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IMPACT OF SUBSTITUTING SOYA BEAN MEAL BY MORINGA (*Moringa oleifera*) LEAVES MEAL IN THE DIET ON GROWTH PERFORMANCE, NUTRIENTS DIGESTIBILITY, BLOOD CONSTITUENTS AND CARCASS TRAITS OF GROWING RABBITS.

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ABSTRACT

In completely randomized block design, seventy two weaner New Zealand White (NZW) rabbits, 4-5 weeks old and with an average body weight of 458 ± 7g were used in a feeding trial for 56 days .The present study aimed to ascertain the effect of feeding diets containing different levels of Moringa oleifera leaves meal (MOLM) asa substitution forsoya bean meal on growth performance, nutrients digestibility,haematological and biochemical blood parameters and carcass traits of rabbits.Therabbits were randomly divided into three experimental groups of 24 rabbits per each and they distributed on three different pelleted diets containing 0, 12.5 and 19 % MOLM to substitute 0, 50 and 75 % of soya bean meal in the basal diet,respectively.

***The results of the study revealed that** chemical composition (%) ofcomposite sample of MOLM resulted from 6 successive cuts of moringa plants recorded: 90.03 DM, 27.44 CP, 8.13 EE, 8.77 CF, 34.63 NFE and 11.06 %Ash, indicating high crude protein, fats and minerals contents in MOLM.*

The final body weight (FW), daily weight gain (DWG) and relative growth rate (RGR) were insignificantly increasedwith rabbits fed MOLM diets. Feed intake was significantly (P<0.01)declined with rabbits fed 19 % MOLM diet than those fed control or 12.5 % MOLM diet. However, Feed conversion ratio (FCR), growth performance index (GPI) and economic efficiency were significantly (P<0.01) improved with rabbits fed MOLM diets compared with those fed the control diet.

Crude protein (CP) and OM digestibility coefficients and nutritive value (%) of MOLM diets expressed as DCP and TDN were significantly higher (P < 0.01) with rabbits fed MOLM diets than with

those fed the control diet, while EE, CF and NFE digestibility coefficients were not affected by the dietary treatments.

The haematological and biochemical blood parameters were not significantly affected by the dietary treatments, with exception of RBCs, total proteinand globulin which were significantly (P < 0.01) higher, whereas MCH and cholesterol levels were significantly (P < 0.05) lower with rabbits fed MOLM diets. However, all the haematological and biochemical parameters values of rabbit groups were within the normal physiological range.

Carcass traits were not significantly influenced by the dietary treatments. Internal organs of rabbits in all groups, including liver, kidney, heart, lungs and spleen appeared normal in size and did not show any signs of toxicity.

***Conclusively,** the results of the present study suggest that MOLM possess good protein quality for growth of rabbits and can be incorporated in the growing rabbits diets up to 19% in replacement up to 75 % of soya bean meal without any detrimental effects on growth performance, nutrients utilization, blood constituents and carcass traits.*

Key words: Rabbits, MOLM, soya bean meal, growth performance, nutrients digestibility, blood parameters, carcass traits.

INTODUCTION

Rabbits can plays a major role in solving the protein gap in developing countries, where average consumption is still far below the recommended standard level (FAO, 2014). Many people like rabbits meat consumption due to its high nutritional value and the low cholesterol content (De Blas and Wiseman, 2010).

Despite these advantages, rabbit production nowadays has been decreased in Egypt due to many problems; the highcost of feeding is considered the most important. This has been attributed to the feedstuffs shortage, especially the conventional protein and energy sources like soya bean meal and maize grains which mostly are imported from the abroad with foreign currency.

Recently, the interest has been increased towards the utilization of moringa (*Moringa oleifera*) leaves meal as a good protein source in the diets of farm animals as asubstitutefor the traditional protein sources such as soya bean, sunflower and ground nut meals (Sarwatt *et al*, 2002; Asaolu *et al*, 2009;

Fadiyimu *et al*, 2010; Mendieta-Araica *et al*, 2011; El Tazi, 2014; Melesse *et al*, 2011 and Ghomsi *et al*, 2017) in order to decrease the feeding costs.

Sarwatt *et al.*, (2004) reported that moringa foliage is a potential inexpensive protein source for livestock feeding. The advantages of using moringa as a protein source are numerous and include the fact that it is a perennial plant that can be harvested several times in one growing season. One hectare cultivated area gives about 240 tons or more green forage resulted from 8 cuts in the year (Foidl *et al*, 2001).

The literature showed that moringa leaves are considered good source of high quality protein in the feed of farm animals, it rich in both essential and sulfur-containing amino acids and true protein represents about 87% of the total crudeprotein in the leaves(Makkar and Becker, 1997, Fuglie, 2001, Bennett *et al*., 2003, Siddhuraju and Becker, 2003; Yang *et al*, 2006, Ferreira *et al*., 2008; Nuhu, 2010 and Moyo *et al*., 2011). Moringa leaves contain high levels of minerals (about 10%), particularly Ca and Fe. They are also rich in a wide range of vitamins such as ß-carotene, ascorbic acid, vitamin B1, B6 and niacin (Price, 2007; Sanchez, 2006) ,as well as flavonoids (quercetin and kaempferol), which are known to be more potent antioxidants than ascorbic acid (Yang *et al*, 2006). Moringa leaves may thus be used as an antioxidant feed (Makkar *et al*., 2007). They have a relatively high concentration of lipids (5 up to 10%) with an important proportion (33 to 45%) of α-linolenic acid (Moyo *et al*., 2011; Olaofe et *al*., 2013).

