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THE INFLUENCE OF DRIED *MORINGA OLEIFERA* LEAVESIN FEEDING OF GROWING RABBITS
1- GROWTH PERFORMANCE,NUTRIENTS DIGESTIBILITY, NITROGEN UTILIZATION AND ECONOMICAL EFFICIENCY

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ABSTRACT: A total of eighty New Zealand White (NZW) male rabbits of 6 weeks of age with an average initial body weight 885.75±42.4 g were used to study the effects offeeding *Moringa oleifera* leaves supplemented diets on growth performance, nutrients digestibility, dietary nitrogen utilization and economical efficiency. Rabbits were distributed into 4 groups of twenty rabbits each. The first group received basal diet (un-supplemented) which served as control diet (C) (0.0% *Moringa*), while 2, 4 and 6% of the dietary soybean meal protein in the basal diet were replaced by *Moringa oleifera* leaves protein (0.5., 1.00 and 1.5%) in groups M1, M2 and M3, respectively. The results showed that the incorporation of the different levels of dried *Moringa* leaves in growing rabbit diets resulted in significant increases in the digestibility coefficients of DM, OM, CF and NFE, while there was an insignificantly increments in CP digestibility in the experimental groups compared to the control group (C). The highest digestibility coefficients and feeding values in terms of TDN and DCP were significantly obtained in group fed diet M3, followed by those fed diet M2. All nitrogen utilization factors were significantly affected by the addition of dried *Moringa oleifera* leaves (MOL) in the rabbit diets except the N-absorbed. The results, also showed that feeding *Moringa* diets significantly decreased fecal nitrogen (FN) by 11.98, 15.99 and 21.09%, respectively, and urinary nitrogen (UN) by 8.64, 10.92 and 23.28%, respectively, in groups fed M1, M2 and M3 diets, than those fed the control diet (C). The maximum N-balance (NB) value (g/h/day) was recorded for rabbits fed diets M2 and M3 with 20.51 and 27.35%, respectively, increments than those fed the control diet (C). The highest NB/NI% and NB/NA% were significantly obtained in group fed diet M3 with 37.03 and 27.98%, followed by those fed diet M2 with 24.33 and 17.14% increments, respectively, than those fed the control diet (C). Rabbits final body weight (12 weeks of age), daily weight gain and performance index were significantly (P<0.05 or 0.01) increased in groups fed *Moringa* supplemented diets and the highest values were obtained in group fed M3 diet, while the lowest values were obtained in rabbits fed the control diet. The rabbits fed M3 diet recorded significantly the highest daily feed intake (96.85 g/day), while the lowest value was recorded by those fed diet control diet (C) (85.43 g/day).Better feed conversion ratio was recorded in rabbits fed M3 diet (3.35 g. feed/g. gain). Meanwhile, the results showed that the inclusion of dried *Moringa oleifera* leaves in growing rabbit diets significantly (P≤0.05) decreased the values of feed conversion ratio and present 3.52, 3.42 and 3.35 in groups fed M1, M2 and M3 diets, respectively. Also, the results showed that feeding *Moringaoleifera* leaves supplemented diets significantly increased the performance index and relative growth rate% than those of the control group (C). The economical efficiency% and the relative economical efficiency% were increased by feeding *Moringa* diets (M1, M2 and M3) than those fed the control diet (C) and the increments were related to the increase of *Moringa* level in the rabbit diet. The highest economical efficiency% was recorded in group fed M3 diet (175.3%) followed by those fed M2 diet (169.4%) while the lowest economical efficiency% value was recorded in group fed the control diet (C) (152.9%).

Key words: Rabbits, Moringa, growth performance, digestibility and economical evaluation.

INTRODUCTION

One of the major factors limiting the productivity of small animals in developing countries is the over-dependence on low digestibility feeds which cannot meet even the maintenance requirements of these animals. Animal feed additives are used worldwide for many different reasons. Some help to cover the needs of essential nutrients and others to increase growth performance, feed intake and therefore optimize feed utilization. Probiotics, prebiotics, enzymes, some plant leaves and highly available minerals, as well as herbs has a positive effects on the production efficiency and growth performance and can be seen as feed alternatives (Caspar Wenk, 2003). *Moringa* (*Moringa oleifera* Lam.) is the best known and most widely distributed species of *Moringaceae* family. *Moringa* trees are native to India, Pakistan, Asia and Africa, where it can be grown in a variety of soil conditions preferring well-drained sandy or loamy that is slightly alkaline (Kristin,2000 and Luqman *et al.*, 2012). It can grow well in the humid tropics or hot dry lands and can survive under drought conditions Anwar *et al.* (2007a). The tree is known by such regional names as Benzolive, Drumstick tree, Horseradish tree, Kelor, Marango, Mlonge, Mulangay, Saijihan and Sajna (Fahey, 2005). The plant thrives best under the tropical insular climate. It can grow well in the humid tropics or hot dry lands and can survive in less fertile soils and it is also little affected by drought (Anwar *et al.*, 2007b). It is considered as one of the World's most useful trees, as almost every part of the *Moringa* tree can be used for food, medication and industrial purposes (Khalafalla *et al*., 2010). *Moringa* tree; roots, leaves, flowers, seeds, fruits (pods) and even tree trunk have been consumed by humans and used for various domestic purposes as for alley cropping, animal forage, fertilizer, foliar nutrient, green manure, gum, sugar-cane juice-clarifier (powder seeds), bio-pesticide, water purification (seeds meal) and machine lubrication (oil). Several biological properties ascribed to various parts of this tree. The leaves have been reported to be a valuable source of â-carotene (precursor of vit. A), vitamins (B-complex, C, D and K) beside some important macro-elements as calcium, potassium, zinc, iron, copper and selenium (Booth and Wickens, 1988; Dorga *et al.*, 1975). Moreover, it was reported that *Moringa 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) and Osman *et al.* (2012). It was also, used to promote the immune system against infections Jaiswalk *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 has been investigated by many workers, the results showed differences among authors for crude protein, crude fiber, ether extract, ash, acid detergent lignin, macro and micro-elements Kakengi *et al.* (2003); Moyo *et al.* (2011) and Oduro *et al.* (2008). The difference in chemical constituents of fairly 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) and Onu and Aniebo (2011). Based on claims that *Moringa* leaves increase animal productivity as it has nutritional and therapeutically properties, great attention in Egypt has been given by plant breeders 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.

