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Review Paper

Effects of supplementing rabbits diets with *moringa oleifera* dry leaves at different levels on their productive performance

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ABSTRACT

Forty growing male New Zealand White (NZW) rabbits at 7 weeks of age with average live body weight of 772±8 g were used in a complete randomized design (CRD) of four treatments (10 in each) for 12 weeks feeding period. Rabbits in the 1st group were fed Commercial Rabbit Diet (CRD) without supplement (control, T_1). While, in the 2nd, 3rd and 4th groups, diets contained 5.48, 10.97 and 16.45% *Moringa oleifera* Dry Leaves (MDL) to replace of 10, 20 and 30% of the protein content of CRD for T_2, T_3 and T_4, respectively. The contents of CP and EE were higher, but NFE content was lower in MDL as compared with CRD. The contents of DM, OM, CF and ash were similar among treatments. The digestibilities of OM, CP, EE and NFE and the contents of TDN, DCP and DE increased significantly ($P<0.05$) with increasing levels of MDL. Dry matter content of the cecal digesta was significantly higher ($P<0.05$) in T_4 (30% MDL) than T_1 (control), however, cecal pH value revealed inverse trend. The concentrations of TVFAs and NH_3-N in cecal digesta increased significantly ($P<0.05$) with increasing levels of MDL in diets. The concentrations of total protein, albumin and globulin increased significantly ($P<0.05$); however cholesterol concentration decreased significantly ($P<0.05$) with increasing levels of MDL. The intake of total DM and CP decreased significantly ($P<0.05$) with increasing levels of MDL. Average daily intake of TDN, DCP and DE were significantly highest ($P<0.05$) in T_1 and T_2. Final body weight, total and daily weight gain and growth performance index (GPI) increased significantly ($P<0.05$) with increasing levels of MDL. The amounts of DM, TDN, CP, DCP and DE required for producing one kg weight gain decreased significantly ($P<0.05$) with increasing levels of MDL. Total feed cost and price of total weight gain increased significantly ($P<0.05$) with increasing MDL. Feed cost per kg gain was significantly ($P<0.05$) higher in T_4 compared to T_1. Slaughter and carcass weights and dressing percentage increased significantly ($P<0.05$). Abdominal fat weight and the contents of ether extract and ash decreased significantly ($P<0.05$) with increasing level of MDL supplementation as compared with control.

Keywords: Rabbits, *Moringa oleifera* dry leaves, digestibility, blood biochemical, growth performance, carcass traits.

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INTRODUCTION

Several biological properties ascribed to various parts of Moringa tree, the leaves were reported to be valuable source of carotene (precursor of vitamin A), vitamins (B-complex, C, D and K) beside some important macroelements as calcium, potassium (K), zinc (Zn), iron (Fe), copper (Cu) and selenium (Se) (Dorga et al., 1975; Booth and Wickens, 1988). Moreover, *M. oleifera* leaves and fruits prevent effectively morphological changes and oxidative damage in human and animals by enhancing the activities of antioxidant enzymes, reducing the intensity of lipid peroxidation and inhibiting generation of free radicals (Sreelather and Padma, 2009; Osman et al., 2012). It was also used to promote the immune system against infections (Jaiswall et al., 2009) and its extracts have positive effects on hematological parameters of rabbits (Chinwe and Isitua, 2010).

The chemical composition of Moringa leave meal was investigated by several workers and the results differ for crude protein, crude fiber, ether extract, ash, acid detergent lignin, macro and micro-elements (Moyo et al., 2011; Kakengi et al., 2003; Oduro et al., 2008). The differences in chemical constituents is related to type of soil, irrigated-water quality, ambient temperature and relative humidity, plant age, stage of maturity and the way in which leaves are collected, dried and sieved (Moyo et al., 2011; Onu and Aniebo, 2011).

In Egypt, great attention was by plant breeders to implant *Moringa oleifera* imported seeds in agricultural and newly reclaimed lands for human and animal uses. Limited studies have been conducted on lactating cattle, laying hens and rabbits, with either fresh (green fodder) or dry leaves. Moringa dry leaves supplementation may play a role as growth enhancer for rabbits when fed at maximum 30% of the daily ration (El-Badawi et al., 2014). *M. oliefera* leaves is a potential plant protein supplement and could be included in the diet to substitute 40% of the concentrate feed mixture protein. Improved digestibility, rumen fermentation, milk yield and composition were reported in lactating Friesian cows (El-Esawy, 2015).

