. Also, the urea concentration and ALT values were lower ($P<0.05$) with MOL supplementation at Levels of 20 and 30% than that in 10% group. It could be concluded that the partial substitution of concentrate feed with *Moringa oleifera* leaves up to 10 % growing lambs' diets can improve growth performance, blood hematology, and plasma constituents, and exert protective effects in the liver without inducing adverse effects on animal health.

Keywords: *Hematological profiles, lambs' performance, Moringa oleifera leaves, Some blood plasma constituents.*

Introduction

In Egypt and other developing countries, ruminant rations still depend mainly on soybean meal or cottonseed cake as a source of protein in concentrate feed mixture diets (Kholif *et al.* 2018), however, due to inadequate supply and increased prices in recent years, it is essential to look for alternative protein sources that can generate high-quality byproducts. For ruminants, *Moringa oleifera* leaves (MOL)

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are a practical and high-quality protein alternative source to soybean and rapeseed meals. Also, MOL has the potential to enhance microbial protein synthesis in the rumen (Soliva *et al*., 2005).

The leaves of *Moringa oleifera* are distinctive because they contain an abundant amount of minerals and a low content of hazardous chemicals, resulting in a safe supplement (Eman, 2014).

Moyo *et al*. (2011) reported that the dried MOL contained 30.3% crude protein and 19 amino acids. Additionally, rumen bypass protein with a favorable amino acid profile accounts for around 47% of the protein in MOL. The high level of crude protein in moringa leaves makes it suitable as supplementary feed for cows, goats, and fish (Szumacher-Strabel *et al*., 2011; Zhou *et al.,* 2012). Using *Moringa oleifera* leaves as a source of protein has numerous advantages, one of which is the possibility of multiple harvests throughout the season. Moreover, dry moringa leaves maintain their nutrients well when stored for extended periods (Mendieta-Araica *et al.,* 2011). Moringa leaves have been utilized extensively in recent years to replace conventional protein feeds for aquatic, ruminant, and monogastric animals (Mahfuz and Piao, 2019). Adegun and Aye (2013) stated that MOL could completely replace cotton seed cake as a protein source in a concentrate mix fed to sheep. Moreover, Kholif *et al*. (2018) found that the substitution of MOL up to 75% of DM in the lactating goat diet improved the ruminal fermentation, feed intake, and milk quality and quantity under Egyptian conditions.

The increase in the level of moringa leaves in fattening lamb rations tended to decrease the nutritive value of rations and increased DM intake and feed conversion ratio (Sobhy *et al.* 2015). Supplemental *Moringa oleifera* leaves to the grass of sheep diets increased the intake of dry matter and crude protein, nutrient digestibility, nitrogen retention, and better hematological profile of animals (Fadiyimu *et al.,* 2010). Moreover, the inclusion of Moringa leaves at a rate of 25% improves the blood profile of animals (Fadiyimu *et al*., 2010). The current study aims to investigate the effects of partially replacing various levels of the crude protein of concentrate feed mixture with the crud protein of *Moringa oleifera* leaves (MOL) in a lamb's diet on growth performance, hematological profiles, and some blood plasma constituents.

Material and Methods

Animals, diets and management

This study was conducted at Animal Production Research Farm, Faculty of Agriculture, Assiut University. Four groups of six lambs each were randomly selected from a total of twenty-four healthy, growing native male Farafra lambs that were 5–6 months old and weighed 30 ± 0.50 kg. A completely randomized design was used to conduct the experiment. Each animal was kept in a separate pen of within 1.75 by 2 meters. The experimental period consisted of two periods; 15-day adaptation period followed by 120 days experimental phase. The experimental diets were provided to the lambs until they achieved their desired slaughter (market) weight of around 45.0 kg.