For that, this study was conducted on growing New Zealand White (NZW) rabbits to verify the nutritional impact of feeding different supplementation levels of dried *Moringa oleifera* leaves on feed and water intake, nutrients digestibility, dietary nitrogen utilization, average daily gain, feed conversionratio and carcass characteristics.

MATERIALS AND METHODS

The field part of the present study was carried out at Rabbit Research Laboratory (Abbis), while the chemical analysis was performed at the Nutrition Research Laboratory, belonging to the Animal and Fish Production Department (El-Shatby), Faculty of Agriculture, Alexandria University, Alexandria, Egypt. The study was carried out during the period from September 2017 to August 2018.A total of eighty weanlings male New Zealand White (NZW)rabbits of 6 weeks of age with an average initial body weight 885.75±42.4 g were obtained from a local commercial farm. Rabbits were allotted at random among four experimental groups (each contained twenty rabbits) with nearly similar means (insignificant differences) of live body weight. A complete mixed diet was formulated tomeet or exceed the essential nutrient requirements for growing rabbits and saved as control diet (C) according to NRC (1984) and De Blas (1986). Three experimental diets (M1, M2 and M3) were prepared in which 2, 4 and 6% of soybean meal protein in the control diet was replaced by dried *Moringa oleifera* leaves (MOL) protein (0.5, 1.0 and 1.5% of the diet, respectively).The composition and chemical analysis of the experimental dietswere summarized in Table (1). A commercial vitamin and mineral premix was added for all the experimental diets. Animals were individually caged in metal galvanized cages under the same managerial conditions in well ventilated block building. Fresh air circulated in the house using exhaust fans. Temperature during the experimental periods varied between 18 and 22 0C employing electrical heaters. The rabbits were kept within a cycle of 16 h light and 8 h dark using artificial light. Fresh water was automatically available all the time by stainless steel nipples for each cage. The experimental diets were offered to rabbits *ad libitum* in pelleted form. Live body weight (g) and daily feed consumption (g) were individually recorded each week up to 12 weeks of age (marketing age). Feed conversion ratio was calculated as g feed/g gain. Nutritional and economical parameters and performance traits were estimated. Performance index (PI) and relative growth rate (RGR) were calculated according to North (1981) as given below:-

PI = [live body weight (kg) / Feed conversion] x 100

$$RGR = \frac{w2 - w1}{1/2(w1 + w2)} \times 100$$

Whereas: W1 = the initial body weight, and W2 = the final body weight

Viability and the clinical health status of all rabbits were recorded daily and viability percentage was calculated as follows:-

$$\text{Viability \%} = \frac{\text{Total number of live animals at the end}}{\text{Total number of animals at start}} \times 100$$

The economical efficiency was calculated by the following equation:-

Y = [(A - B) / B] x 100

Where A is selling price of obtained gain and B is the feeding cost for this gain (cited by El-Kerdawy, 1997).

At the end of the fattening period, four digestibility and nitrogen balance trials were carried out using a total of twenty male rabbits (five rabbits / group). Rabbits were kept individually in metabolic cages, (50x50x40 cm), that allow collecting feces and urine separately. Rabbits of each group were offered one of the experimental diets. The trials lasted for 21 days, 14 days as a preliminary period followed by 7 days for measurements of actual consumed feed and feces and urine output according to European reference method for rabbit digestion trails (Perez *et al.*, 1995). Samples of daily feces (20%) of each rabbit were collected every day, dried at 60 - 70 ^{0}C for 48h, bulked, mixed, finally ground and kept for chemical analysis. Urine was quantitatively collected for each animal and the volume was measured, then 0.1 ml of concentrated hydrochloric acid was added to

10% sample of the urine before storing freezing for chemical analysis.

Chemical composition of the control diet, feces and urine were analyzed according to A.O.A.C. (1995). Acid Detergent Fiber (ADF) and Neutral Detergent fiber (NDF) were carried out according to Van Soest (1963).

The total digestible nutrients (TDN%) and the digestible crude protein (DCP%) were calculated according to classic formula (Cheeke *et al.*, 1982).

Economic efficiency was calculated according to Raya *et al.* (1991) from the following equation:

$$\text{Economic efficiency (\%)} = \frac{\text{Net revenue (L.E)}}{\text{Total feed cost (L.E)}} \times 100$$

Where;

Net revenue = Price of weight gain (L.E) - Total feed cost (L.E).

Price of weight gain (L.E) = Average weight gain (kg/head) × Price/kg live body weight (L.E).

Total feed cost (L.E) = Average feed consumption (kg/head) × price /kg feed (L.E).

Data were analyzed by General Linear Model (GLM) procedure according to SAS program **(SAS, 2004).** Significant differences were detected using ANOVA and Orthogonal Test.

