

**UTILIZATION OF *Moringa oleifera* AS A NEW RABBITS FEED.
2- EFFECT OF DIETARY INCLUSION OF *Moringa oleifera* HAY ON
REPRODUCTIVE AND PRODUCTIVE PERFORMANCE OF DOE
RABBITS**

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ABSTRACT

A total number of 36 does of New Zealand White (NZW) rabbits with initial body weight 2658 ± 84 gm and 24 weeks of age were used in this investigation to evaluate the effect of dietary inclusion of different levels of moringa hay (leaves+ twigs) as a partial substitute for alfalfa hay on their reproductive and productive performance. The animals were randomly allotted to three experimental groups (12 doe in each). The 1st group was served as a control and fed basal pelleted diet (Diet A) contained 18% alfalfa hay, represents about 14.3 % of the total crude protein of the diet. The 2nd and 3rd groups were fed the same basal diet, but 50 and 75% of alfalfa hay (B and C Diets, respectively) were replaced by moringa hay (leaves+ twigs) on the basis of its contents of protein

Conception rate was significantly improved ($P < 0.05$) in doe rabbits fed Diet C compared with those fed Diet A (control) or Diet B. Differences in gestation length, litter size at birth, 21 days and at weaning (28 days) and litter weight at 21and 28days among experimental groups were not significant. Litter weight at birth and litter weight gain at all studied ages were insignificantly increased for rabbits fed Diet C compared with those fed the basal diet (Diet A). Bunny weight at 21 and 28days was insignificantly higher in doe rabbits fed Diet B than those fed Diets A or Diet C. Pre- weaning mortality percentages at all studied ages were similar in all groups. During the 1st, 2nd and 3rd parity, daily and weekly milk yield were insignificantly higher with rabbits fed Diet B or C than those fed the basal diet (control). The differences for daily and weekly milk yield during 1st, 2nd and 3rd weeks were not significant; however, the differences during the 4th week of lactation were significant ($P < 0.05$).

Milk conversion ratio was insignificantly improved with rabbits fed Diets B or C compared to the control during the 3rd and 4th week of lactation.

The differences in most doe and offspring traits among the three parities were not significant. However, bunny weight at weaning (28 days) was significantly ($P < 0.05$) increased in the three parities. Milk yield at most stages of lactation insignificantly increased in all parities, except at 1st week of lactation at which the effect of parity on milk yield was highly significant ($P < 0.01$). Milk conversion ratio at all stages of lactation insignificantly decreased in all parities. However, the differences in milk conversion ratio were significant ($P < 0.05$) during the 2nd and 3rd week.

Conclusively, the results of the present study demonstrated that Moringa oleifera hay (leaves+ twigs) is good unconventional source of protein for feeding doe rabbits and could be added in the diet at levels up to 13.5% to replace about 75% of alfalfa hay without any adverse effects on reproductive and productive traits of New Zealand White doe rabbits.

Key word: *Moringa oleifera*, reproductive and productive traits, rabbits

INTRODUCTION

Shortage of animal feedstuffs is the main obstacle facing the development of animal production in Egypt. Inadequate nutrition for animals and poultry resulted in low milk, eggs and meat production, in addition that human population is increasing rapidly which led to more decrease in animal products. Many attempts are devoted to solve this problem, among these, cultivation of unconventional new forage crops that tolerate drought and salinity in the newly reclaimed soils in Sinai and north coast of Egypt.

Moringa oleifera plant is one the most of widely distributed species of family moringaceae. *Moringa oleifera* is a perennial tree grows in most of the tropics and has several industrial, agricultural and medicinal uses, therefore is so called the life tree. It tolerates drought, high environment temperature up to 45^o (Morton, 1991) and a wide range of soils (pH from 4.5-9, Palada and Changl, 2003). *Moringa* plants can be harvested several times during the 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). *Moringa* leaves are rich in antioxidants that have high capacity to scavenge free radicals and play a significant role in reducing mortality and mobility due to cancer, heart diseases and other chronic illness. *Moringa oleifera* leaves meal are good

source of high quality protein and can be used to replace soya bean or groundnut cake in livestock diet (Makker and Becker, 1997 and Sarwatt *et al.*, 2002). Leaves meal of *Moringa oleifera* are abundant also in many of essential vitamins, and minerals (Fuglie and Lowell, 2001, Anwar and Bhangar, 2003, Siddhuraju and Becker, 2003, Anhwange *et al.*, 2004 and Anwar *et al.*, 2007).

