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Effect of Adding Moringa Leave-Extract to Growing Rabbits Ratins on Performance, Cecal Microbial Activity and Blood Parameters

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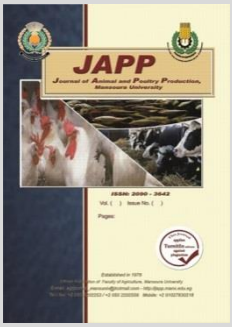

ABSTRACT

This study aimed to test the effect of adding Moringa leave-extract as a feed additives to growing rabbits rations on performance, cecal activity and blood traits. A total number of 72 growing New Zealand White (NZW) rabbits at 6 weeks of age were randomly distributed into 3 equal groups for 70 days. The control group was fed a basal diet without additives (ME_0); treated groups were fed the basal diet supplemented with either 200mg (ME_{200}) or 400mg (ME_{400}) moringa extract/ kg diet. All animals were almost equal in their initial body weight, but the final body weight increased due to the additive; feed intake followed the opposite pattern; Feed conversion ratio (FCR) was better for M_{400} followed by M_{200} then M_0. Results indicating that adding Moringa extract at the levels of 200 or 400mg improved all the digestion coefficients of all nutrients comparing to the control diet. The heaviest body weight at slaughter was recorded for ME_{400}; followed by M_{200} then M_0. It was evident that feeding moringa leaves extract increased serum total protein at both levels used. Albumin and Globulin followed the same pattern. Cholesterol level decreased significantly due to treatment. Values of AST and ALT enzymes lie between the normal ranges without any adverse effect on liver function. Total VFA in cecum content increased as a result of the dietary treatments; no differences were reported regarding anaerobic and cellulolytic bacterial, however, *E. coli*, decreased significantly due to dietary treatment indicating that moringa leaf extract had a benefit effect on rabbit hygiene.

***Keywords*:** Moringa leave-extract, performance, blood traits, cecal activity, rabbits

INTRODUCTION

Feed additives are important materials that can improve feed efficiency and animal performance (Salem and EI-Mahdy, 2001). However, the use of chemical products especially hormones and antibiotics may cause unfavorable side-effects. Many of the active ingredients in manufactured drugs are derived originally from plant compounds and have a wide range of use. It is believed that plants are more natural, less toxic, and safer than chemical preparations. The use of natural products is becoming more popular. Ekor (2013) reported that old drugs industry depended upon the raw material of medicinal herbs and plants and their extracts, which proved safe always. They added that World Health Organization (WHO) encourages using medicinal herbs and plants to substitute or minimize the use of chemicals through the global trend to go back nature. Research on the use of various parts of the Moringa oleifera Lam. plant (M. oleifera) as a nutritional and neu-traceutical resource for human and animal diets has increased in recent years, emanating from the widespread use of the plant in traditional cuisines and medicinal remedies in several regions of the world (Falowo *et al.,* 2018). However, little information is available about using extracts of medicinal plant in rabbit diets. Rabbits are characterized by many advantages that make them suitable animal, it could be bred to minimize the gap between the demand and available of animal protein (FAO, 1987, Galal and Khalil, 1994 and Daadar and Seleem, 1999). The application of M. oleifera in livestock feed as a source of protein, anti-biotic and antioxidant compounds has been reported in literature with impressive success; including demonstrated to improve growth performance, milk yield and quality, meat quality as well as reducing the rate of microbial growth in meat products after processing and cold storage (Nkukwana et al., 2014; Falowo et al., 2018; Hashem et al., 2019). Moringa oleifera consumption has been reported to improve the health status, feed conversion efficiency, growth performance and product quality of several livestock species (Falowo et al., 2018). In Egypt great attention has been given to implant Moringa oleifera imported seeds in agricultural and newly reclaimed lands for human and animal uses. Little studies have been conducted on lactating cattle, laying hens and rabbits, with either fresh (green fodder) or dry leaves. Abdel-Rahman et al (2018) concluded that Moringa leaves increase animal productivity as it has nutritional and therapeutically properties. For that, this study was carried out on growing New Zealand White rabbits to verify the nutritional impact of feeding different supplementation levels of Moringa oleifera dry leaves extracts on growth performance, nutrients digestibility, feeding values, carcass traits, blood parameters and cecum activities.