The application of the least of significance test for the differences among the different treatment means were done according to Duncan (1955). Data were analyzed by adapting the following model:

$Y_{ij} = \mu + t_i + e_{ij}$ Where:

Y_{ijk} = an observation of each traits studied.

μ = the overall mean.

t_i = the fixed effect of the i^{th} treatment.

e_{ij} = the random error term associated with each observation and assumed independent, normally distributed with mean zero and variance $\delta 2e$

RESULTS AND DISCUSSION

Chemical analysis of *Moringa oleifera*leaves:

The results of chemical analysis of *Moringa oleifera* leaves Table (2) showed high contents of crude protein (CP) (30.71%)and ether extract (EE) (5.94%) but low contents of crude fiber (CF) (9.78%) and nitrogen free extract (NFE) (46.04%). Cell wall constituents of *Moringa* leaves of NDF, ADF and ADL were 11.40, 8.49 and 1.8%, respectively. Secondary components such as total tannins, condensed tannins and total polyphenols presented 5.0, 3.12 and 2.02 (g/kg), respectively. The results obtained by Moyo *et al.* (2011) reported comparablevalues to the chemical composition of dry *Moringa* leaves in the present study.Meanwhile,a number of researchers obtained different values for the chemical analyzes of dried *Moringa oleifera* leaves (Gupta *et al.*,1989;Oduro *et al.*,2008 and Nuhu 2010). There are considerable variation among the nutritional values of *Moringa* leaves, which depend on factors like genetic background, agro-climatic conditions, age of shrubs or trees, season of harvesting, leaves collection and drying procedures and the method applied to get the final form of the product (El-Badawi *et al.,* 2014). In general, all previous studies confirmed that *Moringa* leaves are rich in protein, amino acids and mineral elements that are important for growth and health of human and animals.

Nutrients digestibility and Nutritive values:

Nutrients digestibility coefficients and nutritive values of growing rabbits as affected by feeding *Moringa*leaves supplemented diets are shown in Table (3). The incorporation of the different levels of dried *Moringa* leaves in growing rabbit diets resulted in significant ($P\leq0.05$ and 0.01) differences in the digestibility coefficients of DM, OM, CF and NFE, while there was an insignificantly increments in CP digestibility in the experimental groups compared to the control group. Ewuola *et al.* (2012) suggested that the use of *Moringa oleifera* leaves in the rabbit diets has beneficial effects on the nutrients digestibility. The digestibility coefficients of DM and OM were significantly ($P\leq0.05$) increased by 5.67, 10.32 and 11.73% and by 7.13, 11.54

and 13.11% in the experimental groups fed diets M1, M2 and M3, respectively, than those fed the control diet. The rabbis feed M3 diet present significantly (P≤0.05) the highest digestibility coefficient values of ether extract (EE) and nitrogen free extract (NFE) (76.18 and 80.09%, respectively), followed by those fed diet M2 (75.54 and 79.19%) and M1 diets (73.44 and 77.45%), respectively. Similarly, Muhammad *et al.* (2016) showed that the digestibility coefficients of EE in lactating buffaloes were higher (P<0.05) by 11.32% in group fed *Moringa* containing diet comparing to those fed the control diet. Crude fiber digestibility in groups fed *Moringa oleifera* leaves(MOL) diets (M1, M2 and M3 diets), was significantly (P≤0.01) increased by 15.60, 24.16 and 35.28%, respectively, comparing with those fed the control diet (C). Vidjannagni*et al.* (2018) reported that the digestibility coefficients of acid detergent fiber and hemicelluloses of *Moringa oleifera* leaves based diet were higher than those of *Moringa oleifera* leaf-free diet. However, Adeniji and Lawal (2012) did not find any significant difference in nutrients digestibility between un-supplemented or *Moringa* supplemented rations on rabbits.On the other hand, the digestibility coefficient of crude protein was insignificantly increased by feeding diets containing dried*Moringa oleifera* leaves (MOL).The results in Table (3) showed that the digestibility of crude protein recorded in groups fed M1, M2 and M3 diets were 70.34, 72.53 and 73.78%, respectively, while it was 68.34% in group fed the control diet. El-Aidy *et al.* (2017) stated that crude protein digestibility of suckling buffalo calves was significantly (P<0.05) higher in diets containing up to 15% dried *Moringa oleifera* leaves comparing with those fed the control ration. Also, Gebregiorgis and Nurfeta (2011) reported that the digestibility of CP increased with increasing the levels of *Moringa* leaves in the buffalo diets.

The results showed that feeding M3 diet present significantly (P≤0.01) the highest TDN (66.67) followed by those fed M2 and M1diets (65.41 and 63.61) with 10.75, 8.66 and 5.67% higher than those fed the control diet (C). The DCP was insignificantly increased by feeding dried *Moringa oleifera* leaves (MOL) diets. The results in Table (3) showed that DCP insignificantly increased by 6.97, 6.26 and 3.26%, respectively, than those fed the control diet (C). El-Badawi *et al.* (2014) indicated that nutritive values in terms of TDN and DCP were significantly (P≤0.05) increased as the *Moringa* supplementation level increased up to 0.30%.In the contrary, the results obtained are in disagreement with Nkukwana *et al.* (2014) and Helal *et al.* (2017) who reported that TDN and DCP in the rabbits fed*Moringa* supplemented diets were insignificantly differed than those fed the control diet (0% *Moringa*).

