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Website: http://www.aun.edu.eg/faculty_agriculture/arabic *E-mail: ajas@aun.edu.eg*

Effect of Nutritional and Functional Properties of Moringa Oleifera Leaves (MOL) on: I. Semen Quality and Offspring Performance of New Zealand White (NZW) Bucks

[*]EL Deeb, Mariam A. [1]; O. S. Afifi [1]; H. A. Mahmoud[1] and[**]M. S. Refay[2]
[1] Fac. of Agriculture, Dept. of Poultry Production, Assiut University, Assiut, Egypt
[2] Fac. of Agriculture, Dept. of Poultry Production, New Valley, Assiut University
***Corresponding author:** eldeeb3@yahoo.com
****Email**: Mohhamed.kelani@agr.au.edu.eg

Abstract:

The study aimed to assess the effects of feeding Moringa Oleifera leaves meal (MOL) on performance and semen quality of NZW Bucks at age 12 month for 3 months period. A total of 30 bucks, average body weight (3227 g ± 20.3), were distributed into 3 treatments (10 bucks/treatment). Dietary treatments according to MOL inoculation levels to basal diet were; 0% (control, T1), 4% (T2) and 8% (T3). Basal diet (control) was formulated to contain 17.9% crude protein and 2790 Kcal /kg DE and were formulated to meet all essential nutrient requirements of male rabbits. Semen was collected twice weekly for six weeks for assessment and furthermore bucks were allowed to mate with female NZW, received same MOL levels. Therefore, the performance of offspring were evaluated from weaning till 5 weeks periods. Results of semen quality, total volume and sperm concentration indicated that feeding bucks 4% or 8% MOL were not different from the control group. However, same parameters were significantly higher (P<.05) in 4% MOL fed bucks (.93ml and $92.7x10^7$, respectively) compared to those received 8% MOL (.66ml and $76.1x10^{7,}$ respectively). Motility was higher (P<.05) in 4% MOL compared to the control group (78.5 vs. 74.0%, respectively) but not to the 8% MOL fed bucks. No treatments effect was detected in semen abnormality rate. Furthermore, weekly semen collection time was significant (P<.05) without any consistent trend. No interaction effect between treatments and frequent collection time was found. The results of Bucks' offspring performance at 5 weeks- old revealed improved body weight, body weight gain and FCR (P<.05) in group fed 4% MOL (1493g, 1264g and 2.9) compared to the control (1388g, 1074g and 3.6), respectively. However, no differences were found in these parameters between T3 and either T1 or T2 groups. The interaction between treatments, weeks and sex revealed significant (P<.05) increased male body weights more than the females due to MOL supplementation starts from week 2 till termination of the experiment, indicating positive effect towards males. In conclusion, MOL could be incorporated at 4% without adverse effect for optimal reproductive efficiency and performance in male rabbits intended for breeding purpose and furthermore, for improving body weight of males offspring till marketing age.

Keywords: Diet, Male Rabbits, Semen quality, Performance, Moringa Oleifera leaf

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Introduction:

Improved efficiency and high quality semen, quantity and quality, of NZW Male rabbits are required for male sexual reproduction attributes. In fact, difference in the seminal features is known to be affected by many factors (feeding, genetic strain, health status, rearing condition, season, age and collection frequency). Henceforward, these factors are contributing to the great variation in semen qualities (Castellini, 2008; Alvariño, 2000; Love *et al*., 1998; Colenbrander *et al.,* 2003; Lavara *et al*., 2005 and WHO, 1999). Indeed, the quality of diet is the most imperative one. Luzi *et al.* (1996) revealed that the most important factor of all on semen quality was not the amount of diets supplied to male rabbits but its chemical characteristics.

Last two decades, shortage of grain due to utilization of corn in ethanol production as alternative energy substitute, and high cost of imported feed ingredients were the driving force to exploit other alternative novel feeds in the developing countries. Recently, there has been great attention in utilization of Moringa (Moringa Oleifera) or the so called "miracle plant". Moringa Oleifera is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses with high nutritional value and various phenolic compounds (Farooq *et al*., 2007). The leaf meal of MO does not only provide protein source and abundant of all essential amino acids but also some essential vitamins, and minerals (Sreeramulu, 1982; Dahot, 1988; Gupta and Barat, 1989; Fuglie, 2001; Anwar and Bhanger, 2003; Siddhuraju and Becker, 2003; Anhwange *et al*., 2004; Anwar *et al*., 2007 and ELDeeb *et al*., 2014). Incorporating MOL into rations can support production in different species; livestock (Makkar and Becker, 1996 and Ferreira *et al*., 2008 ;); poultry (Juniar *et al* 2008; Paguia *et al*., 2012; and EL-Deeb *et al*., 2014), swine (Knight, 2011) and growing rabbits (Odetola *et al.,* 2012).