MATERIALS AND METHODS

The present study was carried out at the Department of Animal production, Faculty of Agriculture, Menoufia University in compliance with the guidelines approved by the Committee of Ethics of Scientific

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Moringa leaves preparation, extraction and GC-MS chromatogram analysis.

Samples of moringa leaves were dried and milled through a 0.25 mm screen to obtain a fine powder. 100 grams of moringa leaves powder were extracted in a70% hydro-ethanolic solution (100 g/L) at 40 °C for 72.0 h (El-Desoky et al., 2017). Extract of moringa leaf ethanolic extract was filtered with Whatman No. 1 filter paper (Little Chalfont, Buckinghamshire,HP7 9NA, UK). The obtained supernatant was evaporated at 45 °C to remove the ethanol and complete dryness and then stored at −20 °C (Hashem et al., 2019)

The chemical analysis of moringa leaves extract performed using Trace GC Ultra-ISQ mass spectrometer (Thermo Scientific, Austin, TX, USA) with a direct capillary column TG–5MS (30 m x 0.25 mm x 0.25 µm film thickness). The GC-MS chromatogram analysis and chemical composition of moringa leaves extract has been summarized in Figure (1) and Table 1.

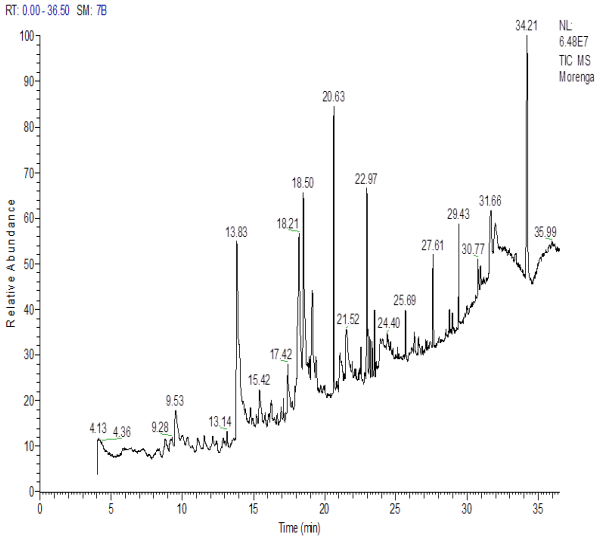

Fig. 1. GC-MS chromatogram of Moringa extract sample

The above chromatogram and Table (1) indicated that the moringa leaf extract did not have any anti-nutritional factors.

Table 1. The chemical composition of Moringa leaves extract using GCMS*

Peak	R.t**	Name	Area %	Molecular Weight	Molecular formula
1	9.53	4-Methylpiperidine-1-carboxylic acid, phenyl ester	2.52	219	C13H17NO2
2	13.83	5-Hydroxymethylfurfural	18.54	126	C6H6O3
3	14.8	16-Hydroxyhexadecanoic acid	0.59	272	C16H32O3
4	15.21	6-Acetyl-á-d-mannose	0.5	222	C8H14O7
5	15.43	11-AMINOUNDECANOIC ACID	3.94	201	C11H23NO2
6	15.82	16-Hydroxyhexadecanoic acid	0.56	272	C16H32O3
7	16.22	1H-INDOL-5-OL, 3-(2-AMINOETHYL	0.97	176	C10H12N2O
8	17.42	4-Methyl (trimethylene) silyloxyoctane	2.57	214	C12H26OSi
9	18.2	Melezitose	9.36	504	C18H32O16
10	18.5	3-[(2,5DIMETHYLANILINO)METHYL]-5-(3-FLUOROBENZYLIDENE)-1,3-THIAZOLIDINE-2,4-DIONE	9.1	356	C19H17N2O2SF
11	18.93	Ethyl iso-allocholate	1.47	436	C26H44O5
12	20.63	Palmitic Acid methyl ester	15.91	270	C17H34O2
13	21.52	21.52 HEXADECANOIC ACID, 2,3-DIHYDROXYPROPYL ESTER	3.05	330	C19H38O4
14	22.97	17-OCTADECENOIC ACID, METHYL ESTER	9.01	296	C19H36O2 296
15	23.49	Linolenic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester (Z,Z,Z)-	1.5	352	C21H36O4
16	25.69	DOTRIACONTANE 1.12 C32H66 450	5.12	450	C32H66
17	26.31	Cholestan-3-one, cyclic 1,2-ethanediyl aetal, (5á)-	0.59	430	C29H50O2
18	31.66	á-D-Galactopyranoside, methyl 2,3-bis-O-(trimethylsilyl)-, cyclic butylboronate	3.26	404	C17H37BO6Si2
19	34.21	Vitamin E 10.09 430	10.09	430	C29H50O2