The experimental rations were as follows, the first group was fed on 60% the concentrated feed mixture and 40% wheat straw as DM and served as a control. However, in the treatment groups, we partially substitute the crud protein of the concentrated feed mixture at rates 10, 20, and 30% with *Moringa oleifera* leaves protein of T1 (10 MOL), T2 (20 MOL), and T3 (30 MOL), respectively. The crud protein of commercial concentrated mixture was approximately 14%. To adjust the percentage of crud protein among treatment groups we used soybean meal. The concentrate feed mixture, wheat straw, and Moringa leaves were analyzed chemically for nutrient contents according to AOAC (2005) and are shown in Table (1). Also, the ingredients and chemical composition of concentrate mixture of different diets are shown in Table (2).

All lambs were fed 60% of their nutrient requirements as a concentrated mixture and covered the rest of the requirements from wheat straw as DM *ad libitum* based on NRC (1985) guidelines. Moreover, the quantity of concentrated mixture was adjusted every month according to changes in body weight, by using the recommendation of NRC (1985). The concentrated feed mixture was offered at 8.00 a.m., while wheat straw was offered at 10.00 a.m. Blocks of vitamins-minerals and fresh water were available free of choice. Lambs were sheared and subjected to vaccination as well as injected or drenched against internal and external parasites before the experiment started.

Growth performance parameters

Body weight and daily weight gain: Throughout this experiment, the animals were weighed every two weeks. The difference between the starting and final body weight divided by the number of feeding days was used in calculating the mean average daily gain

Feed intake and Feed conversion ratio: The actual daily feed intake was calculated by collecting and weighing the residual feed.

The daily total dry matter intake (in grams) was divided by the daily average weight gain (in grams) to calculate the feed conversion ratio.

Table 1. Chemical composition (%) of the concentrated mixture, soybean meal wheat straw, and Moringa leaves (on DM basis)

Items %	Ingredients			
	CFM*	Soybean meal	Wheat straw	Moringa leaves
Dry matter (DM)	94.11	88.33	93.12	94.87
Organic matter (OM)	86.46	82.21	89.20	88.88
Crude protein (CP)	13.7	44.23	1.79	22.34
Crude fiber (CF)	17.15	3.29	39.71	9.86
Ether extract (EE)	3.71	1.39	0.45	6.08
Nitrogen free extract (NFE)	51.91	33.3	40.37	50.60
Ash	7.65	6.12	10.80	5.99

Table 2. The ingredients and chemical composition of the concentrate feed mixture (CFM) for different experimental rations (% on DM basis)

Items %	Treatments			
	Control	10 MOL	20 MOL	30 MOL
Ingredient (% of total ration)				
CFM	45	37	30	22
Soybean meal	15	13	10	8
Moringa leaves	-	10	20	30
Wheat straw	40	40	40	40
Chemical composition of experimental rations				
DM	94.11	92.67	91.03	90.87
OM	86.46	84.55	82.95	83.00
CP	13.7	13.90	13.88	14.06
CF	17.15	16.79	14.43	13.17
EE	3.71	3.83	4.03	4.65
NFE	51.91	50.03	50.61	51.12
Ash	7.65	8.12	8.08	7.87

CFM: The Concentrated Feed Mixture
10 MOL: Substitution of 10% crude protein of the CFM with Moringa leaves protein
20 MOL: Substitution of 20% crude protein of the CFM with Moringa leaves protein
30 MOL: Substitution of 30% crude protein of the CFM with Moringa leaves protein

Blood sampling

The blood samples were collected two times at two and four months of the experiment, approximately 10 ml of blood were taken from each animal in every group via the jugular vein before the morning feeding. Every blood sample was split into two tubes containing ethylene diamine tetraacetic acid (EDTA), one for hematological measures and the other for plasma separation to assess the biochemical characteristics. Samples were immediately centrifuged for 15 minutes at 4000 rpm, the plasma was extracted and kept in Eppendorf tubes at -20 ˚C until analysis. Shortly after collection, non-coagulated blood was examined to provide an approximated blood picture. Standard methods were followed for the hematological and serum biochemistry analyses of the blood.