Therefore, the objective of this study was to investigate the effect of different levels of replacing commercial rabbit diet protein by *M. oleifera* dry leaves protein on digestibility, blood parameters, growth performance, feed conversion ratio and economic efficiency of growing New Zealand white rabbits.

MATERIALS AND METHODS

Experimental rabbits and diets

Forty growing male New Zealand White (NZW) rabbits at 7 weeks of age with average live body weight of 772±8 g were used in a complete randomized design of four treatments (10 in each) for 12 weeks feeding period. Rabbits in the 1^{st} group were fed commercial rabbit diet (CRD) without supplement (control, T_1). While, in the 2^{nd}, 3^{rd} and 4^{th} groups, diets contained 5.48, 10.97 and 16.45% *M. oleifera* Dry Leaves (MDL) instead of 10, 20 and 30% of the protein content of CRD for T_2, T_3 and T_4, respectively. Rabbits in all groups were fed to cover their requirements according to NRC (1977). Table 1 shows ingredients used in formulation of the tested diets.

Housing and management

Rabbits were housed in galvanized wire cages (40 × 50 × 60 cm) and fresh water was automatically available *ad-libitum*. All rabbits were kept under the same managerial, hygienic and environmental conditions.

Experimental procedures

Live body weight and feed intake were recorded weekly throughout the experimental feeding period. Thereafter, daily weight gain, feed conversion ratio and economic efficiency were calculated. Also, growth performance index (GPI) was calculated according to North (1981) given as:

GPI = [final body weight (kg) / feed conversion ratio] × 100

Digestibility trials

Digestibility trials were undertaken at termination of the experiment (18 weeks of age) using three animals from each group. Rabbits were housed individually in metabolic cages. The experimental diets were offered daily and fresh water was provided *ad-libitum*. Feed intake was determined and feces were collected for 5 days as a collection period. The feces of each animal was mixed and dried at 60°C for 24 h; thereafter, representative samples were ground for chemical analysis. Chemical analysis of the 4 diets and feces was determined according to AOAC (1995), while nutritive values as TDN, DCP and DE were calculated for the experimental diets.

Slaughter technique

After termination of the feeding experiment, three representative rabbits randomly chosen from each group were fasted for 12 h, weighed and slaughtered. After complete bleeding, the drained blood was collected and weighed. Slaughtered animals were de-skinned, dressed out and the hot carcass was weighed and recorded. Edible offals (liver, heart, spleen and kidneys), non-edible offals (lungs, clean empty gastrointestinal tract and testicles) and trimmings (skin, four legs, blood and gastrointestinal tract contents) were separately weighed and recorded.

Cecal contents samples

Cecal contents of slaughtered rabbits were taken for

Table 1: Formulation of tested diets (%).

Ingredients	T_1	T_2	T_3	T_4
Soybean meal 44%	17	14.45	11.9	9.37
Wheat bran	20	18.4	16.9	14.98
Yellow corn grain	28	27.9	27.77	27.85
Berseem hay	30	28.77	27.46	26.35
Moringa	0	5.48	10.97	16.45
Molasses	2	2	2	2
Limestone	1	0.5	0.5	0.5
Common salt	0.5	1	1	1
Premix*	0.5	0.5	0.5	0.5
Dicalcium phosphate	1	1	1	1
Total	100	100	100	100

*Each one kg of premix (minerals and vitamins mixture) contains vitamin A, 20000 IU; vitamin D3, 15000 IU; vitamin E, 8.33 g; vitamin K, 0.33 g; vitamin B1, 0.33; vit. B2, 1.0 g; vitamin B6, 0.33 g; vitamin B5, 8.33 g; vitamin B12, 1.7 mg; pantothenic acid, 3.33 g; biotine, 33 mg; folic acid, 0.83 g; choline chloride, 200 mg.

Table 2: Proximate composition of MDL and tested diets.

Item	MDL	Experimental diets			
		T_1	T_2	T_3	T_4
DM %	88.98	87.22	87.13	87.41	87.50
Composition of DM %					
OM	89.88	90.29	90.27	90.25	90.22
CP	29.60	16.23	16.37	16.51	16.65
CF	11.24	12.55	12.54	12.52	12.51
EE	3.90	2.67	2.68	2.70	2.71
NFE	45.14	58.84	58.68	58.52	58.35
Ash	10.12	9.71	9.73	9.75	9.78

determination of pH using Bechman pH meter. However, samples from cecal contents were taken for determination of NH_3-N concentration according to the method of AOAC (1995) and TVFAs concentration according to Warner (1964).