Little information is available on using MOL as a dietary supplement on NZW bucks reproductive performance and semen quality. Therefore, the current study was carried out to investigate the effect of dietary inclusion of different levels of MOL on productive and reproductive performance of mature NZW bucks.

Materials and Methods:

Site of the study:

This experiment was carried out at the Experimental Poultry Research farm, rabbit division at the Faculty of Agriculture, Assiut University. The experiment lasted for 3 months, using male New Zealand White (NZW) Rabbits at age 12 months, from October till December, 2014. The aim of the study was to investigate and assess the impact of dietary inclusion of Moringa oleifera leaf meal (MOL) on productive bucks semen quality and their offspring post weaning performance till 5 weeks old.

Animal, diet, experimental design and managerial procedure:

A total number of 30 NZW Bucks at age 12 month with an average body weight (3227 ± 20.3g), were equally distributed into 3 treatments (N=10) according to dietary levels of MOL; Control group

T1(0%), T2 group (4%) and T3 group (8%). All bucks were free of any physiological disorders and were kept under the same managerial, hygienic and environmental conditions and housed in flat wire desk cages of commercial type batteries in a windowed rabbitry with natural ventilation. Bucks were fed treatment diets, for 4 weeks before semen collection. Diets were nearly iso-nitrogenous and iso-caloric on the basis of digestible energy and crude protein and contained similar levels of micro elements. The diet was fortified with adequate vitamins and minerals mixtures to meet all essential nutrient requirements for rabbit bucks according to Cheek (1977), Table (1). A constant supply of fresh tap water was automatically available via stainless steel nipples located inside each cage. All bucks were offered diet and water ad lib.

Moringa oleifera leave meal:

The plant leaf was purchased from the National Research Center at Cairo. The powder form of the leaves was produced using a portable heavy duty blender. Representative samples were subjected to laboratory analysis to determine the nutrient contents of MOL (Table 2), and the feed mixture as well following the standard methods of analysis described by the Association of Official Analytical Chemists (AOAC,1990).

Table 1: Diet Composition

Ingredients	g/ 100 g Diet		
	Control (0%)	T1 (4%)	T2 (8%)
Alfalfa, 17%	39	36.4	38.5
Yellow corn, 9%	26.6	30.0	35.4
Soybean meal , 44%	13	11.4	9.8
Wheat bran,	19.1	16	6.2
Bone meal	0.4	0.4	1.2
Limestone	1.0	0.9	0.0
Salt	0.4	0.4	0.4
Moringa, 31.9%[1]	0.0	4.0	8.0
DL- methionine	0.2	0.2	0.2
Premix[2]	0.3	0.3	0.3
Total	100	100	100
Calculated analysis			
DE/kg diet	2796	2791	2788
C. Protein, %	17.98	17.95	17.91
C. Fiber, %	12.77	12.21	12.13
Ca, %	1.08	1.08	1.07
P, %	0.54	0.5	0.5

[1] 3308 ME (Kcal/Kg Moringa leaves) according to Becker (1995), Kakengi *et al*., (2007) and Andrew (2011)

[2] Each3 kg of vitamin mineral premix: contains: vitamin A, 1200000; vitamin D3, 300000IU; vitamin E,700 mg ; vitamin K_3, 500 mg ; vitamin B_1 500mg ; vitamin B_2 200mg ; vitamin B_6 ,600mg, vitamin B12,3 mg; folic acid, 300mg; choline chloride, 1000 mg; Niacin , 3000mg; Biotin 6 mg; panathonic acid 670 mg; manganese sulphat , 3000 mg; iron sulphat , 10000 mg, zinc sulphat, 1800 mg, copper sulphat 3000 mg, iodine 1.868 mg, cobalt sulphat , 300 mg; selenium, 0.108 mg

Table 2: Chemical composition[1] of MOL

Items	%	Items	%
Moisture	9.46	**Ether extract**	5.92
Dry matter	90.54	**Ash**	13.89
Crud protein	31.93	**Organic matter**	76.65
Crud fiber	10.66	**Nitrogen free extract**	28.14

[1] According to A.O.A.C. procedure, 1994

Data collection:

Semen collection:

30 male New Zealand White (NZW) rabbit were placed on treatments diets for 4 weeks and before semen collection. Bucks were trained for semen collection and for later assessment to evaluate the effect of feeding different levels of MOL on semen quality. Bucks were stimulated before semen collection by placing a doe on top of the cage for few minutes. Two ejaculates collected twice a week for each buck with an interval of at least 15 minutes (Bencheikh, 1995, Moce *et al.,* 2000) for 6 successive weeks using artificial vagina. Recorded data of semen collection was pooled per week when no differences were detected for each buck. Immediately, after semen collection the following variables were assessed: ejaculate volume (ml) without gel fraction was determined by graduated test tube and recorded in milliliter, pH (Whatman pH Indicator paper; Whatman limited Maidstone, England). Sperm motility was determined on freshly collected semen placed on a warm stage at 37˚C. The samples were diluted with a physiological saline solution and observations were made at x400 magnification. Sperm concentration ($x10^7$/ml) was calculated by Neubauer chamber and total sperm concentration per ejaculate were derived by calculation. Percent of sperm abnormality (%) were rated according (El-Sherbiny, 1987).

Two weeks before terminating the experiments, bucks were allowed to mate naturally with 30 females NZW does fed same MOL levels (data not published) to study the offspring's growth performance from weaning time and lasted for 5 weeks period.

Offspring performance:

Total 40 Kits from each treatment were sexed and weight at weaning and weekly thereafter for 5 consecutive weeks and fed same Bucks treatment diets (Table, 1). At the end of 5 weeks trial, data recorded for body weight, body weight gain and feed consumption and feed conversion ratio (FCR = feed consumption g/body weight gain g) for both sexes. Also, total mortality rate, was calculated and expressed as (%).

Statistical Analyses:

Data of semen and offspring were statistically analyzed using Two and three Way Analysis of Variance (ANOVA), respectively, applying the General Liner Model (GLM) procedure, SAS software, version 9.1 (SAS, 2008). Percentage values were transformed using arcsine before statistical analyses. Significant differences among treatment means were separated by Duncan's multiple rang test (Duncan, 1955) with a 5% level of probability. All data obtained was

analyzed using the following Models for semen and offspring:

$Y_{ikj}= u +T_i+ W_k + (T_i * W_k) + e_{ikj}$,

$Y_{ikjm}= u +T_i+ W_k + S_j + (T_i * W_k) + (T_i * S_j)+ (S_j * W_k)+ (T_i *W_k * S_j) + e_{ikjm}$,

Where, Yij = is the analyzed measurement, u = is the overall mean, Ti = is the effect of MOL feeding treatments (i, =0, 4 and 8%), W_k = weeks (1,2….5), S_j = sex (male and female) and eij and e_{ikjm} = random error. When two interaction effects were not significant, data were pooled.

Results and Discussion:

Nutrient composition of MOLM:

Analyses of the chemical composition of dried leaves of MOL (Table, 2) are: protein (31.93%), ether extract (5.92%), crude fiber (10.66%), ash (13.89%) and NFE (28.14%). According to Yameogo *et al.,* (2011) analyses of dried MOL's chemical composition showed protein (27.2%), lipids (17.1%), crude fiber (19.4%) and ash (11.1%). Location and fertilization system resulted in a wide range of protein values (20-35%) as explained by Radovich (2011).

Bucks Performance:

The average body weight of NZW bucks at the commencement of the trial were (3227g ± 20.3). At the end of the experiment changes in body weight were not detected as male were fully matured. Also feed consumption during the trial showed that total feed consumed/ buck for control, 4% and 8% MOL treatments were (6653±146.5, 6442±81.5, and 5910± 166.4; respectively) for the whole period of the trial.

Semen quality:

Results of semen quality assessment; total volume (ml), sperm concentration, motility (%), abnormality (%), concentration per ejaculate and pH are presented in (Tables; 3, 4 and 5). Results revealed significant main effect due to treatments levels and weeks of collection (P<.05) on both total volume and concentration (Table, 3). However, no significant interaction between treatments and weeks were found. Bucks received 4% of MOL (T1) was superior in total volume and sperm concentration $x10^7$/ml (P<.05) compared to those animals received 8% MOL (.93± .07ml, 92.7± 5.82% vs. .66± .05ml and 76.1±3.88%; respectively). However, the values of volume and concentration in 4% fed bucks were numerically higher but not significantly different from the control group (.77±.06 and 82.6±6.27; respectively). Weekly semen collection data indicated increased ejaculate volumes as progressed in weeks (P<.05). Also, sperm concentration $x10^7$per ejaculate (Table, 5) indicated superiority in bucks fed on 4% treatment's diet over those fed 8% MOL or the control group (P<.05). Interestingly, the interaction effect between treatments and weeks resulted in decreased the concentration gradually with a trend pertained the superiority to bucks received 4% MOL. Consequently, on 4^{th} week, all treated groups showed same reduction values and were not significant. Reported data on semen collection frequency revealed that two ejaculates collected once a week gave good semen production results (Benchcheikh, 1995 and Moce *et al*., 2000). To the contrary, overall sperm concentration

was significantly lowered (P<.05) according to advanced collection period, started from week two and further till weeks 6. These results may be explained due to: (i) 2 ejaculates twice a week for 6 weeks were performed and (ii) increased total volume over collection periods. Even though, T2 showed more persistency in maintaining concentration at the end of collection weeks. Motility (%) and abnormality data are presented in (Table, 4). Motility (%) was significantly higher in T2 (4%, MOL) than the T1 (0%, MOL) but was not different from those received T3 (8% MOL).