Information regarding the effect of feeding moringa leaves meal on productive performance of rabbits under the Egyptian conditions is lacking. The present study was carried out to investigate the effect of substitution of 50 and 75 % of soya bean mealin the diet for moringa oleifera leaves meal (MOLM) on growth performance, blood constituents, nutrients digestibility andcarcass traits of growing rabbits.

MATERIALS AND METHODS

The experimental work of the present study was carried out at Rabbits Research Unit, Department of Animal and Poultry Production, Faculty of Technology and Development, Zagazig University, Zagazig, Egypt. The experimental work was initiated in December 2015 and terminated in February, 2016. The laboratory work was performed at Central Lab for Soil, Foods and Feedstuffs (International Accredited Laboratory and has ISO 17025, since 2012), Faculty of Technology & Development, Zagazig University, Zagazig, Egypt.

1. *Cultivation of moringa plant and preparation of moringa leaves for the study:*

Moringa plant was cultivated in the experimental Station of Faculty of Technology & Development; Zagazig University. The farm is located in Ghazala Village (20 km far from Zagazig City, Egypt) of clay soil and the ambient temperature during 8 months of plantation was between 22-35°C.The seeds of moringa were cultivated in March, 2015 at rate of 20 kg /feddan (One feddan equal 4200 m^2 area) at the spaces of 30×60 cm for intensive cultivation. Irrigation of moringa plants was each 15 days. Rabbits faecesresulted from the rabbit research unit of Faculty of Technology & Developmentwas used as organic fertilizer to moringa plants.The 1^{st} cut for green forage was taken after 90 days of planting and the following cuts (6 cuts) were taken each 45 days after there. Moringa harvesting (cuts) was at 1.25 m height.The leaves were harvested and the stems were removed. The leaves of each cut were air-dried under shade until the moisture of collected leaves reached 10- 12%. The dry leaves were stored in polyethylene bags at room temperature (25°C) until formulation of the experimental diets in the Feed Mill. Composite sample from each cut of fresh and air dry moringa leaves was taken for the chemical analysis.

2. The experimental animals and their management:

In completely randomized block design, seventy two (72) weaner rabbits of mixed sexes and aged between 4-5 weeks old and with an average body weight of 458 ± 7g were used in a feeding trial for 56 days.

The rabbits were purchased from special commercial farm located in Meet Ghamr, Dakahliya Governorate, Egypt. They animals were randomly divided into three experimental groups of 24 rabbits per each with 3 rabbits in 8 replicates.The animals were housed (3 rabbits together) in flat deck wire cages (50 x 55 x 40 cm), provided with galvanized feeders and automatic drinkers nipple. The rabbit groups were fed three experimental pelleted diets, containing MOLM at levels of zero (control), 12.5 and 19% to substitute zero, 50 and 75% of soya bean meal, respectively in the basal diet (control). Chemical analysis of moringa oleifera leaves meal and soya bean meal was done before formulation the experimental diets (Table 1). Formulation and chemical composition of the experimental diets are shown in Table 2. The experimental pelleted diets were manufactured in Atmeda Feedstuffs Mill, Meet Ghamr, Dakahliya Governorate, Egypt. The experimental diets were formulated to be *iso nitrogenous* and *iso caloric* and meet the nutrient requirements of growing rabbits according to NRC (1977). The diets were offered to rabbits *adlibitum* and tap water was available to rabbits all the time. The rabbits

Table 1. Chemical analysis (%) of ingredients used in formulation of the experimental diets:

Ingredients	DM	CP	EE	CF	NFE	Ash
MOLM*	90.03	27.44	8.13	8.77	34.63	11.06
Soya bean meal	90.15	42.79	2.08	7.27	32.38	5.63
Yellow corn	90.59	8.81	4.18	3.82	71.47	2.31
Barley grains	92.14	11.43	2.18	6.56	69.28	2.69
Wheat bran	89.29	14.11	3.12	11.51	56.34	4.21
Alfalfa hay	87.56	14.25	2.35	26.48	35.13	9.35

* Composite sample of *Moringa oleifera* leaves meal (MOLM) was taken from 6 successive cuts of moringa plants.

were maintained in ventilated room under the same managerial and hygienic conditions. The experiment lasted for eight weeks.

3. Data collection for calculating the growth performance traits:

At the start of the experiment, all the rabbits were weighed before allotting them to their feeding treatments. The rabbits were weighed weekly to determine the weight gain. The experimental diets were offered *ad libitum* in the morning at about 09.00hr. The quantity of feed offered daily and leftover were weighed to determine the daily feed intake, while feed conversion ratio (FCR) was determined by dividing the total feed intake by the total weight gain. Mortality and growth rates were calculated. Relative growth rate of rabbits was calculated according to Broody (1945) by using the following equation:

Relative growth rate (RGR) = [(W2-W1) x 100] /[1/2 (W2+W1)].

Where,W1= The initial body weight (g), and W2 = The final body weight (g).

Growth performance index (GPI) was calculated according to North (1981) as follow:

GPI = (Final live body weight, Kg/ Feed conversion ratio) x100.

4. *Economic efficiency of the experimental diets:*

Economicfeed efficiency (EE) was calculated according to the prevailing prices of the experimental diets and rabbit's meat, during year of 2016. It was calculated as follows:

EE = Net revenue / Total feed cost

While, Net revenue = Selling price of total weight gain – Total feed cost.

Table (2) Ingredients and chemical composition (%) of the experimental diets.