Nitrogen utilization:

The results showed that all nitrogen utilization factors were significantly (P≤0.05) affected by the addition of dried *Moringa oleifera* leaves (MOL) in the rabbit diets except the N-absorbed Table (4). Feed intake (FI)and nitrogen intake (NI) were significantly (P≤0.05) higher in rabbits fed the control diet (C) than those fed diets supplemented with dried *Moringa oleifera* leaves (MOL). Moreover,rabbits fed *Moringa* supplemented diets had lower (P<0.05) fecal and urine nitrogen losses than those fed control diet (0% *Moringa*). The results showed that feeding M1, M2 and M3 diets significantly (P≤0.05) decreased the fecal nitrogen (FN) by 11.98, 15.99 and 21.09%, respectively, and urinary nitrogen (UN) by 8.64, 10.92 and 23.28%, respectively, than those fed the control diet (C). In the contrary, Adeniji and Lawal (2012) did not find significant differences among rabbits for fecal and urinary N losses with diets contained *Moringa* leaves in replacement ground nut cake at 0, 20, 40, 60, 80 and 100%.

On the other hand,the results showed that the supplementation rabbit diets with dried *Moringa oleifera* leaves (MOL) (groups M1 and M2) insignificantly increased the absorbed nitrogen (AN) than those fed the control diet (C). El-Badawi *et al.* (2014) showed that rabbits fed *Moringa* leaves supplemented rations had lower (P≤0.05) fecal and urine nitrogenlosses than those fed the control diet (0% *Moringa*). The authors reported that *Moringa* leaves might contain some phytochemical compounds that enhanced dietary crude protein digestibility and absorption. In this concern, Asaolu *et al.* (2011) reported that the minimum fecal and urinary nitrogen losses were recorded on goats fed 100% *Moringa* fodder in comparison with rations contained *Moringa* with either 50% leucaena or gliricidia.

However, the maximum N-balance (NB) value (g/h/day) was recorded for rabbits fed M2 and M3 diets with 20.51 and 27.35%, respectively, increments than those fed the control diet (C). Moreover, the highest NB/NI% and NB/NA% were significantly (P≤0.05) obtained in group fed M3 diet with 37.03 and 27.98%, followed by those fed M2 diet with 24.33 and 17.14% increments, respectively, than those fed the control diet. On the other hand, the NB (g/day), NB/NI% and NB/NA% were insignificantly differed between groups fed the control diet and those fed diet M1.

The better dietary protein utilization associated diets containing different supplementation levels of *Moringa* leaves were referred by many others to its protein quality and amino acid profile Djakalia *et al.* (2011) and Dougnon *et al.*(2012). However, according to our results the better dietary N utilization of *Moringa* rations is more likely related to some effective compounds that enhanced N utilization.

Growth performance and feed consumption:

Growth performance data of growing NZW rabbits as affected by dietary supplementation with different levels of *Moringa oleifera* are presented in Table (5). At 12 weeks of age, there were significant differences (P<0.01) among the experimental groups in final body weight, total and daily weight gain, daily feed consumption, and performance index.

The results showed that the highest final body weight (12 weeks of age) was significantly (P≤0.05) obtained in groups fed M3 diet, followed by those fed M2 and M1 diets (2146, 2073 and 2024 g, respectively) Figure (1). In the same trend, Helal *et al.* (2017) reported that livebody weight was significantly improved for the growing rabbits which fed diets supplemented with *Moringa oleifera* leaves compared to those fed the control diet (0% *Moringa*). Also, Hassan *et al.* (2016) reported that the addition of *Moringa oleifera* leaves meal up to 0.3% of broiler diets improved growth performance of broiler chickens reared under heat conditions.

The highest average daily weight gain (6-12 weeks) was significantly (P≤0.05) obtained in groups fed M3 diet (28.91 g/day). The lowest daily weight gain values were significantly (P≤0.01) obtained in group fed the control diet (C) (23.40 g/day). Similarly, El-Badawi *et al.* (2014) reported that *Moringa* supplemented diets had a positive effect on average daily weight gain of rabbits fed 0.15 and 0.30% *Moringa* supplemented rations.

Daily feed consumption (during 6-12 weeks of age) was significantly differed between the experimental groups. The highest daily feed consumption (g/day) was significantly (P≤0.01) recorded in group fed M3 diet (96.85 g/day), while the lowest value was recorded by those fed the control diet (85.43 g/day). In contrast, Helal *et al.* (2017) showed no significant differences between rabbits fed the control diet (0.0% *Moringa*) or those fed diets contained 1% *Moringa oleifera* leaves. Also, Banjo (2012) reported that the inclusion of dietary *Moringa*, significantly (P<0.05) enhanced body weight gain of broiler chickens at 2% level of inclusion but did not affect feed intake.

The better feed conversion ratio was recorded in the group fed M3 diet (3.35 g. feed/g. gain). The results showed that the inclusion of dried *Moringa oleifera* leaves in growing rabbit diets significantly (P≤0.05) decreased feed conversion ratio and present

3.52, 3.42 and 3.35 in groups fed M1, M2 and M3 diets, respectively. In the same trend, Marai *et al.* (2002) and El-Badawi *et al.* (2014) reported that feeding *Moringa* supplemented diets in growing rabbits had a positive effect on the live body weight and feed conversion ratio which leads to the improvement of the performance index%.

The results in Table (5) showed that the addition of dried *Moringa oleifera* leaves in growing rabbit diets significantly (P≤0.01) improved the performance index and relative growth rate% values in growing rabbits. The results showed that the increasing of the replacement up to 6% of dietary soybean meal protein by dried *Moringa oleifera* leaves protein significantly (P≤0.01) increased the performance index and relative growth rate% than those of the control group (C). Rabbits fed the M3 diet recorded significantly (P≤0.01) the highest performance index and relative growth rate% values in group fed M3 diet (64.06 and 78.90%). Bouatene *et al.* (2011) reported that rabbits fed *Moringa* leaves supplemented diets showed the highest growth rate.