The total amount of MOL meal consumed by each animal during the 6 weeks semen collection for treatment diets; 0%, 4% and 8% were 0.0g, 250g and 470g; respectively.

Table 3: Effect of feeding different levels of MOL on NZW bucks semen quality; volume (ml) and sperm concentration, (X ±SE)

Parameters	Volume (ml)				Concentration (X*10^{7})/ml			
Treatment/ (Wks.)	Cont.T1 (0.0%)	T2 (4%)	T3 (8%)	X_{wk}	Cont. T1 (0.0%)	T2 (4%)	T3 (8%)	X_{wk}
1	.60±.11	1.05±.19	.66±.15	.78±.1^{b}	137.9±20.19	122.6±21.34	97.1±11.24	119.2±10.7^{a}
2	.98±.15	1.15±.1	.62±.07	.92±.08^{a}	74.9±3.91	70.9±8.82	89.1±9.63	78.3±4.7^{b}
3	.62±.26	.97±.2	1.0±.15	.87±.12^{a}	55.5±1.82	86.7±13.62	59.2±5.09	67.13±5.85^{b}
4	.82±.11	.90±.11	.67±.13	.8±.07^{ab}	76.2±13.37	82.8±12.66	59.2±3.5	72.73±6.36^{b}
5	.69±.06	.55±.1	.44±.06	.56±.05^{b}	72.4±9.66	84.3±4.77	81.9±8.31	79.5±4.42^{b}
6	.91±.13	.96±.2	.57±.06	.82±.09^{a}	78.8±2.94	109.1±10.50	69.9±4.05	85.9±5.7^{b}
X_{trt}	.77±.06^{ab}	.93±.07^{a}	.66±.05^{b}		82.6±6.27^{ab}	92.7±5.82^{a}	76.1±3.88^{b}	
Probability (P<)								
Weeks (Periods)	*				*			
Treatments	*				*			
Wks*Trt	NS				NS			

^{A,b} means with different superscript letters are significantly different (P<.05)
NS= non significant *=probability (P<.05)

Table 4: Effect of feeding different levels of MOL on NZW bucks semen quality, motility (%) and sperm abnormality, (X ±SE)

Parameters	Motility (%)				Abnormality			
Treatment/ (Wks.)	Control (0.0%)	T1 (4%)	T2 (8%)	X_{wk}	Control (0.0%)	T1 (4%)	T2 (8%)	X_{wk}
1	72±1.22	79±2.92	78±2.55	76.3±1.5^{ab}	7.3.77.1	6.8±.34	7.0±0.5	7.0±0.2
2	72±1.22	77±2.55	76±1.0	75±1.09^{b}	7.4±.75	8.2±.56	6.8±0.9	7.5±.43
3	74±1.87	82±3.0	80±1.58	78.6±11.5^{a}	7.2±.51	7.7±.58	8.1±.37	7.7±.28
4	79±1.87	82±1.22	75±1.58	78.6±1.14^{a}	7.3±.25	7.5±.57	6.0±.84	6.9±.37
5	70±0.0	82±1.22	72±1.22	71.3±0.59^{c}	7.2±.37	6.7±.49	6.5±.74	6.8±.07
6	77±2.0	79±1.87	74±1.87	76.7±1.16^{ab}	6.7±.66	7.1±.53	6.4±.53	6.7±.32

X_{trt}	74±.81[b]	78.5±1.0[a]	75.8±0.8[ab]		7.2±.19	7.3±.22	6.8±.28	
Probability (P<)								
Periods(wks)	*				NS			
Treatments	*				NS			
Wks*Trt	NS				NS			

[A,b] means with different superscript letters are significantly different (P<.05)
NS= non significant **=probability (P<.01)

In this study all semen quality parameters as; volume, concentration and motility tend to follow an upward trend in bucks received 4% MOL compared to control animals. It was stated that the number of sperms and their motility are the most important parameters pertaining to fertility (Castellini & Lattaioli, 1999 and Brun *et al*., 2002). In fact, high nutritive value of MOL incorporated into - NZW bucks diets possess a potential to improve reproductive efficiency of rabbit bucks and subsequently enhance fertility performance. No differences were found in the abnormality or pH recorded data (Table, 5) due to either treatments or collection weeks. All interaction values showed no differences. Our results agreed with (Abu Ahemen & Ikpechukwu, 2013) who suggested using MOL at 15% level without adverse effect on semen quality. Also, Ewoula *et al.,* (2014) stated that inclusion of MOL in rabbits diet up to 7.5% improved semen quality but recommended using level 2.5% MOL for optimal reproductive efficiency in male rabbits.