Items	The experimental diets		
	Control (0.0 %MOLM)	**12.5% MOLM**	**19% MOLM**
Ingredients (%):			
Yellow corn	17	17	17
Barley grains	18	18	18
Wheat bran	26	26	26
Soya bean meal	16	8	4
Moringa leaves meal	-	12.5	19
Alfalfa hay	20	15.5	13
Lime stone	2	2	2
Table salt	0.5	0.5	0.5
Premix for growth*	0.3	0.3	0.3
Dl – methionine	0.1	0.1	0.1
Anti – Fungal powder	0.1	0.1	0.1
Total	**100**	**100**	**100**
Chemical composition (%):			
Dry matter (DM)	90.10	90.70	91.22
ME (kcal/kg) **	2650	2703	2697
Crude protein (CP)	16.83	16.59	16.40
Crude fibre (CF)	11.22	10.60	10.42
Ether extract (EE)	2.71	3.46	3.74
Nitrogen free extract (NFE)	49.50	49.64	49.92
Ash	9.84	10.41	10.74
Total calcium (Ca)	0.88	1.10	1.16
Total phosphorous (P)	0.52	0.52	0.55
Lysine***	0.92	1.35	1.57
Methionine +cysteine***	0.99	0.91	0.61

***Each 3 kilograms of premix contains:** Vit. A 12000000 IU, Vit. D_3 1500000 IU, Vit. E 50 gm, Vit. K_3 2 gm,Vit. B_1 2 gm, Vit. B_2 6 gm, Vit. B_{12} 0.01 gm, Chol.Chlod 1200 gm, Biotine 0.2 gm, Niacine 50 gm, Pantothenic acid 20 gm, Folic acid 5 gm, Magnesium 400 gm, Copper 5 gm, Iodin 0.75 gm, Selenium 0.1 gm, Iron 75 gm, Manganese 30 gm, Zinc 70 gm.

**It was determined according to Kalogen (1985)

***It was calculated according to NRC (1977).

5.Digestibility trial:

At the end of feeding trial period (56 days), five rabbits were randomly taken from each group to conduct a digestibility experiment. The animals were housed individually in metabolic cages (40×50×50 cm) which allow collecting the faeces and urine separately. Each cage was equipped

with an automatic drinker nipple and a manual feeder. The experimental period lasted 8 days, three days as a preliminary period for adaptation and five days as a main period for accounting the daily feed consumption and faeces output (Perez *et al*., 1995).

The collection was performed at approximately 09:00 h. each morning before offering the daily ration, and then 10% of the total faeces output were dried at 65°C for 24 h and stored in polyethylene bags till the end of the experiment .All the collected faeces for each animal were mixed, then representative faeces samples were ground for chemical analysis. The apparent nutrients digestibility coefficients were determined using the total collection method described by Perez *et al.* (1995) according to the following classical formula:

Apparent nutrient digestibility (%) =100× NI-NE/ NI

Where: NI = Nutrient intake, NE = Nutrient excreted in faeces.

Nutritive value of the experimental diets expressed as TDN (Total Digestible Nutrients) was calculated according to the equation suggested by Cheeke *et al.* (1982) as follows:

TDN% = DCP% + DCF% + DNFE% + DEE% x 2.25.

Where: DCP = Digestible Crude Protein, DCF = Digestible Crude Fiber, DNFE =Digestible Nitrogen Free Extract and DEE =Digestible Ether Extract.

ME (Kcal / Kg diet DM) of the experimental ration was calculated according to the following formula of Kalogen (1985):

ME (Kcal / Kg diet DM) = (0.588 +0.164 X) 239

Where X=Dry matter (DM) digestion coefficient of the experimental diet.

6. Blood samples collection:

At end of the 8th week of trial, 5 rabbits from each group were randomly chosen and fasted for 24 hrs. The rabbits were weighed and handly slaughtered and blood sample was taken from each rabbit into two clean and dry heparinized and non-heparinized tubes. Blood samples in the heparinized tubes were analyzed for the haematological parameters (RBCs = Red blood cells, WBCs= White blood cells, HCT = Haematocrit, MCV =Mean corpuscular volume, MCH = Mean corpuscular haemoglobin, MCHC= Mean corpuscular haemoglobin concentration, Neutrophils and Lymphocytes)..

Blood samples in the non-heparinized tubes were centrifuged at 3000 r.p.m for 15 minutes and then blood serum was taken to determine the levels and activity of some biochemical parameters that indicate the health status of animals (total protein, albumin, globulin, total bilirubin, urea-N, creatinine, total cholesterol, ALT and AST). Blood haematological and

biochemical analysis was performed in one of the accredited medicinal analytical labs.

7. Blood haematological and biochemical analyses:

Packed cell volume (PCV) was determined by spinning about 75µl of each blood sample in heparinized capillary tube in a haematocrit centrifuge for about 5 minutes and read on haematocrit reader as described by Walker*et al.* (1990), while erythrocytes (RBC) and leucocytes (WBC) counts and differential white blood counts (neutrophils, eosinophils, basophils, lymphocytes and monocytes) were determined using haemocytometer method as described by Walker *et al.* (1990). The haemoglobin (Hb) concentration and the blood constants: mean cell haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were determined using cyanet haemoglobin method and appropriate formula respectively as described by Jain (1986).

8. ***Carcass traits:***

After taking the blood samples and complete bleeding, slaughtered animals were de-skinned, dressed out and the hot carcass including head was weighed and recorded. Edible offals; liver, heart, spleen and kidneys, were weighed.