***GCMS: Trace GC Ultra-ISQ mass spectrometer.**

**** R.t: retention time (min).**

The above chromatogram (Fig.1) and Table 1 indicated that the moringa leaf extract did not have any anti-nutritional factors.

Animals and experimental and diet:

A number of 72 (36 males and 36 females) growing New Zealand White (NZW) rabbits were used in this experiment at 6 weeks of age (with an average body weight of 736g±43). All experimental animals were housed in galvanized cages kept in well-ventilated pens. Each cage had a stainless-steel nipple for drinking water and a feeder to allow recorded feed intake for each rabbit. Feed and water were offered *ad libitum*. All rabbits were kept under the same management, hygiene, and environmental conditions (24±2ºC with 55-65% humidity) during the experimental period of 10 weeks. Rabbits were randomly distributed into 3 groups 24 rabbits for each (50% males and 50% females). The experimental rabbits were fed the basal diet formulated to meet the requirements of growing rabbits (NRC, 1977) .Control group fed the basal diet without additives (ME_0), the treated groups fed the basal diet supplemented with either 200mg (ME_{200}) or 400mg (ME_{400}) moringa extract/ kg die respectively. Chemical composition for basal diet was determined according to A.O.A.C (1995) .The acid detergent fiber (ADF) and neutral detergent fiber (NDF) was determined according to Van Soest et al. (1991)...Both feed intake and body weight were recorded weekly. Body weight gain and feed conversion ratio were calculated. The formula and chemical composition of the basal diet are presented in Table 2

Table 2. Chemical composition of the basal experimental diet*.

Ingredients	%
Clover hay (CH)	28
Barley grain	17
Yellow corn	9.5
Wheat bran	21.25
Soybean meal (44%CP)	18
Molasses	3
Limestone	0.95
Dicalcium phosphate	1.6
NaCl	0.3
Vitamin & Mineral premix **	0.3
DL- Methionine	0.1
Chemical composition (%on DM basis)	
Dry matter	89.84
Organic matter	94.16
Crude protein	17.32
Ether extract	3.12
Crude fiber	12.48
Nitrogen free extract	61.24
Neutral detergent fiber	38.15
Acid detergent fiber	18.51
Calcium	0.91
Phosphorus	0.46

*** Calculated according to NRC (1977).**

**** Each one kg of vitamin & mineral mixture contains: Vit.A 4000000 IU; Vit D3 50000IU; Vit E 16.7g.; Vit K3,0.67g.; Vit.B1 67g; VitB2 2.00g; Vit. B6 0.67g; Vit B12 3.33mg ; Cholin chloride 400g.; Biotin 0.07g ;Niacin 16.7g.; pantothenic acid 6.7g; Folic acid 1.7g;; Copper 1.7g; Iron 25.00g; Manganese 10.00g; Iodine 0.25g; Selenium 33.3g; Zinc 23.3g and Magnesium 133.3g.**

Digestibility trial

At the termination of the growth period, five adult healthy male animals per treatment were taken and assigned into 3 groups. The rabbits housing system was in metabolic cages (80 x 90 x 35cm) for a digestibility trial of 7 days .To determine nutrients digestibility, the cages facilitated the separate collection of unconsumed feed and feces from urine. Feed intake and fecal output were recorded using total collection method. Feces collected were weighed daily and oven-dried at 65^0C for 24 h. Feces of each rabbit were bulked, milled and the representative samples collected and kept in sealed bottles for laboratory analysis.