Hematological profiles

The hematological profiles were assessed using automatic, fully Digital Hematology Analyzer (Shenzhen Mind ray Auto Hematology Analyzer (Model Bc-3200, Shenzhen Mind ray Biomedical Electronics Co. Hamburg 20,537, Germany). These parameters included a total count of white blood cells (WBC's), and its differential percent of each cell (Eosinophil%, Lymphocytes%, Neutrophils %, Basophiles %, Monocytes %). Also, the total count of red blood cells (RBC's), hemoglobin (g/dl, HGB), hematocrit (HCT, packed cell volume, PCV, %), platelets (PLT,10^3mm^3), mean corpuscular hemoglobin (MCH, pg), mean corpuscular volume (MCV, µm3), mean corpuscular hemoglobin concentration (MCHC, g/dl), and mean platelet volume (MPV, µm3) were determined

Biochemical parameters

Plasma glucose levels and Urea were assayed according to recommendation of Younge (2001) using special kits supplied by Diamond Chemical Company, Egypt. Plasma Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and total cholesterol (TC) were determined according to recommendation of Titas (1976) using assay kits supplied by BioMed Chemical Company, Egypt. Plasma total proteins and albumin concentrations were measured according to guidelines and recommendation of Titaz (1976). Total globulin level values were obtained by subtracting albumin values from the corresponding values of total protein. plasma total protein and albumin were assayed using special kits delivered from BioMed Chemical Company, Egypt. These biochemical parameters were analyzed by spectrophotometer (Hitachi 911 automatic analyzer).

Statistical analysis

Data were analyzed statistically using SAS (2001) software's general linear model procedure, version 8.2. K. Differences between groups in growth performance feed intake, feed conversion, blood hematological parameters, were evaluated using one-way ANOVA. Significant differences between treatments were tested using Duncan's multiple range test (Steel and Torrie, 1980). Data were presented as means ± SE. P values less than 0.05 ($P < 0.05$) were considered significant. The following model was used:

$$Y_{ij} = \mu + T_i + E_{ij}$$

The blood biochemical parameters were evaluated by two-way ANOVA according to the following statistical model.

$$Yijk = \mu + Ti + Mj + (TM)j + Eijk$$

Where: Yij = experimental observation, μ = overall mean, Ti = treatment effect, i = control, 10MOL, 20MOL, 30MOL, Mj = The effect of Blood samples time, j = 2 and 4 months, (TM)j = interactions between time and treatment, Eij = errors related to individual.

Result and Discussion

Lamb growth performance

The average body weight gain (BWG) and the average daily gain (ADG) in different groups were not significantly affected by substitution of the crude protein of the concentrate feed mixture with *Moringa oleifera* leaves protein (Table 3). However, it could be noticed that the increase in the level of substitution of CFM by MOL tends to decrease the BWG and ADG of growing lambs in comparison with the control group by 12.61, 23.25 and 26.19% for 10 MOL, 20 MOL, and 30 MOL, respectively. The negative influences on growth rate parameters with the increase in the level of MOL in lams diets could be due to high concentration of anti-nutrient components such as phytates, tannins, and oxalate in *Moringa oleifera*, there may be a reduction in crude protein digestibility (Su and Chen, 2020 and Zaher *et al.*, 2020). Moreover, because of their antimicrobial activity, the highest level of MOL appears to hurt the microbes of the rumen (Bodas *et al.* 2012)

The rumen microorganisms can use modest concentrations of secondary metabolites of *Moringa oleifera* such as tannins, essential oils, phenolics, and saponins as energy sources without hurting rumen fermentation (Hart *et al.* 2008 and Bodas *et al.* 2012). Similar results were found by Zaher *et al*. (2020), they found that replacing CP of a concentrate mixture in the diets of growing goats with 75 and 100 *Moringa oleifera* foliage decreased (P < 0.05) final body weight and average daily gain when compared with other groups. Also, Adegun and Aye (2013) found that the body weight gain did not change with supplementation of 25, 50, 75, and 100% *M. oleifera* leaf meal in daily diets for rams as substitutes for cotton seed meals when compared with the control group. Similarly, Sarwatt *et al.* (2002) showed that the substitution of sunflower seed cake with 25, 75, and 100% Moringa meal did not significantly alter the body weight gain (g/d) of goats.