Dressing % = (Carcass weight + Giblet weight/ pre-slaughter weight) × 100.

9. ***Chemical analysis.***

The chemical analysis of the feed ingredients and experimental diets used in the study were determined in Central laboratory for Soil, Foods and Feedstuffs (International Accredited Lab and has ISO 17025 since 2012), Faculty of Technology & Development, Zagazig University, Zagazig, Egypt. Chemical analysis of feed ingredients and the experimental diets was performed according to the International Standard Methods (ISO). Moisture content was doneaccording to ISO 6496: 1999, crude ash according to ISO 5984:2002, crude protein, according to ISO 5983-1:2002, crude fat, according to the method described in Official Journal of the European Union (EN), 2009, L54/ 37, Volume 52, and crude fiber was according to the method described in Official Journal of the European Union (EN), 2009, L54/ 40, Volume 52. Mineral elements contents were determined by atomic absorption spectrophotometry using ISO 6869:2000. Phosphorus was determined according to ISO 6491:1998.

10. Statistical analysis

Data obtained in this study were subjected to the analysis of variance as a completely randomized block design according to Snedecor and Cochran (1982) and using the Linear Model Program of SPSS (2004). The differences between the treatments means were separated by Duncan Multiple Range Test (Duncan, 1955). Data in percentage values were transformed with the arcsine square root procedure to normalize variance before analysis. Statistical Model was as follow:

$$Yij = \mu + Ti + e_{ij}$$

Where: Yij = The independent variable μ = The overall mean, Ti = The effect of treatment and eij = The experimental error.

RESULTS AND DISCUSSION

1. *Growth performance traits:*

The results of growth performance traits of rabbits fed diets containing different levels of MOLM as substitution for soya bean meal are presented in Table 3.

The mean values obtained for final body weight (FW), daily weight gain (DWG)and relative growth rate (RGR) were insignificantly increasedwith rabbits fed MOLM diets. Feed intake was significantly influenced ($P < 0.01$) by the dietary treatments and recordedthe lowestvalue ($P < 0.01$) with rabbits fed 19%MOLM diet. However, feed conversion ratio (FCR) andgrowth performance index (GPI)were significantly ($P<0.01$) improved with rabbits fed MOLM diets compared with those fed the control diet (without MOLM).Feed conversion ratiorecorded 3.32, 2.98and 2.78,whereas, GPI (%) recorded 48.03, 57.02 and 59.27 % for rabbits fed zero (control), 12.5 and 19 % MOLM diets,respectively.The economic efficiency was significantly higher with rabbits fed MOLM diets than with those fed the control diet and positively correlated to the level of MOLM in the diet. Mortality rate showedinsignificantly decrease with rabbits fed MOLM diets compared with those fed the control diet.

The lower feed intake of rabbits fed 19% MOLM diet may bedue to the presence of saponins and phenol compounds in moringa leaves .These compounds have bitter and pungent taste and make the diet less palatable when its quantity increased with increasing the level of MOLMin the diet(Ufele*et al,* 2013).

The improvement in FCR and GPI with rabbits fed MOLM diets in spite of decreasing the daily feed intake could be attributed to the presence

Table 3. Growth performance traits (X ± SE) of growing NZW rabbits fed for 8 weeks the experimental diets from 5 to 13 weeks of age.

Parameters	Experimental groups (%)			Sig.
	Control (0.0 MOLM)	12.5 MOLM	19.0 MOLM	
Initial body weight(g)	457.75± 7.01	458.00±7.38	457.71±6.32	NS
Final body weight(g)	1568.29± 47.20	1677.32±70.17	1630.50±42.32	NS
Body weight gain(g)				
5-9WK	408.25± 24.43	469.17 ± 28.16	438.71 ± 14.87	NS
9-13WK	711.67± 33.81	737.50 ± 54.42	736.23± 35.24	NS
5-13WK	1109.52± 45.98	1215.23±66.87	1172.14 ± 41.44	NS
Daily body weight gain(g)				
5-9WK	14.58 ± 0.87	16.76 ±1.01	15.67 ± 0.53	NS
9-13WK	25.42 ± 1.21	26.34 ±1.95	26.29 ± 1.26	NS
5-13WK	19.81± 0.82	21.70 ±1.19	20.93 ± 0.74	NS
Relative growth rate (%)				
5-9WK	60.48±2.62	66.47±2.54	64.55±1.66	NS
9-13WK	58.98±2.59	55.52±3.21	57.88±2.05	NS
5-13WK	108.67±2.14	111.80±2.81	111.61±1.82	NS
Daily Feed intake (g)				
5-9WK	47.88±1.44^{a}	49.40±0.74^{a}	44.29±1.32^{b}	*
9-13WK	83.48±1.36^{a}	80.21±1.38^{a}	71.58±0.39^{b}	**
5-13WK	65.68±0.95^{a}	64.74±0.92^{b}	57.93±0.75^{c}	**
Feed conversion ratio (g feed / g gain)				
5-9WK	3.35± 0.18^{a}	3.02±0.16^{ab}	2.85±0.11^{b}	*
9-13WK	3.34±0.13^{a}	3.02±0.14^{ab}	2.76±0.12^{b}	*
5-13WK	3.32±0.12^{a}	2.98±0.09^{b}	2.78±.06^{b}	**
Growth Performance index	48.03±2.76^{b}	57.02±3.31^{a}	59.27±2.90^{a}	**
Mortality rate (%)	12.50	8.33	8.33	NS
Total feed cost (LE)	11.44± 0.16^{a}	11.11± 0.16^{a}	9.63± 0.13^{b}	**
Price of total gain (LE)	30.13± 1.06	32.91± 1.29	31.72^{a}± 1.09	NS
Net revenue	19.01+ 1.03^{b}	21.80±1.19^{a}	21.64± 0.98^{a}	*
Economic efficiency (%)	171.19^{c}+ 9.49^{b}	197.65± 9.4^{a}	214.24± 7.62^{a}	**