The present study was carried out to study the effects of inclusion of moringa hay (leaves and twigs) at different levels in the diet to substitute alfalfa hay on reproductive and productive performance of does NZW rabbits under Egyptian condition.

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 October, 2016. The present experiment was conducted at does sexual maturity (24 weeks of age) and till fulfillment of three parities. The laboratory work was performed at Central Lab. for Soil, Foods and Feedstuffs (International accredited Laboratory, has ISO 17025, since 2012) belongs to Faculty of Technology & Development, Zagazig University, Zagazig, Egypt.

A total of number of 36 does of New Zealand White (NZW) rabbits, 24 weeks old and with average initial body weight 2658 ± 84 gm were used in this study to evaluate the effect of dietary inclusion of different levels of moringa hay (leaves +twigs) on their reproductive and productive performance traits. The doe rabbits were allotted to three experimental groups (12 doe in each) which were fed three different diets. The 1st does group was served as a control and fed a basal pelleted diet (Diet A) contained 18% alfalfa hay represented about 14.3% of the total crude protein of the diet. The 2nd and 3rd groups were fed Diets B and C, where 50 and 75%, respectively of alfalfa hay in the basal diet were replaced by moringa hay (leaves +twigs). All the experimental diets were iso nitrogenous and iso caloric.

Moringa plants were cultivated at research farm of faculty of technology and development, Zagazig University. All plants were first harvested at 90 days of growth and each 45 days for the following successive cuts. Representative samples of the air-dried moringa leaves and twigs were taken for chemical analysis, also samples of feed ingredients of the experimental diets were taken

for chemical analysis to determine crude protein, crude fiber, ether extract, nitrogen free extract, calcium and phosphorus according to the methods of AOAC (1995). Chemical analysis was performed in the Central Lab for Soil, Foods and Feedstuffs (International accredited Lab, since 2012 and has ISO 17025), Faculty of Technology& Development, Zagazig University, Egypt.

The diets were formulated to meet the nutrient requirements of rabbits for reproductively according to NRC (1977). The diet were mixed and pelleted at a commercial feed mill of Atmida, Meet Ghamr, Dakahlia Governorate, Egypt

Chemical analysis of alfalafa hay and *Moringa oleifera* is presented in Table 1. Ingredients and chemical composition of the experimental pelleted diets are shown in Table 2.

The animals were housed in flat deck batteries, provided with galvanized feeders and automatic drinkers. The doe rabbits were housed separately in individual wire cages (50 x 55 x 40 cm) provided with nest box and buck rabbits were housed separately in individual cages (50 x 60 x 40 cm). All batteries were located in a naturally ventilated room. All rabbits were provided with pelleted diets and drinking water *ad libitum* throughout the experimental period. All animals were kept under the same management and hygienic conditions.

Mating was randomly carried out between females and males of the same group. Each female was transferred to the male's battery to be mated and returned back to its cage after mating. Each female was subjected to two services from the same male at the time of mating in order to assure copulation.