The inclusion of MOL at a rate of 10% increased (P < 0.05) daily dry matter intake from concentrate, roughage, and total intake as compared with 20 MOL and 30 MOL. However, no differences were detected between the other treatment groups (20 MOL and 30 MOL) and the control group or between the control and 10 MOL groups. Similarly, Sultana *et al*. (2021) stated that the DM intake and live weight gain of bulls were unaffected by substituting up to 50% of the concentrated feed mixture with mixtures of Moringa mush (leaves, twigs, and branches). Kholif *et al.* (2018) found that replacing 75% dry matter of berseem clover with *M. oleifera* leaf can improve feed utilization in Nubian goats.

Table 3. Effect of partial substitution of the crud protein of the concentrate feed mixture with *Moringa oleifera* leaves protein on growth performance of growing lambs

Items	Treatments				P-value
	Control	10 MOL	20 MOL	30 MOL	
Initial weight (kg)	30.33± 2.81	31.0 ± 1.82	29.91±1.81	29.33 ±1.78	0.952
Final Weight (kg)	43.58± 3.53	42.76 ± 2.57	40.66±.235	39.83 ± 2.23	0.744
BWG (kg)	13.25± 0.87	11.76 ±1.23	10.75±0.73	10.50 ± 0.50	0.143
ADG (g/d)	112.28± 7.40	99.71± 1.05	91.10 ± 6.26	88.98 ± 4.23	0.143
Feed Intake (FI, g/day)					
DMI of concentrate	845.63^{ab} ± 19.31	891.26^{a} ± 16.39	801.20^{c} ± 14.50	841.97^{bc} ± 14.45	0.001
DMI of roughage	143.50^{ab} ± 4.9	152.80^{a} ± 4.3	144.20^{ab} ± 4.2	138.20^{b} ± 4.5	0.018
Total DM intake	998.20^{ab} ± 32.2	1004.70^{a} ±19.3	945.40^{b} ± 17.01	980.90^{b} ± 17.6	0.004
***FCR (g/g gain)**	8.85^{b}± 0.14	10.98^{a} ±0.29	10.50^{a} ± 0.18	10.99^{a} ± 0.14	0.001

a,b,c Values in the same row with different superscripts differ significantly (P<0.05).
10 MOL: Substitution of 10% crude protein of the CFM with Moringa leaves protein
20 MOL: Substitution of 20% crude protein of the CFM with Moringa leaves protein
30 MOL: Substitution of 30% crude protein of the CFM with Moringa leaves protein
*FCR: Feed conversion ratio (g feed/g gain)

Feed conversion ratio (FCR) expressed as g feed /g gain was improved (P < 0.05) with control group when compared with other treatment groups. This result may be due to the negative effects of increasing the level of *Moringa oleifera* leaves in the diets of lambs on average daily gain of lambs (Table 3).

Hematological profiles

The influences of the replacement of the concentrated feed protein with MOL on blood hematological variables in growing lambs are presented in Tables (4 and 5). The total white blood cell WBC count was higher (P<0.05) with the inclusion of 20% MOL in the diet of lambs than in other groups, such an increase (P<0.05) was mainly in neutrophils. These results suggest that MOL may have immune properties. Accordingly, Moyo *et al*. (2012) concluded that supplementation with MOL protected goats against diseases induced by oxidative stress. Otherwise, these differences in WBC's differentiation are within physiological ranges (Menghin *et al*., 2016).

Hematological features are widely recognized as a useful tool for accurately evaluating animal health and helping to identify different environmental stressors. (Ewuola *et al*., 2015). The same author also indicated that the aqueous extract of *Moringa oleifera* leaves improved the hematological values of animals. The increase in the count of WBCs, particularly the percentage of neutrophils with supplement 20 MOL agrees with that found by Gupta *et al*. (2010), they found that the administration of *Moeinga oleifera* to mice significantly augmented the count of WBC's and the percentage of neutrophils.