Blood sampling

At the end of the experimental period, blood was collected from sacrificed rabbits (3 animals in each group) in clean sterile tubes for each animal immediately after slaughtering. Blood samples were collected in heparinized tubes and centrifuged at 3500 rpm for 15 min and then plasma was separated and stored at -20°C till biochemical analysis. Total proteins, albumin and cholesterol and concentrations as well as activities of Aspartate (AST) and Alanine (ALT) amino acids transferases were determined using spectrophotometer (Spectronic 21 DUSA) and commercial diagnostic kits (Combination, Pasteur Lap.). Globulin concentration was obtained by difference (total protein – albumin).

Statistical analysis

Data were statistically analyzed using general linear models (GLM) procedures adapted by IBM SPSS Statistics for Windows (2014) for user's guide with One-way ANOVA. Duncan test within SPSS program was done to determine the degree of significance among means.

RESULTS AND DISCUSSION

Table 2 shows that MDL contained 29.60% CP, 11.24% CF, 3.90% EE and 45.14% NFE, which were nearly similar to values obtained by El-Esawy (2015). Calculated composition of tested diets was similar for the different diets, which are isonitrogen and isocaloric.

Table 3: Nutrients digestibility and nutritive values of different diets.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
Digestibility coefficients (%)					
OM	69.55^{c}	73.53^{b}	74.92^{b}	77.89^{a}	0.83
CP	72.10^{b}	75.13^{a}	75.13^{a}	76.17^{a}	0.57
CF	59.36	59.84	60.74	61.11	0.61
EE	68.95^{b}	72.26^{a}	73.22^{a}	73.90^{a}	0.65
NFE	70.87^{c}	76.05^{b}	77.96^{b}	82.34^{a}	1.15
Nutritive values (%)					
TDN	64.99^{c}	68.79^{b}	70.07^{b}	72.88^{a}	0.78
DCP	11.70^{b}	12.30^{a}	12.40^{a}	12.68^{a}	0.11
DE (Kcal/kg)	2866^{c}	3033^{b}	3089^{b}	3213^{a}	34

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Table 4: Cecal fermentation activity of rabbits in different treatments.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
DM content of digesta%	26.22^{b}	28.25^{a}	28.92^{a}	28.65^{a}	0.36
pH value	6.80^{a}	6.67^{ab}	6.49^{ab}	6.38^{b}	0.07
TVFA's (mmol/100 ml)	33.65^{c}	36.94^{b}	39.29^{a}	41.13^{a}	0.79
NH3-N (mg/100 ml)	23.01^{c}	25.35^{b}	27.31^{a}	28.63^{a}	0.59

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Nutrients digestibility and nutritive values

Table 3 shows nutrients digestibility and nutritive values of the experimental diets. The digestibility of OM and NFE and the contents of TDN and DE increased significantly (P<0.05) with increasing levels of MDL, the highest values were with 30% MDL (77.89, 82.34 and 72.88% and 3213 Kcal/kg DM, respectively).

The digestibility of CP and EE and DCP value were significantly higher (P<0.05) in diets supplemented with MDL than the CRD and the highest values were from 30% MDL (76.17, 73.90 and 12.68%, respectively). No significant effect was observed in digestibility of CF among unsupplemented or MDL supplemented diets. It might hold true that, moringa dry leaves in a powdered form could have some digestion promoting effects. These results are in line with those obtained by El-Badawi et al. (2014) who reported that feeding rabbits on rations supplemented with MDL up to 0.30% was associated with significant (P<0.05) increases of nutrients digestibility.

El-Esawy (2015) observed that MOL supplement in rations of lactating Friesian cows resulted in significant increase in the digestibility and nutritive values of the rations with the best results at level of 40% MOL.

Cecal fermentation activity

Table 4 shows cecum fermentation activity of rabbits in different treatments. Dry matter content of the cecal digesta was significantly higher (P<0.05) in T_4 (30% MDL) than T_1 (control), while that of T_2 and T_3 was intermediate between them with insignificant differences. However, cecal pH value revealed opposite trend, which was significantly lower (P<0.05) in T_4 (30% MDL) than T_1 (control), where that of T_2 and T_3 was intermediate between them with insignificant differences. The concentrations of TVFA's and NH_3-N in cecal digesta increased significantly (P<0.05) with increasing level of MDL in diet, without significant differences between T_3 and T_4. These results are in line with those obtained by Khalel et al. (2014) who found that rumen pH values and NH_3-N concentration were lower (P<0.05) with 40% Moringa ration than those containing 0 or 20% Moringa rations, while TVFA's concentration was remarkably higher by nearly 31 and 32% for 20 and 40% Moringa rations than 0% Moringa ration, respectively.