Note: a,b,c = Means in the same row with different superscript differ significantly (P<0.05). SE = Standard Error of Means; NS = Not significantly different (P>0.05); * = Significantly different (P<0.05);**= Significantly different(P<0.01).

of several nutrients in moringa leaves that stimulate growth and increase the nutrients bioavailability and feed utilization such as high quality protein, vitamins, minerals, antioxidants and cytokinine-type hormones (Estrella *et*

al., 2000, Fuglie, 2001, Siddhuraju and Becker, 2003, Fahey, 2005 and Yang *et al*., 2006).

The significant increase in economic efficiencyin rabbits fed MOLM diets is due to the improvement in feed conversion ratio and lower feed cost of MOLM diets.

The obtained results demonstrate that *Moringa oleifera* leaves meal (MOLM) possess good protein source and could be safely included in the diet of growing rabbits up to 19 % as a substitution for about 75 % of soya bean meal without negative effects on growth performance traits of rabbits.Inclusion of MOLM in the diet of rabbits in range of 12.5 – 19 % decreases the cost of feeding and increases the economic efficiency (%).

In this concern, most of the previous studies in the literature review indicated thatMOLM can be used safely in the diet of rabbits at level up to 10- 15 % as a potential replacement for soybean meal (Odetola *et al*, 2012, Dougnon *et al*,2012, Yakubu *et al* ,2013 and Ghomsi *et al*,2017). However, In otherstudies, MOLM was included successfully at level of 20 % (Nuhu, 2010) or 30% (Dahouda *et al*, 2013), and up to 40% of the diet (Safwat *et al*, 2014).The variation and the discrepancy in the results of these studies may be due to the variation in number of rabbits used and the differences in the chemical analysis of MOLMwhich lead toformulation of unbalanced experimentaldiets.

2.Nutrients digestibility and feeding values:

Table 4 shows the nutrients apparent digestion coefficients and feeding value of the experimental diets. Apparent digestion coefficients (%) of DM, EE, CF and NFE were not significantly affected by the dietary treatments and were statistically similar among all the rabbit groups. Crude protein (CP) and OM digestibility coefficients were significantly improved($P < 0.01$ and 0.05) with rabbits fed MOLM diets than with those fed the control diet (without MOLM).

The nutritive values (%) of MOLM diets expressed as DCP and TDN were significantly ($P < 0.01$) higher in MOLM diets than the control diet. However, the nutritive value expressed as ME (Kcal / Kg diet DM) was statistically similar for the tested experimental diets.

The improvement in CP and OM digestibility and the nutritive value of MOLM diets could be attributed to that moringa leaves rich in vitamins and trace elements which introduce in composition or stimulate many of enzymes or co-enzymes responsible for the digestion and metabolism of nutrients inside the body of animal (Fahey, 2005).

Table 4. Apparent nutrients digestion coefficients and nutritive value (X± SE) of the experimental diets fed to growing NZW rabbits.

Parameters	Experimental groups (%)			
	Control (0.0 MOLM)	12.5 MOLM	19.0 MOLM	Sig.
DM(%)	64.02 ± 0.34	65.38 ±0.78	65.23 ± 0.2	NS
OM(%)	64.73± 0.24^{b}	66.11± 0.81^{a}	66.97± 0.25^{a}	*
CP(%)	68.89± 0.37^{c}	74.43± 0.62^{b}	76.13 ±0.18^{a}	**
EE(%)	67.12± 0.69	67.96± 0.2	68.51 ±0.31	NS
CF(%)	46.21± 0.22	47.88± 0.84	48.3 ±0.48	NS
NFE(%)	67.37± 0.28	67.1±1.04	67.75±0.24	NS
DCP(%)	11.59± 0.06^{b}	12.35± 0.10^{a}	12.49±0.03^{a}	**
TDN(%)	54.22± O.22^{b}	56.02±0.66^{a}	57.10±0.21^{a}	**
ME(Kcal/Kg DM)	2649.72± 13.26	2703.13±30.58	2697.28±7.99	NS

Note: a,b,c = Means in the same row with different superscript differ significantly (P<0.05). SE = Standard Error of Means; NS = Not significantly different (P>0.05); * = significantly different (P<0.05); **= significantly different(P<0.01).

The obtained results were in agreement with those reported by Olatunji *et al* (2015) and Nuhu (2010) who reported that feeding growing rabbits graded levels of MOLM up to 20 % of the diet in replacement of soya bean meal showed significant (P < 0.05) improvement in DM and CP digestibility of MOLM diets. Digestibility coefficients of CF and EE were not significantly affected by the dietary treatment and were statistically similar in all rabbit groups.

4. Haematological and biochemical parameters of blood of rabbits:

Data in Table 5 show the haematological parameters of blood of growing rabbitsfed for 8 weeks different levels of MOLM in the diet as replacement for soya bean meal. As shown in Table 5, all the haematological blood parameters were not significantly affected by the dietary treatments ,with exception of RBCs which were significantly (P < 0.05) higher, whereas MCH was significantly (P < 0.05) lower with rabbits fed MOLM diets compared to those fed the control . However, all the haematological parameters values were within the normal physiological range for healthy rabbits according to Hewitt*et al* (1989), Archetti *et al* (2008) Isaac *et al* (2013) and Etim *et al* (2014).