Table 4. Effect of partial substitution of the crud protein of the concentrate feed mixture (CFM) with *Moringa oleifera* leaves protein on white blood cells of growing lambs

Items	Treatments				P-value
	Control	10 MOL	20 MOL	30 MOL	
WBC's x10^3	10.90^b ± 1.10	9.90^b ± 1.20	14.50^a ± 0.80	10.05^b ± 1.05	0.021
Eosinophil, %	0.16 ± 0.08	0.06 ±0.03	0.20 ± 0.03	0.11 ± 0.04	0.353
Lymphocytes, %	60.03^a± 2.8	52.80^{ab} ± 2.40	49.90^b ± 3.2	54.20^{ab} ± 2.50	0.105
Monocytes, %	7.20 ± 0.40	7.80 ± 0.30	8.10 ± 0.20	7.90 ± 0.40	0.407
Neutrophils, %	31.10^b ± 2.30	38.5^{ab} ± 2.40	40.6^a ± 3.10	36.70^{ab} ± 2.07	0.043
Basophiles, %	1.50^a ± 0.60	0.80^b ± 0.30	1.20^a ± 0.10	0.90^{ab} ± 0.30	0.681

a,b,c Values in the same row with different superscripts differ significantly (P<0.05).
10 MOL: Substitution of 10% crude protein of the CFM with Moringa leaves protein
20 MOL: Substitution of 20% crude protein of the CFM with Moringa leaves protein
30 MOL: Substitution of 30% crude protein of the CFM with Moringa leaves protein

Results presented in Table (5) showed that no significant differences in RBC's count and other cellular fractions of blood among treatment groups and control one. However, the RBC's count, hemoglobin, hematocrit, and platelets tended to increase in treatment groups than control one; these results suggest that *Moringa Oleifera* leaves may have anti-anemia properties. Kumar *et al*. (2022) reported that *Moringa oleifera* leaves are a good source of iron ions and vital amino acids, which are necessary for the formation of hemoglobin and myoglobin.

Also, Nurhayati *et al*. (2023) stated that iron in MOL is responsible for higher hemoglobin levels and better animal health. Similar results were found by Meel *et al*. (2018), they indicated that replacing the concentrate feed with the leaves of *Moringa oleifera* in goat kids increased RBC's count, hemoglobin, and PCV, %.

Other hematological parameters were not differed among groups and were within physiological values (Menghin *et al*, 2016). Nurhayati *et al*. (2023) reported that feeding moringa leaves powdered over 12 weeks did not significantly change hematological parameters except for the MCH value, which showed a shift.

Table 5. Effect of partial substitution of the crud protein of the concentrated feed mixture (CFM) with *Moringa oleifera* leaves protein on hematological profile of growing lambs

Items	Treatments				P-values
	Control	10 MOL	20 MOL	30 MOL	
RBC's (X10^6/microl))	9.14 ± 0.56	10.54 ± 0.31	9.70 ± 0.24	9.76 ± 0.28	0.101
HGB (g/dl)	9.81 ± 0.58	10.90 ± 0.25	10.43 ± 0.25	10.17 ± 0.25	0.156
HCT (%)	24.70 ±1.48	27.90 ± 0.56	26.92 ± 0.52	26.25 ± 0.94	0.197
MCV(μm^3)	27.05 ± 0.50	26.58 ± 0.76	25.17 ± 0.44	26.82 ± 0.41	0.242
MCH (pg)	10.75 ± 0.07	10.35 ± 0.21	9.72 ± 0.19	10.18 ± 0.21	0.554
MCHC (f/dl)	39.85 ± 0.60	39.08 ± 0.61	38.65 ± 0.22	38.10 ± 0.66	0.179
RDW (%)	23.42 ± 0.37	24.05 ± 0.65	24.55 ± 0.53	23.53 ± 0.27	0.118
RDWa	15.93 ± 0.30	15.90 ± 0.31	15.07 ± 0.13	15.90 ± 0.30	0.239
PLT (X10^3 /microl)	183.00 ±63.78	298.83 ±36.51	411.83±87.10	335.17 ± 86.93	0.177
MPV(μm^3)	4.53 ± 0.10	4.57 ± 0.03	4.58±0.07	4.68 ± 0.14	0.500

10 MOL: Substitution of 10% crude protein of the CFM with Moringa leaves protein
20 MOL: Substitution of 20% crude protein of the CFM with Moringa leaves protein
30 MOL: Substitution of 30% crude protein of the CFM with Moringa leaves protein
RBC's: (red blood cell), HGB: Hemoglobin, HCT: Hematocrit (packed cell volume, PCV), MCH: (mean corpuscular hemoglobin), MCV: (mean corpuscular volume, MCHC: (mean corpuscular hemoglobin concentration), RDW: Red Cell Distribution Width, PLT: Platelets. MPV: (mean platelet volume).