El-Esawy (2015) reported that rumen pH value was lower for cows fed 20 and 40% Moringa rations as compared to 0 and 60% Moringa rations. Ruminal NH_3-N concentration decreased significantly (P<0.05) by inclusion

Table 5: Biochemical parameters in blood serum of rabbits in different treatments.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
Total proteins (g/dl)	6.34^{c}	6.83^{b}	7.30^{a}	7.75^{a}	0.15
Albumin (g/dl)	3.65^{c}	3.85^{bc}	4.05^{ab}	4.30^{a}	0.08
Globulin (g/dl)	2.69^{c}	2.98^{bc}	3.25^{ab}	3.45^{a}	0.10
Cholesterol (mg/dl)	39.90^{a}	37.80^{b}	30.00^{d}	34.88^{c}	0.98
Activity of AST (IU/ml)	41.65	41.63	42.91	42.50	0.24
Activity of ALT (IU/ml)	26.68	26.31	27.20	27.93	0.38

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

Table 6: Feed intake (on DM basis) by rabbits in different treatments.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
CRD (g/day)	105.61	94.65	84.38	74.70	2.97
MODL (g/day)	00.00	5.49	10.39	14.71	1.41
Total DM (g/day)	105.61^{a}	100.14^{b}	94.78^{c}	89.41^{d}	1.55
TDN (g/day)	68.64^{a}	68.89^{a}	66.41^{b}	65.16^{b}	0.49
CP (g/day)	17.14^{a}	16.39^{ab}	15.65^{bc}	14.88^{c}	0.22
DCP (g/day)	12.36^{a}	12.32^{a}	11.75^{b}	11.34^{b}	0.13
DE (Kcal/day)	303^{a}	304^{a}	293^{b}	287^{b}	2.17

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

of Moringa in the diets, while TVFA's increased by increasing Moringa level and 20 and 40% Moringa rations recorded the highest value as compared to 0% Moringa ration.

Blood parameters

Table 5 shows results of blood biochemical parameters in plasma. *M. oleifera* dry leaves showed significant effects (P<0.05) in blood plasma total protein, albumin, globulin and cholesterol concentrations. The concentrations of total protein, albumin and globulin increased significantly (P<0.05); however, cholesterol concentration decreased significantly (P<0.05) with increasing level of MDL supplement. Activities of AST and ALT enzymes were not significantly affected by MDL supplement. These results are in line with those obtained by Ibrahim et al. (2014) who reported that globulin level was significantly increased in rabbits Tr_3 (4 g MPS/kg diet) by 20.50% as compared to the control group. Musa et al. (2014) observed that mean value of cholesterol is significantly lower in *M. olefera* seed treatment group (P<0.05). El-Esawy (2015) showed significantl increase of total protein and its fractions (albumin and globulin) by inclusion of Moringa leaf into the diets as compared to the control ration. Olatunji et al. (2013) indicated that SGPT and SGOT activities in serum of rabbits were not significantly affected (P>0.05) by the dietary inclusion of Moringa leaf meal (MLM) across the treatment.

Feed intake

Table 6 shows the average daily feed intake by rabbits. The intake of total DM and CP decreased significantly (P<0.05) with increasing level of MDL supplement. Average DM intake decreased by 5.47, 10.83 and 16.20 g/day for T_2, T_3 and T_4 compared with T_1, respectively. The corresponding values for CP were 0.75, 1.49 and 2.26 g/day, respectively. Meantime, average daily intake of TDN, DCP and DE were significantly higher (P<0.05) for rabbits in T_1 and T_2 than those in T_3 and T_4. The intake of TDN decreased by 2.23 and 3.48 g/day; DCP by 0.61 and 1.02 g/day and DE by 10 and 16 Kcal/day for T_3 and T_4 compared with T_1, respectively. These results agreed with those obtained by Odeyinka et al. (2008) who found that average daily DM intake by rabbits decreased significantly with increasing the level of *M. oleifera* leaves. Safwat et al. (2014) revealed that the highest feed intake values by rabbits were observed by the 40% MOLM and control groups without any significant

Table 7: Growth performance of rabbits in the experimental groups.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
Duration period	84 days				
Initial body weight (g)	768	770	769	773	8
Final body weight (g)	2238^{c}	2358^{bc}	2436^{ab}	2525^{a}	32
Total weight gain (g)	1470^{c}	1588^{bc}	1667_{ab}	1752^{a}	31
Average daily gain (g)	17.50^{c}	18.90^{bc}	19.85^{ab}	20.86^{a}	0.38
GPI (%)	37.36^{d}	44.41^{c}	50.96^{b}	58.86^{a}	2.27

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

Table 8: Feed conversion ratio of rabbits in the experimental groups.