Table 1: Chemical analysis of alfalfa hay and *Moringa oleifera* hay (leaves and twigs)

Chemical analysis	Alfalfa hay	<i>Moringa oleifera</i> hay	
		Leaves	Twigs
Dry matter	10.93±0.11	8.03±0.11	9.14±0.10
Crude protein	14.80±0.58	24.40±0.84	6.20±0.56
Ether extract	2.20±0.03	5.20±0.07	3.20±0.04
Crude fiber	28.20±2.13	19.20±0.82	43.00±2.51
NFE	34.90	34.20	29.10
Ash	8.97±0.06	8.97±0.06	9.36±0.05
Total	100	100	100

Table (2): Ingredients and chemical analysis of the experimental diets

Ingredients	Diet A	Diet B	Diet C
Yellow corn	16.00	16.00	16.00
Barley	18.00	18.00	18.00
Wheat bran	26.00	26.00	26.00
Soybean meal (44% CP)	19.00	19.00	19.00
Alfalfa hay	18.00	9.00	4.50
Moringa leaves meal	0.00	4.50	7.00
Moringa twigs meal	0.00	4.50	6.50
Limestone	2.00	2.00	2.00
Salt	0.50	0.50	0.50
Vit. & Mineral Premix*	0.30	0.30	0.30
Methionine	0.10	0.10	0.10
Anti Mycotoxins	0.10	0.10	0.10
Total	100.00	100.00	100.00
Chemical analysis:			
Moisture	14.27	13.32	13.89
Crude protein	18.58	18.70	19.11
Ether extract	2.22	2.26	2.51
Crude fiber	10.64	10.81	11.13
Ash	9.56	9.22	9.13
NFE	44.73	45.69	44.23
Lysine**	0.99	1.21	1.31
Ca	0.88	0.94	0.99
P	0.52	0.56	0.57
Meth+cysteine**	0.65	0.79	0.85

***Vitamin and minerals premix at level of 0.3% of diet supplies the following per Kg of diet:** Vit. A 12000 IU, Vit. D₃ 2000 IU, Vit E 10 mg, Vit. K₃ 2mg, Vit B₁ 1mg, Vit B₂ 5mg, Vit. B₆ 1.5 mg, Vit. B₁₂ 10 mg; Niacin 30 mg, Pantothenic acid 10 mg; Folic acid 1mg, Choine 250 mg, Biotin 50 mg, Copper 5mg, Manganese 60 mg, Zinc 50mg, Iron 30mg, Iodine 0.3 mg Selenium 0.1mg and Cobalt 0.1mg .

**Calculated according to NRC (1977).

Pregnancy was diagnosed by abdominal palpation on day 10 after service. All females were mated one day after kindling (day of kindling = 0). Females that failed to conceive were immediately re-mated following pregnancy test. All bunnies remained in the nests with their mothers for suckling from birth up to weaning (at 28 days after birth) and then they were transferred to the growing batteries.

Estimation of milk yield began from kindling up to weaning at the 7th, 14th, 21st and 28th days of age, by weighing the young (to the nearest gram) before and after suckling. The youngs were deprived of suckling for 24 h by separation between the mother and pups then allowed to suckle. These procedures corresponded with the natural disposition in rabbits by permitting suckling only once a day according to Davies *et al.* (1964) and Zarrow *et al.* (1965).

Statistical analysis:

Data of does reproductive traits were statistically analyzed using Least Squares Analysis of Variance according to Snedecor and Cochran (1982) using the General Linear Model Program of SPSS (2004) using the following fixed model for does:

$$Y_{ij} = \mu + T_i + P_j + T_{pj} + e_{ijk}$$

Where, Y_{ij} = The observed value of a given dependent variable, μ = Overall adjusted mean, T_i = Fixed effect of the treatments (*Moringa oleifera* substitution), $i = 1, 2$ and 3 , P_j = Fixed effect of the parity, $j = 1, 2$ and 3 , T_{pj} = Interactions effect ij the (txp) and e_{ijk} = Error of the model.

The differences between LSM (least square means) were analyzed by Duncan's New Multiple Range test (Duncan, 1955). Data in percentage values were transformed with the arcsine square root procedure to normalize variance before analysis.