Table 5: Effect of feeding different levels of MOL on NZW bucks semen quality; total concentration x10^7/ ejaculate and pH (X ±SE)

Parameters	**Concentration * 10^7 /ejaculate**				**pH**			
Trtst/ Wks	**Control (0.0%)**	**T1 (٤%)**	**T2 (٨%)**	**X_{wk}**	**Control (0.0%)**	**T1 (٤%)**	**T2 (٨%)**	**X_{wk}**
1	85.5±21.5[a]	104±26.8[a]	61±10.7[b]	61±19.9[a]	7.8±0.9	7.4±0.25	7.7±.17	7.5±.11
2	73.8±12.6[a]	80.2±8.53[a]	53.6±6[b]	53.6±10.1[b]	7.6±0.6	7.6±.13	7.7±.08	7.6±.05
3	36.3±17[c]	74.7±10.6[a]	59.4±10.4[b]	59.4±8.1[b]	7.6±0.6	7.6±.06	7.6±.06	7.6±.03
4	65.3±17.3[a]	73.8±12.8[a]	40.9±10.5[b]	40.9±8.2[c]	7.6±0.1	7.7±.05	7.6±.10	7.6±.06
5	49.9±6.9[a]	45.3±6.2[a]	35.9±4.8[b]	35.9±3.6[c]	7.6±0.13	7.8±.12	7.7±.15	7.7±.07
6	57.1±10.3[a]	44±18.8[b]	40±4.1[b]	40±7.6[c]	7.6±0.1	7.7±.15	7.6±.1	7.6±.06
X_{trt}	59±6.5[b]	70.3±6.1[a]	48.5±3.5[c]		7.6±.04	7.6±.05	7.7±.06	
Probability								
Wks	*				NS			
Trt	*				NS			
Wks*Trt	*				NS			

[A,b,c] means in the same raw with different superscript letters are significantly different (P<.05)
NS= non significant *=probability (P<.05)

Offspring bunnies' performance:

Average body weight, body weight gain, feed consumption and feed conversion ratio (FCR) of bunnies produced from NZW bucks and does received dietary different levels of MOL (0%, 4%, and 8%) are presented in Tables 6,7,8 and 9.

Results of body weights of bunnies fed same MOL levels (0%, 4%

and 8%) as parents from weaning time and for 5 consecutive weeks are presented in (Table 6). Statistical analyses showed significant main effect due to treatments levels of MOL, weeks and sex and furthermore high significant effect (P<.01) due to interaction between the three measured indicated parameters. In the control group fed 0% MOL, females bunnies showed higher body weight (P<.05) over the males towards the end of the trial period (1407±78.4 vs. 1368±49.6; respectively). On the contrary, in treatments groups bunnies fed on diet supplemented with either 4% or 8% MOL showed a trend of higher body weights in males over the female and was significant (P<.05) towards the end of the trial (1527±65.5, 1498±69.1 vs. 1460±46.2 and 1360±52.9; respectively). In addition, males in groups T2 and T3 were superior in body weights than the males fed control diet (1527±65.5, 1498±69.1 vs. 1368±49.6; respectively). Females rabbits fed either, T2, T3 or control diets were not significantly different in body weight. These results reveal that during growing period, it is advisable to incorporate MOL in male diet till marketing age.

Table 6: Effect of feeding NZW bucks different levels of MOL on offspring body weight (g) from weaning till marketing age, (X± SE)

Trts/ wks	Body weight (g)						
	Control T1 (0%)		T2 (4%)		T3 (8%)		X_w
	F	M	F	M	F	M	
1	752±27.7	746±34.7	676±33.3	737±31.5	676±25.5	725±32.9	714±12.4^{e}
2	917±39.8	957±44.5	896±31.3	940±44.0	862±28.8	904±50.1	910±15.9^{d}
3	1039±52.4^{c}	1050±48.6^{b}	1053±35.3^{c}	1149±62.1^{a}	999±36.7^{c}	1085±64.9^{a}	1058±20.1^{c}
4	1232±70.1	1197±53.6	1268±42.4	1333±67.9	1180±46.1	1278±70.8	1248±24.0^{b}
5	1407±78.4^{c}	1368±49.6^{b}	1460±46.2^{c}	1527±65.5^{a}	1360±52.9^{c}	1498±69.1^{a}	1435±25.5^{a}
Mortality n=40	**12 (30%)^{a}**		**5 (12.5%)^{b}**		**7 (17.5%)^{b}**		*
Probability (P<.0)							
Trt	*						
Wks	* *						
Sex	**						
T*S*W	**						