The present findings of the study agree with Nuhu (2010) and Olatunji *et al* (2015) who reported that feeding growing rabbits for 8 weeks on diets containing graded levels of MOLM up to 20 % had no significant effects on the haematological parameters of rabbits, including, RBC, WBC, Hb, PCV, MCV, MCH, MCHC, lymphocytes, monocytes and neutrophils.

Table 5. Haematological parameters of blood (X ± SE)*of growing NZW rabbits fed the experimental diets.

Parameters	Experimental groups (%)			
	Control (0.0 MOLM)	12.5 MOLM	19.0 MOLM	Sig.
RBCs (× 10^6/ ml)	5.41±0.14^b	5.92±0.17^a	6.20±0.12^a	*
WBCs (× 10^3/ ml)	8.22±0.82	9.28±1.26	7.5±0.4	NS
Neutrophil (%)	29.80±6.76	21.40±8.66	23.80±4.46	NS
Lymphocyte (%)	55.60±7.50	57.20±6.68	60.00±3.17	NS
Haemoglobin (g/dl)	11.34±0.31	12.04±0.36	11.86±0.12	NS
Platelets(× 10^3/ ml)	286.2±27.21	321.2±54.71	271.2±40.99	NS
HCT (%)	36.76±0.58	39.04±1.1	39.0±0.53	NS
MCV (f/l)	68.26±1.95	66.02±1.35	63.02±1.38	NS
MCH (pg)	20.88 ±0.48^a	20.36±0.45^{ab}	19.18 0.36^b	*
MCHC (g/dl)	30.6±0.29	30.84±0.22	29±1.53	NS

*Mean of 5values for each parameter. Note: RBCs = Red blood cells, WBCs= White blood cells, HCT = Haematocrit, MCV =Mean corpuscular volume, MCH = Mean corpuscular haemoglobin, MCHC= Meancorpuscular haemoglobin concentration.
Note: a,b,c = Means in the same row with different superscript differ significantly (P<0.05). SE = Standard Error of Means; NS = Not significantly different (P>0.05); * = significantly different (P<0.05).

Data in Table 6 show blood biochemical parameters of growing rabbitsfed the experimental diets. The results of serum biochemical parameters presented in Table 6 show no significant dietary influence on albumin, globulin ,urea- N, creatinine andtotal bilirubin, however total protein level and globulin were higher (P < 0.01)and cholesterol level was lower (P < 0.05) with rabbits fed19 % MOLM diet compared with those fed the control or12.5 % MOLM diet.

The reduction in cholesterol level with increase in MOLM in the diet suggests that MOLM has a cholesterol lowering effect.

The results of serum total protein levels of rabbit groups support the results obtained of daily body gain and feed conversion ratio which showed the best values with rabbits fed 19 % MOLM diet in replacement of 75 % of soya bean.

The present findings agree with those reported by Olatunji *et al* (2015) who reported that Albumin, globulin, total protein, SGPT, SGOT and ALP were not significantly affected (P>0.05) in blood serum of rabbits fed diets containing graded levels of MOLM up to 20 (%).

It is apparent that MOLM did not negatively affect the haematological and biochemical indices of the experimental rabbits and the obtained results

Table 6. Blood biochemical parameters (X ± SE)*of growing NZW rabbits fed for 8 weeks diets containing different levels of MOLM as a substitution for soya bean meal.

Parameters	Experimental groups (%)			
	Control (0.0 MOLM)	12.5 MOLM	19.0 MOLM	Sig.
ALT (U/L)	48.08± 8.21	48.54±5.23	54.8±9.05	NS
AST (U/L)	37.0±4.92	40.0±1.95	37.0±3.78	NS
Total protein (g/dl)	6.09 ± 0.17^{b}	6.29 ± 0.21^{b}	$7.24+ 0. 20^{a}$	**
Albumin (g/dl)	4.09±0.22	4.25±0.15	4.02±0.18	NS
Globulin (g/dl)	1.99 ± 0.13^{b}	2.03 ± 0.19^{b}	3.22 ± 0.31^{a}	**
A/G ratio	2.06 ± 0.24^{a}	2.09 ± 0.24^{a}	1.25 ± 0.17^{b}	*
Total bilirubin (mg/dl)	0.43±0.04	0.46±0.05	0.48±0.07	NS
Urea-N (mg/dl)	18.2±1.69	18.2±0.86	16.0±0.71	NS
Creatinine (mg/dl)	0.86±0.03	1.1±0.07	1.02±0.09	NS
Cholesterol (mg/dl)	92.4 ± 1.12^{a}	91.6 ± 1.69^{a}	85.6 ± 1.54^{b}	*

*Mean of 5 values for each parameter. ALT = Alanine transaminase, AST = Aspartate transaminase, Urea-N = Ureanitrogen.

Note: a,b,c = Means in the same row with different superscript differ significantly (P<0.05).

SE = Standard Error of Means; NS = Not significantly different (P>0.05); * = significantly different (P<0.05); **= significantly different(P<0.01).

were within the normalphysiological range for healthy rabbits as reported by Hewitt*et al* (1989), Archetti *et al* (2008) and Etim *et al* (2014).

5. Carcass traits:

Data presented in Table (7) show carcass traits of rabbits fed the experimental diets.