Carcass traits

At the end of the experiment, five representative rabbits from each treatment were randomly chosen and fasted overnight before slaughtering to determine the carcass traits. Slaughtering was carried out according to the Islamic rights using the procedure described by Abou-Ashour and Ahmed (1983). Rabbits were weighed just before slaughter as well as after complete bleeding. According to criteria and terminology for carcass traits and meat composition cited by Blasco *et al.* (1993). Rabbits were skinned and emptied then dissected into two halves. The edible parts for the carcasses were recorded, including heart, liver, and kidneys. Hot carcasses were weighed, and dressing percentages were calculated. For meat composition traits, all carcasses were divided longitudinally into two similar halves. 50 g of the minced meat samples were obtained from the carcass right half, and dried at 70 °C for 36 h to determine meat composition. The dried meat samples were ground and analyzed according to AOAC (1995).

Cecal activity and microbiological count

Samples of cecal contents were taken individually from five rabbits per group after slaughter at the end of the experimental period. Samples was evacuated into a clean sterile tube and immediately strained through two layers of sterile gauze; Values of *p*H were immediately measured in cecal content using a *p*H meter (Model HI 8424). In diluted cecal content and VFA concentration was determined by steam distillation as mentioned by Eadie *et al.* (1967).

Total count of anaerobic bacterial, anaerobic cellulolytic bacteria and Escherichia coli were estimated and recorded according to the microbiological method described by Collin *et al.* (1995) and Awad (2003).

Blood biochemical analysis

Blood serum samples were taken from five rabbits for each treatment after slaughter. Five ml of the blood sample was taken in clean tubes and centrifuged at 5,000 rpm for 10 min at 20 °C. Separated serum was kept at −20°C until the blood biochemical analyses to determine total protein according to Doumas (1975); albumin according to Doumas *et al.* (1971); total cholesterol according to Pisani *et al.* (1995); creatinine (mg/dl) according to Bartels (1972). Urea was measured by the method described by Young (2001) and GOT (AST) and GPT (ALT) were estimated according to Harold (1975). Blood biochemical was calorimetrically determined using the standard kits supplied by Spectrum, Germany.

Statistical analysis:

Data were analyzed using Statistical Analytical System (SAS, 2002), Version, 9.3.1, according to the General Linear Model as following:

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

where Y_{ij} = the observation, which consisted of the initial body weight (g), the average daily gain (g/d),the final body weight (g), the feed conversion ratio (g feed/g BWG), the feed intake (g/rabbit/d), the digestion coefficients of DM, OM, CP, CF , EE and NFE, as well as the carcass traits, meat quality, cecal activity , and blood biochemical parameters, while μ = Overall mean, Ti = the fixed effect of the treatments, and eij = Random error component assumed to be normally distributed. Duncan's multiple range tests was performed (Duncan, 1955) to detect the significant differences among means.

RESULTS AND DISCUSSION

Nutrients digestibilities

Results given in Table (3) show the apparent digestion coefficients of nutrients as affected by the Moringa extract levels. Results indicating that adding Moringa extract at the levels of 200 or 400mg significantly improved digestion coefficients of CF, EE, NDF and ADF nutrients comparing to the control diet, also DM, OM and CP digestibility improved by adding Moringa extract, but the differences were not significant. Sun et al. (2017) reported that Maringa oleifera leaves (MOLs) meal had no significant differences on the nutrient digestibility among the dietary groups. Djakalia *et al.* (2011) revealed that Moringa oleifera lead to highest apparent fecal digestibility with a high protein digestibility. Falowo *et al.* (2018) reported that M. oleifera increased nutritional value. Musa 2008 and Abdel-Rahman et al 2018 observed that increasing replacement level of medicinal plants improved digestion coefficients of almost all nutrients. Hashem *et al.* (2019) reported that Moringa oleifera leaf ethanolic extract

(MLEE) and moringa root ethanolic extract (MREE) increased the digestibility of acid detergent fiber (6.49%) and hemicellulose (13.53%) compared to the other treatments. Also these treatments increased apparent cellulose digestibility and body N retention compared to the control treatment in growing rabbits. Abousekken *et al*. (2007) and Abdel-Rahman et al 2018 concluded that by using dietary mixture of medicinal hay in growing rabbit diet the nutritive values of the experimental diets may be improved. Also, it could be observed that the higher digestibility was relative to lower feed intake where the decreases in feed intake led to an increase in digestibility of almost all nutrients. The lower feed intake generally decreases the digesta flow rate leading to more time for nutrients to expose to the digestive enzymes which will result in more efficient digestion. Baraghit *et al.* (1995) reported that digesta flow rate is negatively correlated with feed intake which would allow the nutrients to be available to the digestive enzymes for longer time. This means that the feed taken by rabbits was potentially digestible but due to the high flow rate in rabbits with more feed intake, feed may not be completely digested.