$^{a, b}$ means with the same letter are not significant in the same raw between males
^{c,d,e} means with the same letter are not significant in the same raw between females
NS .non significant * Significant (P>0.0◦) ** Significant (P>0.01)

The numerous uses of Moringa oleifera as a low cost animal feed promoted nutritionists to examine its efficacy on livestock performance. The essential nutrient contents of moringa oleifera leaves, (MOL), the preferable part of the tree in animal diet as leaf meal, are worthy of special attention. The leaves contain a negligible amount of anti-nutritional fac-

tors such as tannins, saponin, trypsin inhibitor and lectins (Makar and Becker, 1997). High protein and all essential amino acids are abundant in the leaves which can support livestock production (Makkar and Becker, 1996; Ferreira *et al*., 2008 and EL-Deeb *et al.,* 2014). In addition, the leaves are packed with essential vitamins and minerals such as Vitamin A, C & B-vitamins, calcium, iron, copper and sulfur (Sreeramulu, 1982; Dahot, 1988; Gupta and Barat, 1989; Fuglie, 2001; Anwar and Bhanger, 2003; Siddhuraju and Becker, 2003; Anhwange *et al*., 2004; and Anwar *et al.,* 2007). Delivering such powerful feed ingredient as well as having an ability to absorb and neutralize toxic elements in food could justify the development of the plant as one of the major local feed stuffs for cattle, swine and poultry (Knight, 2011). In broiler chicks study, results revealed improved protein conversion ratio PCR in chicks received 2% MOL as compared by those chicks fed control diet (2.36 ± 0.04 and 2.53±0.04; respectively) ELDeeb *et al*., (2014).

Interestingly, mortality rate results (Table 6) indicated that the lowest death rate occurred (P<.05) in bunnies received 4% MOL kits (n= 5/40) compared to group received 8% or the control (n=7/40 and 12/40; respectively). The improved livability of bunnies received MOL may be explained by enhancing immune potential. It has been asserted that MOL boosts the immune systems in broiler chicks (ELDeeb *et al.,* 2014). Results evidenced that average body weight gain (Table, 7) followed the same trend as body weights. Body weight gains were higher in male rabbits received 4% MOL in the 3rd. and 5th. Week on experimental treatment diet due to interaction effect between treatment, sex and weeks (P<.01). The higher weight gain in the rabbits fed MOL diets may partly be due to a better protein quality that is possibly arising from a higher methionine and lysine supply (Booth and Wickens, (1980). Our results agreed with those reported by Ayers *et al.,* (1996); Okorie, (2003) and Odetola *et al*.,(2012).

Table 7: Effect of feeding NZW bucks different levels of MOL on offspring bunnies body weight gain (g) from weaning till marketing age , (X± SE)

Trts/wks	Body weight gain (g/ bunny)						
	Control (0%)		T1 (4%)		T2 (8%)		X_w
	F	M	F	M	F	M	
2	198±21.7	198±22.5	210±19.6	203±19.6	188±16.7	192±27.6	197±8.4[a]
3	136±21.0[c]	98±36.3[b]	156±20.6[c]	182 ±23.2[a]	147±17.4[c]	153±26.9[ab]	149±8.8[b]
4	207±25.6	165±28.1	206±15.7	184±14.1	177±16.2	181±18.1	189±7.9[a]
5	176±16.1	171±22.2	192±12.4	194±11.9	180±15.7	195±18.9	188±6.8[a]
Total BWG,g	**733**±66.4[cd]	**628**±49.0[b]	**867**±41.8[c]	**767**±40.8[a]	**699**±47.8[d]	**710**±37.6[ab]	
Probability (P<.0)							
Trt	*						
Wks	**						
Sex	**						
T*W*S	**						

[a, b] means with the same letter are not significant in the same raw between males
[c,d,e] means with the same letter are not significant in the same raw between females

NS .non significant * Significant (P>0.0◦) ** Significant (P>0.01)

Regarding feed consumption and feed conversion ratio (FCR), results are presented in (Tables 8 & 9). It appeared that a significant interaction between treatments, weeks and sex (P<.05) resulted in changing rabbits' behavior towards consumption of dietary treatments started from week 1. Male bunnies consumed lower amount (P<.05) of feed supplemented with MOL at 4% and 8% compared to the control group (415±13.3, 380±16.5 and 477±14.5g; respectively). Same results for the female rabbits consumed the control diet were higher than those fed 4% or 8% MOL (471±10.8 vs. 436±10.1 and 367±14.7; respectively). It is worth mentioning that no differences between male and female within each treatment along the trial weeks. Interestingly, an associated factor for the increased feed intake by male rabbits might be due to greater palatability of MOL diets as compared to the control diet as they progressed in age.