Carcass traits were not significantly influenced by the dietary treatments and all traits were statistically similar between rabbit groups. The carcass percentages recorded 46.51, 48.0 and 47.22 %, while dressing percentages were 52.34, 54.04 and 53.42% for rabbit groups fed zero

Table 7. Carcass traits (X ± SE)* of growing NZW rabbits fed the experimental diets.

Parameters	Experimental groups (%)			
	Control (0.0 MOLM)	12.5 MOLM	19.0 MOLM	Sig.
Pre slaughter weight (g)	1878±61.96	2045.6±94.65	2033.4±49.48	NS
After slaughter Weight (g)	1832±58.56	1981.8±91.63	1974.2±48.56	NS
Carcass weight (g)	874.6±39.47	981.4±45.55	959.8±21.19	NS
(%)	46.51±0.85	48.00±0.65	47.22±0.32	NS
Liver weight (g)	75.2±7.00	92.0±9.34	94.2±14.67	NS
(%)	4.00±0.31	4.55±0.52	4.62±0.70	NS
Heart weight (g)	9.00±0.84	7.80±0.97	8.80±0.66	NS
(%)	0.48±0.04	0.38±0.03	0.43±0.03	NS
Kidney weight (g)	24.4±1.69	24.2±1.02	23.6±1.63	NS
(%)	1.30±0.07	1.18±0.05	1.16±0.09	NS
Giblets weight (g)	108.6±7.76	124.0±9.19	126.6±13.53	NS
(%)	5.77±0.29	6.11±0.51	6.21±0.63	NS
Lung weight (g)	10.2±0.58	9.6±1.29	10.8±0.97	NS
(%)	0.54±0.03	0.46±0.04	0.53±0.04	NS
Spleen weight (g)	1.00±0.0	1.20±0.2	1.20 ±0.2	NS
(%)	0.05±0.002	0.06±0.01	0.06±0.01	NS
Dressing weight (g)	983.2±45.39	1105.4±45.26	1086.4±29.63	NS
(%)	52.34±1.01	54.04±0.62	53.43±0.74	NS

*Mean of 5 values for each trait, where 5 rabbits were slaughtered in each group.
Note: a,b,c = Means in the same row with different superscript differ significantly (P<0.05).
SE = Standard Error of Means; NS = Not significantly different (P>0.05).

(control), 12.5% and 19 % MOLM diets, respectively.Internal organs, including liver, kidney, heart, lungs and spleen appeared normal in size and did not show any signs of toxicity.

The present findings agree with those recorded by Abubakar*et al* (2015) who reported that dressing and internal organs percentages were not significantly affected in rabbit groups fed for 8 weeks diets containing 0, 15, 30 and 45 % MOLM.The same results were obtained by Nuhu (2010) when rabbits were fed diets containing 0, 5, 10, 15 and 20 % MOLM. However, Ghomsi *et al* (2017) observedthat carcass and dressed weights of growing rabbits were significantly (P < 0.05) decreased by feeding basal diet contained 20% MOLM compared with those fed the control or 10% MOLM diets. The discrepancy in the indicated results may be due to the variation in the composition of the experimental diets, number of rabbits used in each group and using unbalanced diets.

Conclusively, based on the results of the present study, it was concluded that growing rabbits can utilize varying levels of *Moringaoleifera* leaves meal up to 19% to substitute up to 75 % of soya bean meal of the formulated diets without any adverse effects on growth performance, nutrients utilization, blood constituents, carcass traits and elevated the economic efficiency.

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تأثير استبدال كسب فول الصويا بمسحوق أوراق المورينجا (*Moringa oleifera*) في العليقة علي كفاءة النمو- هضم العناصر الغذائية- مكونات الدم – صفات الذبيحة في الأرانب.

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أقيمت التجارب العمليةالخاصة بهذه الدراسة في المزارعالتابعة لكلية التكنولوجيا والتنمية بجامعة الزقازيق ، أما التحاليل الكيمائية فقد تمت في المعمل المركزي للتربة والأغذية والأعلاف (معمل دولي معتمد وحاصل علي الأيزو17025 منذ عام 2012) التابع لنفس الكلية.
أجريت تجربة النمو لمدة 56 يوما في تصميم تجريبي كامل للقطاعات العشوائية باستخدام عدد 72 أرنب نيوزيلندي أبيض مفطوم عمر4- 5 أسبوع بمتوسط وزن458 ± 7 جرام.
هدفت الدراسة تقييم تأثير تغذية الأرانب النامية علي أغذية تحتوي علي مستويات مختلفة من مسحوق أوراق المورينجا كبديل لكسب فول الصويا علي مؤشرات كفاءة النمو ومعاملات هضم المركبات الغذائية وبعض مكونات الدم وصفات الذبيحة في الأرانب.
وزعت الأرانب عشوائيا عليثلاثة مجموعات تجريبية متساوية وتم تغذية كل مجموعة علي واحد من ثلاثة علائق،الأولي أتخذت كمقارنة وإحتوت علي كسب فول الصويا بنسبة 16 % كمصدر أساسي للبروتين. في العلائق الثانية والثالثة تم استبدال50 % ، 75 % من كسب فول الصويا في عليقة المقارنة علي التوالي بما يقابله من مسحوق أوراق المورينجا علي أساس المحتوي البروتيني، وقد ترتب علي ذلك إحتواء العلائق الثلاث علي التوالي علي مسحوق أوراق المورينجا بنسبة : صفر ،12,5 % ، 19,0 %. تم تكوين العلائق الثلاث بحيث تكون متساوية في محتواها من البروتين والعناصر الغذائية الأخري وتلبي الإحتياجات الغذائية اللازمة لنمو الأرنب وفقا لما أوصى به المجلس القومي للأبحاث (NRC,1977). تم تصنيعالعلائق الثلاث (في شكل مصبعات) في مصنع أعلاف أتميدة التابع لمدينة ميتغمر بمحافظة الدقهلية.