No cases of death were registered (up to the 12 weeks of age) in the experimental groupswhich fed the M2 diet; therefore, the viability% recorded in this group was 100%. The rabbits fed the M3 diet recorded lower viability% value (95%). The lowest viability% value was recorded in groups fed the M1 and control diets (C). Increasing the viability% in the dried *Moringa oleifera* leaves diets (M2 and M3) may be due to the improvement in the health status obtained in these groups. Bouatene *et al.* (2011) reported that the inclusion of *Moringa oleifera* leaves in the rabbit diets significantly decreased the mortality rate% as a result of reduced incidence of bloating and scabies. Also, According to Chollom *et al.* (2012) stated that the chickens fed *Moringa oleifera* leaves diets had better health status, viability% and feed conversion ratio (FCR).

Economic evaluation:

Economic evaluation of feeding growing rabbits on graded levels of *Moringa* leaves supplementation is presented in Table (6). The diets price (L.E./Ton) was increased with the increasing the Moringa oleifera leaves level in the rabbit diets presenting 4574, 4588 and 4602 L.E./Ton in M1, M2 and M3 diets, respectively, which increased by 0.307, 0.614 and 0.921%, respectively, than the control diet (C) (4560 L.E./Ton).The total feed cost (L.E.) was increased in groups fed M1, M2 and M3 diets (17.474, 17.699 and 18.741 L.E., respectively), which increased with about 5.81, 7.18 and 13.49%, than those fed the control diet (C) (16.51 L.E.). On the other hand, the feed cost/kg gain (L.E.) was decreased in groups fed M1, M2 and M3 diets (16.179, 15.775 and 15.437 L.E., respectively), which decreased with about 3.69, 6.10 and 8.11%, than those fed the control diet (16.80 L.E.). The selling price of the obtained gain (L.E.) in groups fed M1, M2 and M3 diets being 45.90, 47.69 and 51.60 L.E., respectively which was increased by 9.87, 14.14 and 23.50%, respectively, than those fed the control diet (41.78 L.E.).The high feeding cost of Moringa supplemented diets is due to the high price of Moringa dry leaves. Nuhu (2010) reported that the feed cost of the Moringa supplemented diets was increased as the level of Moringa leaf meal increased from 0% to 20%. However, Adeniji et al. (2010) and Adeniji and Lawal (2012) stated that feed cost / kg weight gain was decreased with increasing the inclusion level of Moringa leaf meal in rabbit diets. The differences of feeding cost for diets containing Moringa leaves are undoubtedly regarded to the common selling prices in different countries.

The economical efficiency% and the relative economical efficiency% were increased by feeding Moringa diets (M1, M2 and M3) than those fed the control diet (C) and the increments were related to the increase of *Moringa* level in the rabbit diet. The results in Table (6) showed that the economical efficiency% increased with feeding growing rabbits M1, M2 and M3 diets (162.676, 169.422 and 175.306%) than the economical efficiency% which obtained in group fed the control diet (152.985%). Moreover, the relative economical efficiency% was higher in groups fed M1, M2 and M3 diets by 6.34, 10.34 and 14.59%, respectively, than those fed the control diet (C).

The increments obtained of the economical efficiency% of groups fed *Moringa oleifera* leave diets may be due to the increased in the final live body weights obtained in these groups as a result of the improvement of growth performance and nutrients digestibilities for rabbits fed *Moringa* leave diets.

El-Badawi *et al.* (2014) reported that the best economical efficiency% was recorded in rabbits fed diets containing 0.15% *Moringa oleifera* leaves, while, feeding diets containing 0.30 or 0.45% *Moringa oleifera* leaves decreased the economical efficiency%.

CONCLUSION

Evidently, it could be concluded that the replacement of up to 6% of the soybean meal protein by dried *Moringa oleifera* leaves protein (1.5% of the diet) ofgrowing rabbit diets caused considerable improvement of growth performance, nutrients digestibility, dietary N utilization,economical efficiency% and viability%without any negative effects onthe health status of growing rabbits.

Table (1): Formulation and chemical composition of the control and experimental diets

Feed ingredients (%)	Control diet (C)	Experimental diets		
		2% replacement (M1)	4% replacement (M2)	6% replacement (M3)
- Egyptian berseem hay	32.0	32.0	32.0	32.0
- Dried *Moringa oleifera* leaves	-	0.5	1.0	1.5
- Yellow corn	7.5	7.4	7.3	7.2
- Wheat bran	23.5	23.5	23.5	23.5
- Barley grain	16.2	16.2	16.2	16.2
- Soybean meal (44%)	16.0	15.6	15.2	14.8
- Molasses	2.5	2.5	2.5	2.5
- Limestone	0.8	0.8	0.8	0.8
-Di-Calcium Phosphate	0.5	0.5	0.5	0.5
- Common salt	0.5	0.5	0.5	0.5
- Vitamin & Mineral premix*	0.2	0.2	0.2	0.2
- DL-Methionine	0.2	0.2	0.2	0.2
- Lysine	0.1	0.1	0.1	0.1
Total	100	100	100	100
Chemical composition (%)				
Dry matter	91.83	91.79	91.81	91.84
On DM basis (%)				
- Organic matter	87.66	87.85	87.79	87.82
- Crude protein	16.68	16.64	16.61	16.57
- Ether Extract	1.92	1.90	1.91	1.91
- Crude fiber	11.78	11.79	11.81	11.78
- Nitrogen free extract	57.43	57.52	57.46	57.56
- Ash	12.19	12.15	12.21	12.18
- DE (kcal/kg feed DM)**	2106.38	2111.83	2102.49	2107.83