Blood Plasma Metabolites

The effects of feeding *Moringa oleifera* leaves at different levels in growing lambs on plasma metabolites are presented in table (6). The plasma total protein and total globulins were not significantly affected by dietary treatments. However, plasma albumin concentration was decreased ($P<0.05$) with increasing the level of MOL in the diets. Concerning the effect of sampling time, it could be observed that the value of total protein and total globulins were higher ($P<0.05$) after four months of feeding than two months of feeding. In contrast the value of albumin was lower ($P<0.05$) after four months than two months of feeding. The improved plasma total protein and total globulins values with the increase in the period of feeding on MOL may be attributed to improving the immune system and oxidative status in growing goats through bioactive composites (Al-Juhaimi *et al*., 2020).

The average values of plasma total cholesterol, glucose, and bilirubin were not significantly affected by the partial substitution of the crud protein of CFM with MOL. However, it could be noticed that the plasma cholesterol increases with an increase in the level of inclusion of MOL in the diets. The higher value of glucose and cholesterol with inclusion higher level of MOL (30%) may be due to higher organic matter digestibility, energy concentration, propionic acid, and total VFA (Kholif *et al*., 2018). Additionally, the total phenolics and secondary metabolites in MOL positively affected lipids profile of animals fed on the MOL diets (Cohen-Zinder *et al*., 2017). Similar results were reported in lactating goats that fed fresh MOL (Al-Juhaimi *et al*., 2020), and growing goats fed different level of dried *Moringa oleifera* leaves (Zaher *et al*., 2020). Concerning the effect of sampling period, plasma total cholesterol concentration decreased (P<0.05) by about 30 % from 2 to 4 month of experimental period, such decrease was more pronounced in lambs fed 10 % MOL. Such result may be due to moringa leaves have biolytic properties; accordingly, MOL-treated lambs have less body weight and body weight gain (Table 3). These results were confirmed by Helmy *et al.* (2017) found hypocholesterolemic effect of Moringa leaves in rats. Also, Das *et al*. (2012) found that *Moringa oleifera* leaf extracts prevent fatty liver by using high-fat diet in mice. similarly, Almatrafi *et al*. (2017) concluded that moringa leaves may prevent steatosis by influencing the expression of genes involved in hepatic lipid synthesis, which lowers the levels of triglycerides and total cholesterol and reduces liver inflammation.

Urea nitrogen concentration was significantly lower (P<0.05) with supplement MOL at levels 20 and 30% than 10 MOL and control groups. Similar results were reported by Yusuf *et al*. (2018) and Zaher *et al*. (2020), they reported that the goats received different levels of moringa leaves in diets (50%, 75%, and 100%) had significantly lower plasma urea than other groups. This finding may have important antibacterial and fungicidal effects. Also, Toledo *et al*. (2014) stated that increasing MOL levels in a diet may decrease the CP content of the diet and reduce kidney function parameters.

The ALT values were lower (P<0.05) with the inclusion of MOL at levels 20 and 30 % in the diets of lambs than those received 10 MOL. However, no differences were found among 20 MOL, 30 MOL, and control groups. Moreover, the urea, ALT, and AST values were not affected by the time of sampling during the experiment. Leitanthem *et al*. (2022) found that replacing CFM with 10 and 20% MOL in the diets of goat kids decreases AST and ALT and does not have any undesirable effects on the liver. Similar results reported by Yousef *et al*. (2018) who reported that *Moringa oleifera* leaves extract decreased serum liver enzymes such as ALT, AST, and ALP and consequently ameliorated liver injury induced by methotrexate in male rats

The interaction between treatment and the sampling time on plasma total protein, globulin, and glucose is statistically significant (P<0.05).