Items	Treatments				MSE
	T_1	T_2	T_3	T_4	
DM (kg/kg gain)	6.03^{a}	5.30^{b}	4.77^{c}	4.29^{d}	0.17
TDN (kg/kg gain)	3.92^{a}	3.64^{ab}	3.35^{bc}	3.12^{c}	0.08
CP (kg/kg gain)	0.98^{a}	0.87^{b}	0.79^{c}	0.71^{d}	0.03
DCP (kg/kg gain)	0.71^{a}	0.65^{b}	0.59^{c}	0.54^{d}	0.02
DE (Kcal/kg gain)	17314^{a}	16084^{ab}	14760^{bc}	13758^{c}	371

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

difference; meanwhile, the other three groups had the lowest values (P<0.05) and the 30% LLM group had also the same significant level with the control group.

Growth performance

Data in Table 7 revealed that initial body weight of rabbits was nearly similar for the different groups without significant difference. Whereas, final body weight, total and daily weight gain and growth performance index (GPI) increased significantly (P<0.05) with increasing level of MDL supplement. *M. oleifera* dry leaves supplement resulted in significant increase (P<0.05) in final body weight by 120, 198 and 287 g; total weight gain by 118, 167 and 282 g; daily weight gain by 1.40, 2.35 and 3.36 g/day or 8.00, 13.43 and 19.20% and growth performance index (GPI) by 7.06, 11.60 and 21.50% for T_2, T_3 and T_4 as compared to T_1, respectively. The positive effect of moringa leaves on growth performance of rabbits was noticed in some previous studies (Kpodékon et al., 2008, 2009). Nuhu (2010) regarded the better growth rate to protein quality and amino acids content of moringa leaves. El-Badawi et al. (2014) found that weight gain and ADG of rabbits fed 0.15 and 0.30% moringa supplemented rations were higher (P<0.05) than those fed 0 or 0.45% moringa rations, respectively.

Ibrahim et al. (2014) reported that live body weight change and daily weight gain were significantly increased in the rabbits of Tr_2 (2 g MPS/kg diet) by 11.7% and in Tr_3 (4 g MPS/kg diet) by 14.3% as compared to the control group (Tr_1). Adeniji and Lawal (2012) replaced moringa as a protein feed instead of ground nut cake at levels 0, 20, 40, 60, 80 and 100% and showed that weight gain values increased from the control diet up to the rabbits on 60% Groundnut cake replaced with *M. oleifera* leaf meal and thereafter, began to decrease.

Feed conversion ratio

Results in Table 8 revealed significant (P<0.05) improvements in feed conversion ratio with increasing level of *M. oleifera* dry leaves supplement. Whereas, the amounts of DM, TDN, CP, DCP and DE required for producing one kg weight gain decreased significantly (P<0.05) with increasing level of MDL supplement. The amounts of DM, TDN, CP, DCP and DE per kg gain decreased by 12.11, 7.14, 11.22, 8.45 and 7.10% in T_2 (10% MDL); 20.90, 14.54, 19.39, 16.90 and 14.75% in T_3 (20% MDL) and 28.86, 20.41, 27.55, 23.94 and 20.54% in T4 (30% MODL) compared to T_1, respectively. These results are in line with the findings of Ibrahim et al. (2014) who reported that rabbits of Tr_3 (4 g MOS) had improved feed conversion ratio. This improvement in feed conversion ratio may be due to the increase in body weight gain and the improvement in nutrients digestibility of diets. El-Badawi et al. (2014) found that feed conversion efficiency by rabbits in terms of g DM intake/ g weight gain was (P<0.05) better with rations containing 0.15 and 0.30% MDL than control.