* Each 3 kg of premix contained: Vitamin A 12000000 IU, V.D3 2200000 IU, V.E 10000 mg, V.K3 2000 mg, V.B1 1000 mg, V.B2 4000 mg, V.B6 1500 mg, V.B 12 10 mg, Pantothenic Acid 10000 mg, Niacin 20000 mg, Biotin 50 mg, Folic Acid 1000 mg, Coline chloride 500 gm, Selenium 100 mg, Copper 10000 mg, Iron 30000 mg, Manganese 55000 mg, Zinc 50000 mg, Iodine 1000 mg and carrier CaCoi to 3000 gm.

**Calculated according to Fekete and Gippert (1985):- DE (kcal/kg) = 4253 - 32.8(CF%) – 144.4 (Ash%).

Table (2): Chemical composition, cell wall constituents and some secondary components of dried Moringa oleifera leaves (MOL)

Items	Chemical composition (%)
	Moringa oleifera leaves (MOL)
Dry matter (DM)	90.71
On DM basis %	
- Organic matter (OM)	92.47
- Crude protein (CP)	30.71
- Crude fiber (CF)	9.78
- Ether Extract (EE)	5.94
- Nitrogen free extract (NFE)	46.04
- Ash	7.53
Fiber fractionation %:	
- Neutral detergent fibers (NDF)	11.40
- Acid detergent fibers (ADF)	8.49
- Acid detergent lignin (ADL)	1.80
Secondary components (g/kg):	
- Total tannins	5.0
- Condensed tannins	3.12
- Total polyphenols	2.02

Table (3): Nutrients digestibility and nutritive values of growing rabbits as affected by feeding *Moringa* diets

Items	Control group (C)	Experimental groups			MSE	Sig.
		M1	M2	M3		
No. of rabbits	4	4	4	4		
Nutrients appearance digestibility coefficients:						
Dry matter (DM)	66.09^{b}	69.84^{ab}	72.91^{a}	73.84^{a}	1.40	*
Organic matter (OM)	65.52^{b}	70.19^{a}	73.08^{a}	74.11^{a}	1.42	*
Crude protein (CP)	68.34	70.34	72.53	73.18	2.53	NS
Ether extract (EE)	69.73^{b}	73.44^{ab}	75.54^{a}	76.78^{a}	1.71	*
Crude fiber (CF)	31.21^{c}	36.08^{b}	38.75^{b}	42.22^{a}	0.97	**
Nitrogen free extract (NFE)	73.28^{b}	77.45^{a}	79.19^{a}	80.09^{a}	1.20	*
Nutritive values %:						
TDN%	60.20^{c}	63.61^{b}	65.41^{ab}	66.67^{a}	0.83	**
DCP%	11.34	11.71	12.05	12.13	0.55	NS

$^{a-d}$ means with the different letters in the same row are differ significant ($P \leq 0.001$)
** ($P<0.001$), * ($P<0.05$), NS= Not significant, MSE=Mean of standard errors

Table (4): Nitrogen utilization of growing rabbits as affected by feeding *Moringa* diets

Items	Control group (C)	Experimental groups			MSE	Sig.
		M1	M2	M3		
No. of rabbits	4	4	4	4		
Nitrogen utilization:						
Daily feed intake (g/day)	132.63[a]	124.78[b]	128. 9[ab]	124.19[b]	2.381	*
Nitrogen intake (NI) (g/day)	3.535[a]	3.322[b]	3.425[ab]	3.292[b]	0.064	*
Fecal nitrogen (FN) (g/day)	1.119[a]	0.985[ab]	0.940[b]	0.883[c]	0.023	*
Absorbed nitrogen (AN) (g/day)	2.416	2.336	2.485	2.409	0.056	NS
Urinary nitrogen (UN) (g/day)	1.319[a]	1.205[ab]	1.175[b]	1.012[c]	0.041	*
Nitrogen balance (NB) (g/day)	1.097[b]	1.131[b]	1.322[a]	1.397[a]	0.038	*
NB/NI %	31.01[c]	34.08[c]	38.551[b]	42.488[a]	0.911	*
NB/AN %	45.37[c]	48.456[c]	53.145[b]	58.064[a]	1.458	*

[a-d] means with the different letters in the same row are differ significant (P≤0.001)
* (P<0.05), NS= Not significant, MSE=Mean of standard errors

Table (5): Growth performance and feed consumption of experimental groups as affected by feeding *Moringa* diets

Items	Control group (C)	Experimental groups			MSE	Sig.
		M1	M2	M3		
No. of rabbits	20	20	20	20		
Initial body weight (g)	935	944	951	932	16.58	NS
Final body weight (g)	1918[d]	2024[c]	2073[b]	2146[a]	9.78	*
Daily weight gain (g)	23.40[c]	25.71[b]	26.71[b]	28.91[a]	1.76	**
Daily feed consumption (g)	85.43[c]	90.51[b]	93.77[ab]	96.85[a]	6.49	**
Feed conversion ratio	3.65[a]	3.52[a]	3.42[b]	3.35[c]	0.049	*
Performance Index (%)	39.77[d]	57.50[c]	60.61[b]	64.06[a]	3.185	**
Relative growth rate (%)	68.9[c]	72.78[b]	74.21[b]	78.9[a]	0.656	**
Viability%	90	90	100	95	-	