Conclusions

This study concluded that *Moringa oleifera* leaves are a good source of nutrients (e.g., protein, trace minerals), and that the replacement of concentrate with *Moringa oleifera* up to the level of 10% can improve growth performance, blood hematology, plasma constituents, and exerts protective effects in liver without inducing adverse effect on lambs' health.

Table 6. Effect of partial substitution the crud protein of the concentrated feed mixture (CFM) with *Moringa oleifera* leaves protein on some blood constituents of growing lambs

Items	Period	Treatments				Mean Period	P-Value		
		Control	10 MOL	20 MOL	30 MOL		Trea	Per	Tr*p
Total protein (g/dl)	2M	6.36 ± 0.22	6.12 ± 0.23	7.78 ± 0.27	6.08 ± 0.19	6.58[b] ± 2.62	0.075	0.001	0.032
	4M	7.12 ± 0.18	6.79 ± 0.19	5.97 ± 0.28	7.28 ± 0.47	6.79[a] ± 0.18			
Mean Treatment		6.74 ± 0.20	6.46 ± 0.21	6.88 ± 0.27	6.68 ± 0.43				
Albumin (g/dl)	2M	2.77 ± 0.68	2.72 ± 0.40	2.6 5± 0.66	2.63± 0.60	2.69[a] ± 0.30	0.045	0.001	0.713
	4M	2.18 ± 0.13	1.97 ± 0.31	1.98 ± 0.75	1.96± 0.53	2.02[b] ± 0.41			
Mean Treatment		2.47[A]± 0.40	2.34[AB]±0.35	2.31[B]± 0.71	2.30[B] ± 0.57				
T.Globulin (g/dl)	2M	3.59 ± 0.20	3.41 ± 0.43	5.13 ± 0.82	3.44 ± 0.23	3.89[b] ± 0.27	0.064	0.001	0.008
	4M	4.95 ± 0.15	4.81 ± 0.21	3.99 ± 0.31	5.32 ± 0.45	4.77[a] ± 0.17			
Mean Treatment		4.27 ± 0.18	4.12 ± 0.27	4.57 ± 0.57	3.85 ± 0.34				
Glucose (mg/dl)	2M	62.50 ± 3.20	54.22 ± 3.32	43.87 ± 0.96	52.55 ± 1.63	53.28 ± 1.80	0.065	0.816	0.004
	4M	39.13 ± 3.60	47.18 ± 6.74	50.60 ±11.31	72.38 ± 6.37	52.32 ± 4.35			
Mean Treatment		50.82 ± 4.21	50.70 ± 3.73	47.23 ± 5.51	62.46 ± 4.33				
Cholesterol (mg/dl)	2M	55.94 ± 3.20	80.10 ±11.24	64.64 ±10.06	76.33 ± 9.47	69.25[a] ± 4.67	0.167	0.001	0.393
	4M	40.86 ± 3.81	43.14 ±7.02	54.27 ± 7.19	56.76 ±12.33	48.76[b]± 4.07			
Mean Treatment		48.40 ± 3.28	61.62 ± 8.42	59.45 ± 6.10	66.54 ± 7.98				
bilirubin (mg/dl)	2M	0.26 ± 0.10	0.08 ± 0.02	0.18 ± 0.03	0.15 ± 0.02	0.17 ± 0.03	0.223	0.207	0.055
	4M	0.15 ± 0.01	0.21 ± 0.04	0.30 ± 0.05	0.18 ± 0.04	0.21 ± 0.02			
Mean Treatment		0.20 ± 0.05	0.14 ± 0.03	0.24 ± 0.03	0.16 ± 0.02				
Urea (mg/dl)	2M	66.50 ± 4.46	63.22 ± 3.17	59.19 ± 3.41	52.96 ± 3.17	60.47 ± 1.98	0.003	0.574	0.098
	4M	76.94±10.81	65.87 ± 2.93	43.99 ± 3.44	46.72 ± 3.46	58.38 ± 4.02			
Mean Treatment		71.72[A]±5.79	64.54[A]± 2.10	51.59[B] ± 3.25	49.84[B]± 2.43				
ALT	2M	13.39 ± 3.74	20.95 ± 4.37	12.22 ± 1.63	8.73 ± .82	13.82±1.80	0.008	0.942	0.970
	4M	14.90 ± 3.37	19.82 ± 2.87	12.57 ± 4.23	7.30 ± 2.38	13.65±1.85			
Mean Treatment		14.14[AB]2.57	20.38[A]± 2.50	12.40[B] ± 2.16	8.02[B]± 1.77				
AST	2M	25.67 ± 5.15	57.97 ± 4.07	39.17 ± 9.75	44.23 ± 5.23	41.76±3.85	0.239	0.573	0.119
	4M	38.50 ± 9.44	28.63 ± 5.51	98.65 ± 50.36	31.72 ± 6.87	49.38±13.51			
Mean Treatment		32.08 ± 5.48	43.30 ± 5.50	68.91 ± 26.05	37.98 ± 4.53				