Table 8: Effect of feeding NZW bucks different levels of MOL on offspring bunnies feed consumption (g) from weaning till marketing age, (X± SE)

Feed consumption (g /bunny)							
Trt/ Periods (wks)	**Cont. (0.0%)**		**T1 (4%)**		**T2 (8%)**		**X_w**
	F	**M**	**F**	**M**	**F**	**M**	
1-2	471±10.8^{d}	477±14.5^{a}	436±10.1^{e}	415±13.3^{b}	367±14.7^{f}	380±16.5^{bc}	424±6.6^{d}
2-3	477±32.3	469±36.3	481±22.9	428±19.4	448±26.9	436±34.7	458±11.^{c}
3-4	557±28.3	598±68.1	556±18.0	530±13.9	529±15.1	556±19.5	551±11^{b}
4-5	762±34.1	718±42.9	710±13.9	671±19.3	709±14.5	711±26.7	714±10.^{a}
FC (1-5)	**1843**±176.8	**1762**±210.1	**2044**±130.0	**1718**±155.5	**1904**±113.4	**1741**±206.9	
Probability (P<.0)							
Trt	NS						
Wks	*						
Sex	*						
T*W*S	*						

$^{a, b,c}$ means with the same letter are not significant in the same raw between males

^{d,e,f} means with the same letter are not significant in the same raw between females

NS .non significant * Significant (P>0.0◦) ** Significant (P>0.01)

Feed conversion ratio (FCR) presented in (Table, 9) showed significant differences due to main effects of; treatments, weeks and sex and interaction between the three parameters (P<.05). Female rabbits fed diet supplemented with 8% MOL showed the best FCR (1.9±.3) among all other treatment groups (2.2±.3 and 2.3±.04, control and 4% MOL; respectively) at first week period (P<.05). However, no differences were found in male rabbits. On the contrary, the second week on experimental diets, males fed either 4% or 8% MOL diet were more efficient (P<.05) utilizing the diet than the control male rabbits (2.5±.2, 2.6±.3 vs. 3.5±.3: respectively) while, female rabbits did not show any differences. Furthermore, male rabbits continued to perform better feed conversion during last week on treatments' diets compared to control group (3.3±.1 and 3.4±.2 vs. 4.3±.60;

respectively). The superior feed conversion ratios for the MOL diets might have also contributed to the superior growth rate and weight gain by male rabbits on the MOL diets as compared to the control. These results are in agreement with earlier results reported by (Ayers *et al.,*1996; Okorie 2003 and Odetola *et al.,* 2012).

Table 9: Effect of feeding NZW bucks different levels of MOLM on offspring kits' FCR from weaning till marketing age, (X± SE)

Trt/ Periods (wks)	Feed conversion ratio (g feed/g gain)						
	Cont. (0.0%)		T1 (4%)		T2 (8%)		X_w
	F	M	F	M	F	M	
1-2	2.2±1.1	2.1±.40	2.3±.04	1.9±.3	1.9±.3	1.8±.3	2.4±.3^{c}
2-3	2.8±1.2	3.5±.30^{a}	2.7±.20	2.5±.2^{b}	3.3±.3	2.6±.3^{b}	3.3±.1^{b}
3-4	2.6±0.7	3.1±.20	2.5±.20	2.8±.1	3.1±.2	3.1±.2	3.1±.1^{b}
4-5	4.5±1.4	4.3±.60^{a}	3.5±.05	3.3±.1^{b}	3.7±.3	3.4±.2^{b}	4.0±.15^{a}
FCR (1-5)	3.8±.57	3.5±.29^{a}	3.2±.16	2.6±.13^{b}	3.1±.17	2.7±.16^{b}	
Probability (P<.0)							
Trt	*						
Wks	* *						
Sex	*						
T*W*S	*						

$^{a, b}$ means with the same letter are not significant in the same raw between males
^{c,d,e} means with the same letter are not significant in the same raw between females
NS .non significant * Significant (P>0.0°) ** Significant (P>0.01)

In conclusion, MOL could be incorporated at 4% without adverse effect for optimal reproductive efficiency and performance of male rabbits intended for breeding purpose and furthermore, for growing male to improve body weight at marketing age.