Table 3.Digestion coefficients (%) of growing rabbits fed experimental diets.

Item*	ME_0	ME_{200}	ME_{400}	SEM	*P. value*
DM	62.49	64.29	64.19	0.62	0.445
OM	64.19	65.01	66.34	0.69	0.470
CP	75.19	76.95	76.39	0.65	0.568
EE	68.05^{b}	72.53^{a}	73.90^{a}	0.72	<0.01
CF	42.14^{b}	47.89^{a}	46.35^{a}	0.71	<0.01
NDF	59.08^{b}	61.99^{ab}	62.95^{a}	0.69	0.043
ADF	67.42^{b}	70.41^{a}	71.40^{a}	0.62	0.010

ME_0, control diet without supplement; ME_{200} and M_{400}, supplemented with 200 or 400mg.

***OM, organic matter; CP, crude protein; EE, ether extract; CF, crude fiber; NDF, neutral detergent fiber; ADF, acid detergent fiber**

[a, b,c]. Means in the same row with different superscripts differ significantly.

SEM, standard error of mean.

Rabbit growth performance

Results in Table (4) showed that all animals were almost equal in their initial body weight in all groups with average of 736g, however, the final body weight significantly (P<0.01) increased due to the additive; being 2564g for M_0, 2855g for ME_{200} and 2923g for ME_{400}. Average daily gain followed the same pattern of the final body weight being 26.28, 30.27 and 31.29g for ME_0, ME_{200} and M_{400}, respectively. Feed intake followed the opposite pattern being 107.97, 100.87 and 98.44g for the same respective order; differences were statistically significant (P<0.01). the FCR (g DM intake/g growth) was better for M_{400} (3.16) followed by M_{200} (3.35) then M_0 (4.12). Sun et al. (2017) showed the average daily weight gain and feed conversion ratio of growing New Zealand White rabbits fed Maringa oleifera leaves diet were significantly better than those of other dietary groups. Abubaker *et al*. (2015) evaluated the effect of feeding graded levels of Moringa oleifera leaf meal (MOLM) in diets on growth performance of weaned rabbits and found that daily weight gain (5.95 - 13.39 g /day) increased with increasing levels of MOLM in diets. Abdel-Rahman *et al*. (2018) reported almost similar values of total gain and ADG for growing NZW rabbits when they were fed diets containing medicinal plants wastes at different levels. Hashem *et al*. (2019) studied the effects of Moringa oleifera leaf ethanolic extract (MLEE), moringa root ethanolic extract (MREE) on growth performance of growing rabbit, final BW and over all feed conversion ratios improved by adding MLEE and MREE compared to the control treatments. Mohamed *et al*. (2020) evaluated Moringa oleifera leaves ethanol extract (MOLEE) as a prophylactic treatment of lead acetate-induced toxicity in New Zealand white rabbits. Results revealed that MOLEE treatment significantly increased body gain. On the other hand, Bakr *et al.* (2019) evaluated the effect of feeding Moringa oleifera leaves meal (MOLM) on productivity of growing rabbits and revealed that inclusion of MOLM in rabbit diets did not affected either feed intake or feed conversion.

Table 4. The growth performance of growing rabbits fed the experimental diets.

Item	ME_0	ME_{200}	ME_{400}	SEM	*P. value*
IBW (g)	736.37	736.20	735.72	2.56	0.99
FI (g/d)	107.97^{a}	100.87^{b}	98.44^{c}	0.53	0.01<
ADG (g/d)	26.28^{b}	30.27^{a}	31.29^{a}	0.36	0.01<
FBW (g)	2564.18^{c}	2855.24^{b}	2923.01^{a}	19.14	0.01<
FCR	4.12^{a}	3.35^{b}	3.16^{c}	0.06	0.01<

[a,b,c] Means in the same row with different superscripts differ significantly. SEM, standard error of mean

IBW, initial body weight; FI, feed intake; ADG, average daily gain; FBW, final body weight; FCR, feed conversion ratio (g feed/g gain).