RESULTS AND DISCUSSION

Effect of dietary inclusion of Moringa oleifera hay on reproductive and productive performance of NZW doe rabbits:

Reproductive performance:

Table 3 shows that Conception rate was significantly higher ($P < 0.05$) in doe rabbits fed either Diet C or B than those fed Diet A (control). The percentages of conception rate recorded 63.9, 78.4 and 88.9 % for doe rabbits fed Zero, 9 and 13.5% of *Moringa oleifera* hay (MOH) in substitution of Zero, 50 and 75%, respectively of alfalfa hay in the diet. Ewuola *et al.* (2015) attributed the improvement in the conception rate of doe rabbits fed *Moringa oleifera* leaves (MOLM) to the considerable amounts of nutrients (protein, energy, vitamins and minerals) present in the later, which enhance the

implantation and development of fetus during pregnancy. The differences in conception rate among the three parities were not significant (Table 3). The present results agree with those obtained by Sedki (1991), Yassen (1992) and El-Kelawy (1993) who found no significant effect of parity on the conception rate of NZW rabbits, while Oudah (1990) reported that parity had a significant effect ($P < 0.01$) on conception rate, being the highest in the 3rd parity in Californian, Bouscat and NZW rabbits.

Number of services per conception was significantly decreased ($P < 0.05$) in doe rabbits with increasing the level of MOH in the diet. Number of services per conception recorded 1.6, 1.3 and 1.12 for those fed Diets A, B and C, respectively without significant differences between parities. Tag El-Din and Mervat (1989) found no significant effect of parity on number of services per conception. While, Oudah (1990) and El-Kelawy (1993) reported that parity had highly significant ($P < 0.01$) effects on the number of services per conception.

The differences in gestation length among groups fed the experimental diets were not significant (Table 3). Similar findings were obtained by Iyabode *et al.* (2014) who found that gestation period is similar for the control rabbits and those fed 10, 20 and 30% Moringa leaf meal in their diet. Odeyinka *et al.* (2008) and Odeyinka *et al.* (2016) reported that dietary supplementation of moringa leaves meal at varying leaves had no significant effect on gestation length. Number of Parity had significant ($P < 0.05$) effect on gestation length which recorded 31.7, 32.8 and 33.6 respectively with 1st, 2nd and 3rd parity (Table 3).

The differences in litter size at birth, 21 days and at weaning (28 days) were not significant between doe rabbits fed the different levels of MOH in the diet in replacement of alfalfa hay (Table 3). These results are in agreement with those obtained by Kelani, (2016) who found that litter size was similarly in the groups fed either 4 or 8% *Moringa oleifera* leaves meal (MOLM) compared to the control group. Emmanuel *et al.*, (2014) reported that replacement of soybean meal with MOLM at levels 10, 20 and 30 % in the diet of doe rabbits had no negative influence on the litter size. However, the differences in litter size at weaning were significant ($P < 0.05$). In our study, Litter size at all ages was insignificantly increased in doe rabbits fed MOH with the advancement of number of parities. (Table 3).

Productive performance:

Litter weight at birth, 21 and 28 days of age were not significantly differed among the doe groups fed the different levels of MOH in the diet in replacement of alfalfa hay. The obtained results agree with Kelani (2016) who reported that dietary inclusion of MOLM at level 4 or 8 % had no significant effect on litter weight either at birth or at weaning. However, Odeyinka *et al.* (2008) and Ola *et al.* (2012) reported that does fed *Moringa oleifera* green leaves plus concentrate feed had the highest litter weight at birth than those fed the concentrate feed alone. Ewuola *et al.* (2015) reported that litter weight tended to decrease with the increase level of *Moringa oleifera* leaves extract in the diet of doe rabbits (100, 200 and 300 ml/L).

In the present study, litter weights at all the studied ages were not significantly affected by the number of parities. The obtained results are in agreement with those reported by El- Maghawry *et al.* (1988) and El-Kelawy (1993) who found that the number of parities had no significant effect on litter weight at birth, 21 and 28 days of age for doe NZW and California rabbits.

Litter weight gain at all studied ages was not significantly differed among the doe rabbit groups during the successive parities (Table 4). These results are in agreement with those obtained by Kelani, (2016) who observed that total kits gain and average daily gain were numerically higher but not significant with doe rabbits fed 4% MOLM than kits of does fed 0% (control) or 8% MOLM.