Economic efficiency

Table 9 shows the economic evaluation of feeding growing

Table 9: Economic efficiency of rabbits in the experimental groups.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
Total feed intake (kg)					
CRD	8.87^a	7.95^b	7.09^c	6.27^d	0.25
MODL	0.00^d	0.46^c	0.87^b	1.24^a	0.12
Total	8.87^a	8.41^b	7.96^c	7.51^d	0.13
Total feed cost (LE)					
CRD	35.48^a	31.80^b	28.36^c	25.08^d	0.83
MODL	00.00^d	9.20^c	17.40^b	24.80^a	1.56
Total	35.48^d	41.00^c	45.76^b	49.88^a	0.76
Feed cost (LE)/kg gain	24.14^b	25.82^{ab}	27.45^{ab}	28.47^a	0.32
Total weight gain (kg)	1.470^c	1.588^{bc}	1.667^{ab}	1.752^a	0.03
Price of total gain (LE)	58.80^c	63.52^{bc}	66.68^{ab}	70.08^a	0.91

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

Table 10: Carcass characteristics of rabbits in the experimental groups.

Item	Treatments				MSE
	T_1	T_2	T_3	T_4	
Slaughter weight (g)	2016^b	2165^b	2374^a	2547^a	66
Carcass weight (g)	1039^c	1157^b	1283^a	1387^a	42
Dressing %	51.53^c	53.42^b	54.03^{ab}	54.46^a	0.34
Blood (g)	61.67	60.00	62.33	63.00	0.79
Skin (g)	293	298	303	326	7
Full viscera (g)	417	412	414	416	10
Empty viscera (g)	153	145	167	164	5
Head (g)	132^b	131^b	133^b	144^a	2
Legs (g)	65	72	68	74	2
Tall (g)	12.1^b	16.0^a	14.1^{ab}	16.3^a	0.7
Heart (g)	7.9^b	7.5^b	8.1^b	10.1^a	0.3
Kidneys (g)	16.1^a	13.9^b	16.8^a	15.7^{ab}	0.4
Liver (g)	80	72	81	80	2
Spleen (g)	0.99^b	1.00^b	1.47^a	1.03^b	0.08
Lungs (g)	13.6	12,9	15.5	15.9	107
Tests (g)	5.6^b	7.7^a	8.2^a	8.5^a	0.4
Abdominal fat (g)	37.9^a	34.9^a	28.8^b	27.0^b	1.4
Meat composition %					
Moisture	73.5	72.9	73.8	74.2	2.0
Protein	20.9	20.4	21.3	21.6	0.2
Either extract	9.7^a	9.8^a	9.1^{ab}	8.6^b	0.2
Ash	1.14^a	1.06^{ab}	0.99^b	0.97^b	0.02

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

rabbits on graded levels of *M. oleifera* dry leaves supplement. Total feed cost increased significantly (P<0.05) with increasing MDL supplement level, which increased by 5.52, 10.28 and 14.40 LE or 15.56, 28.97 and 40.59% for T_2, T_3 and T_4 as compared with T_1, respectively. Meanwhile, feed cost per kg gain increased insignificantly in T_2 and T_3, but increased significantly (P<0.05) in T_4 as compared to T_1. The high feeding cost of Moringa supplemented rations is due to the high price of moringa dry leaves which equals 20 LE/kg as compared to 4 LE/kg commercial rabbit diet.

Moreover, the price of total weight gain increased significantly ($P<0.05$) with increasing MDL supplement level, which increased by 4.72, 7.88 and 11.28 LE or 8.03, 13.40 and 19.18% for T_2, T_3 and T_4 as compared to T_1, respectively. These results are illustrated with those obtained by Nuhu (2010) reporting that the feed cost increased as the level of moringa leaf meal increased from 0 to 20%. Prices of *M. oleifera* dry leaves were 20 LE/kg, commercial rabbit diet was 4 LE/kg and live body weight gain was 40 LE/kg.

Carcass traits

Table 10 shows carcass traits for the different groups. Slaughter, carcass, head, tall, heart and tests weights and dressing percentage increased significantly ($P<0.05$); however, abdominal fat weight decreased significantly ($P<0.05$) with increasing level of MDL supplementation as compared with control. The contents of ether extract and ash decreased significantly ($P<0.05$) with increasing level of MDL supplementation as compared with control. Moisture and protein contents were nearly similar for the different groups. El-Badawi et al. (2014) reported that carcass dressing percentage, carcass traits and lean meat yield were higher ($P<0.05$) for rabbits fed 0.15 and 0.30% MDL supplemented rations than control.

Conclusion

From these results, it could be concluded that replacing 30% of commercial rabbit diet protein by *M. oleifera* dry leaves showed the best results of growth performance of growing rabbits.

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