ME_0, control diet without supplement; ME_{200} and M_{400}, supplemented with 200 or 400mg.

Carcass characteristics

The slaughter weights of the experimental rabbits as affected by the dietary treatments are presented in Table (5). The heaviest weight was recorded for ME_{400} (2303g); the lightest weight was recorded for control (2165g); slaughter weight was intermediate for ME_{200}, differences were significant (P<0.01). The empty carcass weight followed almost the same pattern of slaughter weight being heaviest ME_{400} (1567g) and ME_{200} (1456g) followed by the control group being 1337g; differences were significant (P<0.01). Dressing percentage followed the same pattern being 61.76, 64.97 and 68.04% for ME0, ME200 and ME400, respectively. Weight of different organs (heart, liver, and kidney) was fluctuated without exact trend indicating that dietary treatments did not harm any organ.

Table 5. Carcass characteristics and meat chemical composition of rabbits fed the experimental diets.

Item	ME_0	ME_{200}	ME_{400}	SEM	*P.value*
slaughter wt. (g)	2165.00b	2241.00ab	2303.00a	20.76	0.01
Empty carcass (g)	1337.00c	1456.00b	1567.00a	26.23	<0.01
Dressing percent	61.76c	64.97b	68.04a	1.2	<0.01
Liver (g)	63.20	64.00	64.80	1.21	0.88
Heart (g)	7.48	7.36	7.50	0.23	0.97
Kidneys (g)	15.72	15.56	15.72	0.42	0.99
Meat chemical composition (%)					
Moisture	70.48	71.24	70.99	0.45	0.758
Protein	21.06	22.42	22.30	0.51	0.519
Ether extract	4.26	4.30	4.41	0.04	0.234
Ash	1.40	1.31	1.40	0.35	0.507

ME_0, control diet without supplement; ME_{200} and M_{400}, supplemented with 200 or 400mg.

[a, b,c]. Means in the same row with different superscripts differ significantly.

SEM, standard error of mean.

Abubaker *et al*. (2015) evaluated the effect of feeding graded levels of Moringa oleifera leaf meal in diets on carcass and organ characteristics of weaned rabbits and found that carcass weight increased with increasing levels of MOLM in diets, but dressing percentage was not affected by dietary treatments. Similarly, the weight of liver, heart and kidney characteristics were not different across the treatments. Bakr *et al*. (2019) reported that feeding Moringa oleifera leaves meal did not significantly affected carcass traits.

Data in Table (5) revealed that rabbits fed the experimental diets had nearly similar carcass chemical composition and dietary treatments did not have any adverse effect on meat quality of growing rabbits. Moisture ranged between 70.48 and 71.24%. Protein percentage was 21.06 to 22.42%. Ether extract ranged between 4.26 and 4.41% while ash content ranged between 1.31 and 1.40%. Abdel-Rahman et al (2018) reported similar results with growing NZW rabbits fed different levels of medicinal plant wastes.

Cecal activity and microbial count

Results in Table (6) present the cecal activity of rabbits as affected by moringa leaf extract. No differences in PH values in all groups was found. Total VFA increased as a result of the dietary treatments; values were 2.48, 2.98 and 2.91 mleq/100ml for M_0, M_{200} and M_{400}. No differences were reported regarding anaerobic and cellulolytic bacterial. E.coli, however, decreased significantly due to dietary treatment indicating that moringa leaf extract had a benefit effect on rabbit health. Values reported herein are within those reported by Musa (2008) for rabbits received diets supplemented with medicinal plants. Analytical studies by Falowo *et al*. (2018) have identified M. oleifera as an important source of bio active compounds including flavonoids and phenolic compounds, some organoleptic properties, and oxidative stability. Berasain et al. (2018) found an antibacterial potency of aqueous extract of coriander (*Coriandrum sativum L.*) leaves against bacterial pathogens isolated from the digestive system associated organs of rabbit. The results showed that using aqueous extract of leaves improved fermentation parameters of rabbits when compared with the control. Hashem *et al*. (2019) studied the effects of Moringa oleifera leaf ethanolic extract (MLEE), moringa root ethanolic extract (MREE) on cecal fermentation of growing rabbit. The lowest cecal total volatile fatty acid concentration was observed with the MLEE treatment.