[a-d] means with the different letters in the same row are differ significant (P≤0.001)
* (P<0.05), NS= Not significant, MSE=Mean of standard errors

Table (6): Economic evaluation of experimental rabbits as affected by feeding *Moringa* diets

Items	Control group (C)	Experimental groups			MSE	Sig.
		M1	M2	M3		
No. of rabbits	20	20	20	20		
Initial body weight (6 weeks)	935	944	951	932	16.58	NS
Final body weight (12 weeks)	1918[d]	2024[c]	2073[b]	2146.4[a]	9.78	*
Average body weight gain (g)	983[c]	1080[b]	1122[b]	1214.4[a]	1.76	**
Feed consumption (g/rabbit)	3621.5[c]	3820.3[ab]	3857.7[b]	4072.3[a]	6.49	**
Price of diets (L.E/ton)[1]	4560	4574	4588	4602	-	-
Total feed cost (L.E)[2]	16.514	17.474	17.699	18.741	-	-
Feed cost/kg gain (L.E)	16.799	16.179	15.775	15.437	-	-
Selling price of obtained gain (L.E)[3]	41.778	45.900	47.685	51.595	-	-
Net Revenue (L.E)	25.265	28.426	29.986	32.854	-	-
Economic efficiency (%)	152.99	162.68	169.42	175.31		
Relative Economical efficiency %	100	106.34	110.74	114.59	-	-

[a-d] means with the different letters in the same row are differ significant (P≤0.001) ** (P<0.001), * (P<0.05) NS= Not significant
[1]based on the actual prices of feedstuffs in the market, the cost of control diet was 4560 L.E./Ton, The diets M1, M2, M3 are 4574, 4588 and 4602 L.E./Ton , respectively, [2]Total feed cost (L. E.) = Feed price / kg (L. E.) x Average feed intake (kg/rabbit). [3] Selling price of 1 kg of rabbit = 42.5 L.E.

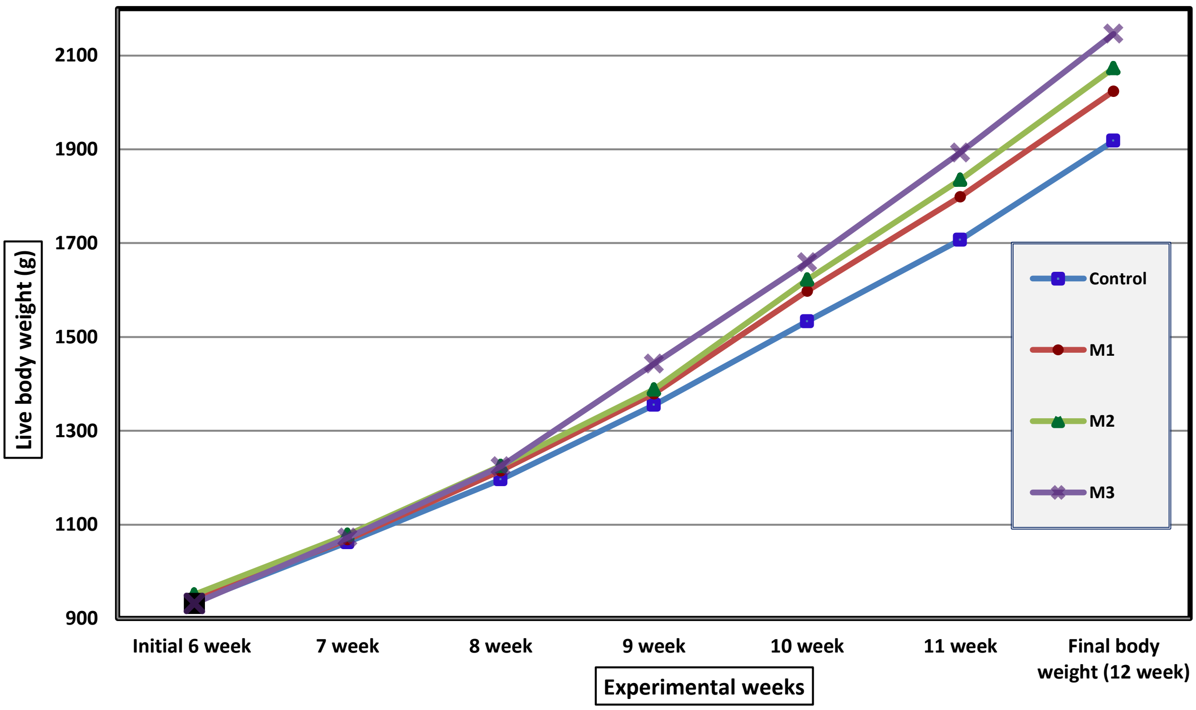

Figure (1): Live body weight development of the experimental groups from 6-12 weeks of age.

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الملخص العربى

تاثير تغذية الارانب النامية على العلائق المحتوية على اوراق *المورينجا اوليفيرا* الجافة
١- كفاءة النمو ومعاملات الهضم واستخدام النيتروجين والكفاءة الأقتصادية

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تم إستخدام ثمانونذكر من الارانب النيوزيلاندى البيضاءعمر ستة أسابيع بمتوسط وزنإبتدائى٨٨٥,٧٥ ± ٤٢,٤ جرام لدراسة تأثير أضافة التغذية على علائق محتوية على مستويات مختلفة من أوراق المورينجا الجافة على كفاءة النمو ومعاملات الهضم وأستخدام النيتروجين والكفاءة الأقتصادية. تم تقسيم هذة الأرانب إلىأربعة مجموعات تجريبية (٢٠ ارانب/مجموعة) وتم تغذية المجموعة الأولى على عليقة أساسية(C)بدون إضافة أوراق المورينجا الجافة فى حين تم أستبدال ٢، ٤، ٦% من بروتين كسب فول الصويا بالعليقة الأساسية ببروتين أوراق المورينجا اوليفيرا الجافة بمعدل ٠.٠ و ٠,٥٠ و ١,٠٠ و ١,٥٠% فى العلائق التجريبية M1, M2, M3على الترتيب. وأستمرت التجربة حتى أصبح عمرالأرانب أثنى عشر أسبوع.