Bunny weight at birth, 21 and 28 days for rabbits fed diets containing 9 or 13.5% MOH (Diet B or C) were statistically similar with those fed control diet (Table 5). These results are in agreement with those obtained by Odeyinka *et al.* (2016) who reported that feeding MOLM at different levels had no significant effect on bunny weight at birth. Bunny weight at birth was almost similar with the advancement of parity number. Bunny weight at weaning (28 days) was significantly ($P < 0.05$) increased with the advancement of parity number (Tables 5).

Mortality percentage of stillbirth was insignificantly higher in doe rabbits fed Diet B or C than doe rabbits fed the control diet (Table 5). Pre- weaning mortality percentage from birth- 21 days and birth-28 days were similar for doe rabbits fed the different experimental diets. However, pre- weaning mortality percentage from 21-28 days of age was insignificantly decreased with rabbits fed Diet B than doe rabbits fed Diet C or those fed the basal diet (Table 5). These results are in agreement with those obtained by Odeyinka *et al.* (2008) and

Odeyinka *et al.* (2016) who reported that dietary supplementation with different levels of moringa leaves had no significant effect on neo-natal mortality.

Mortality percentage at birth was increased from the 1st to the 2nd parity, then decreased in the 3rd one, however the differences were not significant (Table 5).

Daily milk yield was higher during the 2nd and 4th week of lactation for rabbits fed Diet B than those fed Diet A (control diet) or Diet C (Table 6). However, milk yield was the highest for doe rabbits fed Diet C during the 1st and 3rd week as compared with doe rabbits of other groups. Milk yield reached the peak at 3rd week of lactation and then declined during the 4th week in all the experimental doe groups. The differences for daily milk yield during 1st, 2nd and 3rd weeks were not significant; however, daily milk yield during the 4th week was significantly ($P < 0.05$) higher with doe rabbits fed either B or C Diets than fed Diet A (control).

Milk yield at most stages of lactation increased insignificantly in the 1st, 2nd and 3rd parity, except at the 1st week of lactation which the effect was highly significant ($P < 0.01$). In this connection Khalel *et al.* (2014) found that daily and weekly milk production were higher ($P < 0.05$) when cows fed rations contained either 20% or 40% *moringa* green forage. Also, Sarwatt *et al.* (2004) stated that the small amounts of *moringa* leaves improved the rumen environment and improved the feed utilization and cow's milk production.

Doe rabbits fed the basal diet (control group) showed the best values of milk conversion ratio as compared with those fed Diet B or C during the 1st and 2nd week, but, rabbits fed Diet B or C recorded the best values than the control during the 3rd and 4th week of lactation (Table 6). However, the differences were not significant. Milk conversion ratio at most stages of lactation insignificantly decreased with the advancement of parity number. The differences in milk conversion ratio due to effect of parity were significant ($P < 0.05$) during the 2nd and 3rd week and not significant during the 1st and 4th week of lactation (Table 6).

Conclusively, the results of the present study demonstrated that *Moringa oleifera* hay (leaves+ twigs) is good source of protein for feeding doe rabbits and could be added in the diet at levels up to 13.5% to replace about 75% of alfalfa hay without any adverse effects on reproductive and productive traits of New Zealand White doe rabbits.

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تأثير ادخال دريس المورينجا (الأوراق+ الأفرع الجانبية) فى العلائق بمستويات مختلفه على الأداء التناسلى والإنتاجى لأمهات الأرانب

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قسم الإنتاج الحيوانى والداجنى- كلية التكنولوجيا والتنمية- جامعة الزقازيق- مصر