تتلخص نتائج الدراسة فيما يلي :

١- أظهر التحليل الكيميائي التقريبي لأوراق المورينجا أوليفيرا المجففة هوائيا في عينة ممثلة مجمعة مأخوزة من 6 حشات متتالية من نبات المورينجا التركيب الغذائي الآ تي : 90,03% مادة جافة، 27,44% بروتين خام ، 8,13 % دهن خام ، 8,77 % ألياف خام ، 34,63% كربوهيدرات زائبة ، 11,06 % رماد خام، دلالة علي إرتفاع محتوي أوراق المورينجا في البروتين الخام والدهن الخام والعناصر المعدنية. كما أظهر التحليل الكيمائي (%) لكسب فول الصويا المستخدم في تكوين العلائق الثلاث التركيب الغذائي الآتي: 90,15% مادة جافة ، 42,79% بروتين خام ، 2,08 % دهن خام ، 7,27 %ألياف خام ، 32,38% كربوهيدرات زائبة ، 5,63 % رماد خام.

٢ -تحسن بصورة غير معنوية كل من وزن الجسم النهائي وعائد الوزن اليومي وسرعة النمو، بينما تحسن معدل التحويل الغذائي ودليل كفاءة النمو معنويا (علي مستوي إحتمال 1 %) في الأرانب المغذاه علي العلائق المحتوية علي أوراق المورينجا علي الرغم من تناقص معدل الإستهلاك اليومي للغذاء بزيادة مستوي مسحوق أوراق المورينجا في العليقة إلي 19 % ، فقد سجلت قيم معدل التحويل الغذائي 3,32 ، 2,98 ، 2,78 كيلو جرام غذاء لكل كيلو جرام نمو، وقيم دليل كفاءة النمو 48,03 ، 57,02 ، 59,27% علي التوالي في مجاميع الأرانب المغذاه علي علائق الكنترول ، 12,5 % ، 19 % مسحوق أوراق المورينجا.

٣ -تناقصت تكلفة الغذاء وارتفعت الكفاءة الإقتصادية (علي مستوي إحتمال 1%) في مجموعتي الأرانب المغذاه علي مسحوق أوراق المورينجا مقارنة بمجموعة المقارنة وكانت الزيادة متناسبة طرديا مع مستوي أوراق المورينجا في الغذاءالمأكول.

٤ -إرتفعمعامل الهضم الظاهري للمادة العضوية والبروتين الخام معنويا (علي مستوي إحتمال 1 % علي التوالي) في العلائق المحتوية علي مسحوق أوراق المورينجامقارنة بعليقة المقارنة(الكنترول) ، بينما لم تتأثر معاملات هضم المادة الجافة والدهن الخام والألياف الخام والكربوهيدرات الذائبة بالمعاملات الغذائية.

٥ -إرتفع بصورة معنوية (علي مستوي إحتمال 5 %) عدد كرات الدم الحمراء ومستوي كل من البروتين الكلي والجلوبيولين (علي مستوي إحتمال 1 %)، بينما إنخفض مستوي الكوليسترول الكلي معنويا أيضا (علي مستوي 95%) في دم الأرانب المغذاه علي العلائق المحتوية علي أوراق المورينجا مقارنة بتلك المغذاه علي عليقة الكنترول.لم تتأثر باقي مؤشرات صورة الدم والمكونات البيوكيميائية في سيرم الدم بالمعاملات الغذائية . كانت مستويات كل المؤشرات المقدرة لصورة الدم والمكونات البيوكيميائية في السيرم في حدود المستوي الفسيولوجي الطبيعي لدم الأرانب النامية دلالة علي إتزان العلائق الثلاث واحتوائها علي العناصر الغذائية اللازمة للنمو وخلوها من المواد السامة.

٦ -لم تتاثر معنويا صفات الذبيحة بالمعاملات الغذائية ، فقد سجلت نسب الذبيحة (Carcass %) 46,51 ، 48,0 ، 47,22 % ، بينما سجلت نسب التصافي (dressing %) 52,34 ، 54,04 ، 53,43 % في مجاميع الأرانب المغذاه علي التوالي علي علائق الكنترول ، 12,5% ، 19 % مسحوق أوراق المورينجا.كانت الأعضاء الداخلية في الأرنب في كل المجاميع والمشتملة علي الكبد والكلي والقلب والرئتين والطحال في مستوي الحجم الطبيعي ولم تظهر عليها أي مظاهر إكلينيكية لحدوث أي تسمم للحيوان أثر التغذية علي مسحوق أوراق المورينجا.

التوصية: تشير نتائج الدراسة الحالية علي أن أوراق المورينجا الجافة مصدرغني للبروتين عالي الجودة ويمكن إضافتها بنجاح في علائق الأرانب النامية بمستويات مختلفة حتى نسبة 19 % لكي تستبدل حتي 75 % من كمية كسب فول الصويا في العليقة بدون أي تأثيرات ضارة علي كفاءة النمو وهضم المركبات الغذائية ومكونات الدم وصفات الذبيحة.