Table 6. Cecal activity and microbial count of rabbits fed the experimental diets

Item*	ME_0	ME_{200}	ME_{400}	SEM	*P.value*
PH	6.15	5.93	6.06	0.07	0.49
TVFA (meq/100ml cecal liquor)	2.48^b	2.98^a	2.91^a	0.07	<0.01
Total anaerobic bacterial (log_{10} cfu/g)	5.72	5.78	5.89	0.10	0.80
Anaearobic cellulytic bacterial (log_{10} cfu/g)	5.87	5.72	5.59	0.08	0.42
E. coli count (log_{10} cfu/g)	6.19^a	5.24^b	5.57^b	0.13	<0.01

ME_0, control diet without supplement; ME_{200} and M_{400}, supplemented with 200 or 400mg.

***TVFA, total volatile fatty acids; CFU, colony forming unit.**

[a, b,c]. Means in the same row with different superscripts differ significantly.

SEM, standard error of mean.

Blood biochemical parameters

Blood constituents as affected by the different experimental diets are shown in Table (7). It was evident that feeding growing rabbits diets containing different levels of moringa leaves extract increased total protein at both levels used. Values were 6.63, 7.34 and 7.54g/dl with feeding ME0, ME_{200} and ME_{400}, respectively; different was significant (P<0.01). Albumin followed the same pattern being 4.14, 4.42 and 4.66g/dl. The respective values of Globulin were 2.22, 2.92 and 2.88g/dl. These values were within the normal plasma protein without any adverse effect. Treatments did not affect neither urea nor creatinine. Cholesterol level decreased significantly due to treatment; values were 52.99, 49.95 and 50.66 mg/dl, respectively. The liver function was tested by measuring the activity of AST and ALT enzymes. Values of both enzymes lie between the normal ranges without any adverse effect on the experimental rabbits.

Table 7. Blood parameters of rabbits fed the experimental diets.

Item*	ME_0	ME_{200}	ME_{400}	SEM	*P.value*
TP (g/dI)	6.63^c	7.34^b	7.54^a	0.14	<0.01
Alb (g/dl)	4.14^c	4.42^b	4.66^a	0.06	<0.01
Glob (g/dl)	2.22^b	2.92^a	2.88^a	0.09	<0.01
Urea (mg/dl)	28.49	29.87	29.67	0.34	0.20
Creatinine (mg/dl)	0.97	0.97	0.96	0.01	0.70
AST (u/L)	0.79	0.82	0.83	0.24	0.748
ALT (u/L)	0.62	0.63	0.69	0.30	0.673
Glucose (mg/dl)	98.87^b	98.55^b	100.19^a	0.25	0.01
Cholesterol (mg/dl)	52.99^a	49.95^b	50.66^{ab}	0.58	0.07

ME_0, control diet without supplement; ME_{200} and M_{400}, supplemented with 200 or 400mg.

***TP, total protein; Alb, albumin; Glob, globulin; AST, aspartate transaminase; ALT, alanine transaminase**

[a, b,c]. Means in the same row with different superscripts differ significantly.

SEM, standard error of mean.

Isitua and Iben (2013) reported that moringa leave extracts enhance the activities of aspartate transaminase and alanine transaminase in rabbits exposed to 2.5 mL of the extract. Olubisi et al. (2015) demonstrated that Moringa oleifera leaf extract (MOLE) had no significant effect on rabbits during gestation, levels of erythrocytes, leukocytes, hematocrit, hemoglobin, lymphocytes, monocytes and eosinophil, also he found that the serum biochemical variables examined during gestation, urea was higher in control rabbits, and only in lactation, he noted that only cholesterol was significantly reduced with an increase in MOLE concentration. Earlier study by Musa (2008) recorded similar values for plasma urea, globulin and the activities of ALT and AST enzymes when growing rabbits were fed medicinal plant. Lower values of cholesterol were recorded. The results agree with those obtained by Nasr *et al.* (1996) and Daadar *et al.* (2002) who found that ALT and AST enzymes concentrations were significantly lower and albumin, globulin and total protein values were higher in heat stressed Bauscat rabbit males fed diet supplemented with 5% *Nigella sativa* meal than the control group. Ojo and Adetoyi (2017) found that Moringa oleifera leaf extract at all doses produced significant changes in the blood levels of Packed Cell Volume, hemoglobin and white blood cell count and lower value of serum level of

alkaline phosphatase with a non-significant change in other serum parameters.