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Website: http://www.aun.edu.eg/faculty_agriculture/arabic *E-mail: ajas@aun.edu.eg*

تأثير الخصائص الغذائيه والوظيفيه لاوراق المورينجا على: ١- جوده السائل المنوى واداء الخلفات الناتجه لذكور أرانب النيوزلندى الابيض

مريم أحمد الديب[١]، اسامه سامى عفيفى[١]، حسين عبد الفتاح محمود[١] ، محمد سيد رفاعى[٢]
[١] كليه الزراعه ، قسم انتاج الدواجن ، جامعه أسيوط- اسيوط ٧١٥١٦ مصر
[٢] كليه الزراعه ، قسم انتاج الدواجن- الوادى الجديد، جامعه أسيوط- اسيوط ٧١٥١٦ مصر

الملخص:

هدفت الدراسه لتقييم تاثير تغذيه دكور أرانب النيوزلندى الابيض (عمر ١٢ شهرا) على مسحوق أوراق المورينجا لمده ٣ شهور على جوده السائل المنوى وأداء الخلفة الناتجة. تم استخدام عدد ٣٠ ذكر بمتوسط وزن جسم (٣٢٢٧ جم ± ٢٠.٣). تم توزيع الذكور على ٣ معاملات (١٠ ذكور/معامله) تبعا لمستويات المورينجا فى العليفه وكانت: كونترول (٠% مسحوق أوراق المورينجا)، (٤% مسحوق أوراق المورينجا) و(٨%. مسحوق أوراق المورينجا) وتم تكوين العليقه الأساسيه لتحتوى على ١٧.٩% بروتين خام، طاقه مهضومه ٢٧٩٠ ك ك/ كجم علف وجميع العناصر الضروريه لتغطيه الاحتياجات الغذائيه لذكور الارانب وكانت جميع العلائق متشابهة الطاقة والبروتين. تم جمع السائل المنوى من الذكور مرتين أسبوعيا لمده ٦ أسابيع متتاليه لتقييم تأثير مستويات المورينجا. كما سمح للذكور يتلقيح اناث نيوزلندى ودراسه اداء الخلفات الناتجة لمده ٥ أسابيع بعد الفطام متتاليه. وقد اظهرت نتائج فحص السائل المنوى ان الحجم وتركيز الحيوانات المنويه للذكور المغذاه على مستويات ٤% و ٨% مورينجا لم تختلف معنويا عن المجموعه المقارنه (٠%). بينما كانت نفس القياسات السابقه اعلى (P<.05) فى المجموعه المغذاه على ٤% (٩٣ ،٩٢ مل x ١٠ ^{٧}) مقارنه بالذكور المغذاه على ٨% مورينجا (٦٦ ،٧٦.١ مل x١٠ ^{٧}) على التوالى. أظهرت أيضا نتائج حركة الحيوانات المنوية إرتفاع معنوى فى مجموعه ٤% مقارنه بالكونترول (٧٨.٥ و ٧٤%) على التوالى. كما أظهرت نتائج فترات الجمع الاسبوعيه اختلافات معنويه فى صفات السائل المنوى ولكن بدون اتجاه واضح. أما بالنسبه لنتائج الخلفات فقد وجد تحسن معنوى فى كل من وزن الجسم ، الزياده فى وزن الجسم وكذلك معدل التحويل الغذائى (P<.05) فى المجموعه المغذاه على ٤% مورينجا (١٤٩٣جم، ١٢٦٤ جم و ٢.٩) على التوالى مقارنه بمجموعه الكونترول (١٣٨٨ جم، ١٠٧٤ جم و٣.٦). لم يكن هناك اختلافات معنويه بين المجموعه المغذاه على ٨% مورينجا وكل من ٤% و مجموعه الكونترول. كان تاثير التداخل الثلاثى بين المعاملات والاسابيع والجنس معنوى ، حيث ارتفعت اوزان الجسم معنويا (P<.05) فى الذكور عن الاناث نتيجة لإستخدام المورينجا بدايه من الاسبوع الثانى وحتى نهايه التجربه مما يشير لاتجاه موجب خاصه فى الذكور. نستنتج من هذه النتائج انه يمكن استخدام مسحوق اوراق المورينجا عند مستوى ٤% لتحسين كفاءه الاداء التناسلى والانتاجى فى ذكور الارانب المستخدمه لاغراض التربيه وكذلك فى علائق الخلفات الناتجة لتحسين وزن الجسم عند عمر التسويق.