أوضحت النتائج أن تغذية الأرانب النامية على علائق محتوية على مستويات مختلفة من أوراق المورينجا الجافة أدت إلى زيادة معنوية فى معاملات الهضم للمادة الجافة والمادة العضوية والألياف الخام والكربوهيدرات الذائبة وبطريقة غير معنوية على البروتين الخام مقارنة بتلك المغذاة على العليقة الأساسية (C) (٠,٠% مورينجا). تم الحصول على أعلى قيم لمعاملات الهضم والقيم الغذائية معبرا عنها ب *TDN و DCP*فى المجموعة المغذاة على العليقة M3 يليها المجموعة المغذاة على العليقةM2.أظهرت النتائج أن كل قيم النيتروجين الغذائى المستخدم تأثرت معنويا بأضافة أوراق المورينجا الجافة لعلائق الأرانب النامية عدا النيتروجين الممتص. تغذية الأرانب النامية على علائق المورينجا (M1, M2 and M3) أدت إلى أنخفاض معنوى فى نيتروجين الروثبمعدل ١١,٩٨ ، ١٥,٩٨ و ٢١,٠٩% على التوالى، ونيتروجين البول بمعدل ٨,٦٤ ، ١٠,٩٢ و ٢٣,٣٥% على التوالى، عن تلك المغذاة على العليقة الأساسية (C). تم الحصول على أعلى قيم للأتزان الأزوتى (جم/يوم) فى المجموعة المغذاة على العلائق M2 وM3 بزيادة قدرها ٢٠,٥١ و ٢٧,٣٥%، على التوالى، عن تلك المغذاة على العليقة الأساسية(C). تم الحصول على أعلى قيم للاتزان الأزوتى/النيتروجين المأكول والأتزان الأزوتى/النيتروجين الممتص فى المجموعة المغذاة على العليقة M3يزيادة معنوية قدرها ٣٧,٠٣ و ٢٧,٩٨% على التوالى،يليها المجموعة المغذاة على العليقة M2بزيادة معنوية قدرها٢٤,٣٣ و ١٧,١٤% على التوالى، عن تلك المغذاة على العليقة الأساسية (C).الوزن النهائى للجسمأرتفع معنويا (عند عمر ١٢ اسبوع) ومعدل الزيادة اليومية للجسم وكذلك كفاءة النمو للأرانب النامية المغذاة على العلائق المحتوية على أوراق المورينجا الجافة(العليقة M3)فى حين أن أقل القيم تم تسجيلها فى المجموعة المغذاة على العليقة الأساسية (C). كمية الغذاء المستهلكأرتفعت معنويا (٩٦,٨٥ جم/ يوم) فى الأرانب المغذاة على العليقة M3مقارنة بالكنترول. سجلت المجموعة المغذاة على العليقة M3أفضل معامل تحويل غذائى (٣,٣٥ جم علف/جم زيادة فى الوزن) من ناحية اخرى فقد أظهرت النتائج أن إضافة أوراق المورينجا الجافة لعلائق الأرانب النامية أدت إلى تحسن فى التحويل الغذائى والتى أظهرت قيم ٣,٥٢، ٣,٤٢ و ٣,٣٥ فى المجموعات التجريبية المغذاة على العلائق M1، M2 و M3، على التوالى.أيضا، أشارت النتائج إلى أن التغذية على العلائق المحتوية على مستويات مختلفة من أوراق المورينجا الجافة أدت إلى زيادة معنوية فى دليل الكفاءة ومعدل النمو النسبى مقارنة بالتغذية على العليقة الأساسية الغير محتوية على المورينجا.زادت % الكفاءة الأقتصادية و% الكفاءة الإقتصاديىة النسبية فى المجاميع التجريبية المغذاة على العلائق المحتوية على أوراق المورينجا الجافةM1 ، M2 و M3 مقارنة بتلك المغذاة على العليقة الأساسية (C).تناسبتالزيادة فى% الكفاءة الأقتصادية و% الكفاءة الأقتصادية النسبية مع زيادة مستوى إضافة المورينجا بالعلائق.سجلت أعلى قيم % للكفاءة الأقتصادية فى المجموعة المغذاة على العليقة M3 (١٧٥,٣%) يليها تلك المغذاة على العليقة M2(١٦٩,٤%). بينما سجلت أقل قيمة % للكفاءة الأقتصادية فى المجموعة المغذاة على العليقة الأساسية (C) (١٥٢,٩%).

الخلاصة

نستخلص من هذه الدراسة أن إضافة أوراق نبات المورينجا الجافة بعلائق الأرانب النامية (أحلال اوراق المورينجا الجافة محل ٢، ٤ و٦% من بروتين فول الصويا) أدت إلي تحسن كفاءة النمو ومعاملات الهضم وصفات الذبيحة والتحليل الكيمائى اللحم والكفاءة الأنتاجية والأقتصادية دون وجود أي أثار سلبية علي تلك الأرانب.