CONCLUSION

It could be concluded that feeding growing rabbits extracts from Moringa leaves could be of great benefits on growth performance, digestibility, cecal activity, blood metabolites and animal hygiene. No harmful effect was found as results of the tested materials. More studies are still needed to evaluate nutrient bioavailability and the mode of action of the bioactive compounds of Moringa leaf extract, as well as to determine the optimal level for adding Moringa leaf extract to rabbit diets.

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تأثير إضافة مستخلص أوراق المورينجا لعلائق الارانب النامية على الأداء الانتاجى والنشاط الميكروبي للأعور وبعض خصائص الدم

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أجريت هذه الدراسة لاختبار تأثير مستخلص أوراق المورينجا كاضافة غذائية للأعلاف على الأداء وقابلية الهضم ونشاط الأعور وخصائص الدم للأرانب النامية. تم استخدام عدد 72 من الأرانب النيوزيلندية البيضاء النامية (NZW) في هذه التجربة في عمر 6 أسابيع. تم إيواء جميع حيوانات التجارب في أقفاص مجلفنة محفوظة في حظائر جيدة التهوية. وزعت الأرانب عشوائياً إلى 3 مجموعات متساوية. تم تغذية المجموعة الضابطة بعليقة أساسية بدون إضافات (ME0) ؛ تم تغذية المجموعات المعاملة بالعليقة الأساسية مضاف إليها 200 مجم (ME200) أو 400 مجم (ME400) من مستخلص أوراق المورينجا / كجم من العليقة. كانت جميع الحيوانات متساوية تقريبًا في وزن الجسم الأولي ، لكن وزن الجسم النهائي زاد بسبب اضافة المستخلص ؛ اتبع الغذاء المأكول النمط المعاكس ؛ كانت الكفاءة الغذائية التحويلية أفضل بالنسبة لـ M400 يليه M200 ثم M0. تشير النتائج إلى أن إضافة مستخلص المورينجا بمستويات 200 أو 400 مجم أدى إلى تحسن معنوى لمعاملات هضم المستخلص الاثيرى , الالياف الخام , الالياف التى تذوب فى المحاليل المتعادلة (NDF) والالياف التى تذوب فى الاحماض (ADF) مقارنة بالمجموعة الضابطة , أيضا تحسنت معاملات هضم المادة الجافة والمادة العضوية والبروتين الخام نتيجة اضافة مستخلص المورينجا مقارنة بالمجموعة الضابطة ولكن كانت الفروق غير معنوية. تم تسجيل أثقل وزن للجسم عند الذبح لـ ME400 ؛ سجل أخف وزن للمجموعة الضابطة ((ME0؛ كان وزن الذبح متوسطًا بالنسبة لـ ME200.. كان من الواضح أن تغذية مستخلص أوراق المورينجا زاد من البروتين الكلي في السيرم عند كلا المستويين المستخدمين . اتبع الألبومين والجلوبيولين نفس النمط. انخفض مستوى الكوليسترول بشكل ملحوظ بسبب المستخلص. تم اختبار وظائف الكبد عن طريق قياس نشاط إنزيمات AST و ALT. وقعت قيم كلا الإنزيمين بين المستويات الطبيعية دون أي تأثير سلبي على أرانب التجربة. زاد إجمالي VFA في محتوى الأعور نتيجة المعاملة الغذائية ؛ لم تكن هناك فروق فيما يتعلق بالبكتيريا اللاهوائية والمحللة للسيللوز. ومع ذلك ، انخفضت أعداد الايشيرشيا كولاى (E.coli) بشكل ملحوظ بسبب الاضافة الغذائية و التى تشير إلى أن مستخلص أوراق المورينجا كان له تأثير مفيد على صحة الأرانب.