استخدم فى هذه الدراسه عدد36 من أمهات الأرانب النيوزيلندي البيضاء بمتوسط وزن جسم حي أبتدائي (2658 ± 84) جرام عمر 24 أسبوعا . وزعت الأرانب إلى ثلاث مجموعات تجريبية لتقييم تأثير استبدال50، 75% من دريس البرسيم الحجازى بدريس المورينجا أوليفيرا (أوراق+ أفرع جانبية) فى علائق أمهات الأرانب على صفاتها التناسلية والإنتاجية. المجموعة الأولى (المقارنة) غذيت عليقة أساسية محببه تحتوي على 18% دريس برسيم يمثل حوالي 14,7% من إجمالي البروتين الخام فى العليقة (عليقه 1). فى المجموعة الثانية والمجموعه الثالثه تم تغذيتها على عليقة3، عليقه 3 حيث تم فيها استبدال50، 75% على التوالى من دريس البرسيم الحجازى فى العليقه الأساسيه بدريس المورينجا على أساس المحتوى من البروتين ليصبح محتوى العلائق الثلاث من دريس المورينجا صفر، 9، 13,5% على التوالى. أوضحت نتائج التجربة حدوث تحسن معنوي ($P < 0.05$) فى معدل الحمل فى الأرانب التى غذيت على عليقه تحتوي 13,5% دريس مورينجا بالمقارنة بالمجاميع الأخرى كانت الفروق غير معنوية بين المجموعات التجريبية فى كل من طول مدة الحمل، وحجم البطن عند الولادة، و21 يوم، 28 يوم (القطام) ووزن البطن عند 21 يوما و 28 يوم. حدثت زيادة غير معنوية فى كل من وزن البطن عند الولادة والزيادة الوزنية للبطن فى جميع الأعمار المدروسة فى أمهات الأرانب التى غذيت على عليقه تحتوي 13,5% دريس مورينجا (عليقه3) بالمقارنة مع مجموعة المقارنة وكان متوسط وزن الولده عند 21 و 28 يوما أعلى فى الأرانب التى غذيت على العليقه عليقه 2 مقارنة بالأرانب التى غذيت على العليقه الأساسيه (عليقه1) أو تلك المغذاه على العليقه3. كانت نسبة النفوق عند القطام فى جميع الأعمار المدروسة متماثلة معنويا فى الأرانب التى غذيت على العلائق التجريبية التى استبدلت. وكان إنتاج اللبن اليومي أعلى بالنسبة للأرانب التى غذيت على العليقة 2 أو العليقة 3 مقارنة بمجموعة المقارنة. وكانت الفروق غير معنوية فى إنتاج اللبن اليومي خلال الأسبوع الأول والثاني والثالث من الادرار ، بينما كانت الفروق معنويه علي مستوي احتمال ($P < 0.05$) فى الأسبوع الرابع. حققت الأرانب التى غذيت على

العليقه 3,2 أفضل القيم لمعامل التحويل الغذائي لإنتاج اللبن مقارنة بمجموعة المقارنة خلال الأسبوع الثالث والرابع ولكن الاختلافات كانت غير معنوية. كانت الفروق في معظم الصفات الإنتاجية والتناسلية بين البطون الثلاثة غير معنوية ماعدا وزن ولدة الأرانبعند الفطام (28 يوما) كان معنويا علي مستوي احتمال 5% ، حيث زادت من البطن الأولي إلي الثالثة تدريجيا. حدثت زيادة غير معنوية في إنتاج اللبن في معظم مراحل الرضاعة من البطن الأولي إلي البطن الثالثة تدريجيا ماعدا الأسبوع الأول من الرضاعة حيث كان تأثير رقم البطن معنويا علي محصول اللبن علي مستوي احتمال 1% .

حدث تحسن غير معنوي في معامل تحويل اللبن في جميع مراحل الرضاعة من البطن الأولي حتى البطن الثالثة وكانت الفروق في معامل التحويل الغذائي للبن معنوية علي مستوي احتمال 5% خلال الأسبوعين الثاني والثالث.

التوصية: أظهرت النتائج الحالية أن دريس المورينجا أوليفيرا مصدر جيد غير تقليدي للبروتين في علائق أمهات الأرانبعويمكن ادخاله في تركيب العليقه بنسبه حتى 13,5% ليحل محل حوالى 75% من دريس البرسيم الحجازى بدون أى تأثيرات ضاره على الصفات التناسليه والانتاجيه لأمهات الأرانبع النيوزيلندي البيضاء.