a,b,c and A, B, C Values in the same row or colum with different superscripts differ significantly (P<0.05).
10 MOL: Substitution of 10% crude protein of the CFM with moringa leaves protein
20 MOL: Substitution of 20% crude protein of the CFM with moringa leaves protein
30 MOL: Substitution of 30% crude protein of the CFM with moringa leaves protein
2M : Two months - 4M : Four months

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تأثير الاســـتبدال الجزئي للبروتين الخام في مخلوط العلف المركز بأوراق نبات المورينجا على النمو وبعض مكونات الدم للحملان النامية

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الملخص

أجريت هذه الدراســـة لمعرفة تأثير الاســـتبدال الجزئي للبروتين الخام في مخلوط العلف المركز بأوراق المورينجا على أداء النمو وصور الدم وبعض مكونات بلازما الدم للحملان النامية. تم تقسيم أربعة وعشرون حملاً من حملان الفرافرة السليمة (عمرها 5 إلى 6 أشهر ومتوسط وزنها 30 ± 0.50 كجم) عشـــوائياً إلى أربع مجموعات. غذيت المجموعة الأولى على المخلوط المركز بمعدل 60% وتبن القمح بمعدل 40% كمادة جافة واســـتخدمت كمجموعة ضـــابطة. مجموعات المعاملات الثلاثة الأخرى اســـتبدل جزئيًا البروتين الخام للمخلوط المركز بمعدلات 10، 20، 30% ببروتين أوراق المورينجا على التوالي. أظهرت النتائج أن التغذية على أوراق المورينجا ليس له تأثير معنوي على وزن الجسم، إلا أنه مع زيادة مستويات المورينجا في العلائق قد يكون له تأثير سلبي على الاداء الإنتاجي.

أدى اســـتخدام اوراق المورينجا اوليفيرا بنســـبة 20% في عليقة الحملان إلى زيادة (P <0.05) في عدد خلايا الدم البيضـــاء وخاصـــة neutrophils مقارنة بالمجموعات الأخرى. . أيضًـــا، تميل مجموعات اوراق المورينجا اوليفيرا إلى أن تكون أعلى في عدد كرات الدم الحمراء والنســـب المئوية للهيموجلوبين والهيماتوكريت مقارنة بالكنترول. انخفض ألبومين البلازما (P<0.05) مع زيادة مستويات اوراق المورينجا اولفيرا في علائق الحملان. كما أن تركيز اليوريا وقيم ALT كانت أقل (P<0.05) مع إضـــافة اوراق المورينجا اوليفيرا عند المســـتويين20، 30% مقارنة بمجموعة 10%. يمكن أن نســـتنتج أن الاســـتبدال الجزئي للعلف المركز بأوراق المورينجا أوليفيرا بنسبة 10% من غذاء الحملان النامية يمكن أن يحسن أداء النمو وصـورة الدم ومكونات البلازما، ويؤدى الى تأثيرات وقائية في الكبد دون إحداث أي آثار ضارة على صحة الحيوان.