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INFLUENCE OF DIETARY ROSEMARY, MARJORAM AND GINGER SUPPLEMENTATION ON REPRODUCTIVE PERFORMANCE OF NEW ZEALAND WHITE RABBIT DOES UNDER SINAI CONDITIONS

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ABSTRACT

Thirty five NZW rabbit does, aged 10 months and weighed 3.21 ± 0.06 kg were divided randomly into five comparable groups (7 each). Rabbits in the 1st group were fed the basal (CO) diet without medicinal plants. While those in the 2nd, 3rd, 4th and 5th groups were fed the basal pelleted diet containing 3% Rosemary (RS), 3% Marjoram (MR), 1.5% Ginger root (ZR) and 2.5% mixture (MX) of these medicinal plants, respectively which were replaced with control diet at the same levels (%) for each diet. Results showed that kindling rate was increased in does of RS, ZR and MX groups (87.5%); MR did not differ from the CO (77.8%). Litter size and weight at weaning was higher (P<0.05) in RS, MR and MX groups than those in the CO or ZR group. Average daily gain of bunnies at birth to weaning was higher (P<0.05) in medicinal plane groups compared to the control group. Doe rabbits fed medicinal plants had the highest (P<0.05) values of total milk yield during lactation period compared with the control rabbits. The mortality rate at all time intervals from birth to weaning tended (P>0.05) to be lower in RS, MR, ZR and MX (8.79, 11.54, 5.95 and 7.46, respectively) than in the CO group (16.84%). Blood plasma estradiol 17-β concentration was higher (P≤0.05) in RS and MX (19.3 and 17.9 pg/ml) than in CO, MR and ZR groups (12.97, 10.7 and 15.83 pg/ml), respectively. Relative economic efficiency increased by 143, 164, 123 and 152 in RS, MR, ZR and MX, respectively, compared with (100%) in CO group.

Key words: Rabbits, rosemary, marjoram, ginger, production and reproduction, Sinai, Egypt.

INTRODUCTION

Shortage in animal feeds has a negative impact on the development of animal production in Egypt. Many developing countries import most of animal and poultry feeds, which is not economically feasible; therefore, more attention was given to untraditional feedstuffs. Nontraditional feed sources such as medicinal plants, crop residues and agro-industrial by-products must be searched in order to decrease the relay on traditional sources, to fill the gap to minimize the gap between the available and the requirements of animal protein **(Galal and Khalil, 1994; Zaki *et al.*, 2000)** and decrease feeding costs **(Al-Shanti, 2003)**. The increase in protein production may come from short cycle animals such as rabbits kept by the small scale farmers. Rabbits are suitable to be raised for great and rapid meat production due to their high prolificacy and fecundity, high feed conversion and efficiency and short generation period **(FAO, 1987; Ahmed *et al.*, 2005).** The rabbit industry, especially in Egypt, needs new cheap non-traditional protein sources, locally available and enough to overcome the issue. These sources must have the privilege to enhance

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animal health and fertility. So it is important to use natural substances that have no adverse effects on animal and human health (**Abdel-Malak *et al.*, 1995; Abaza and El-Said, 2005).** Great attention must be focused on using natural feed additives such as medicinal plants in rabbit feeding.

Many medicinal plants can be used as natural growth promoters. Medicinal plants could improve the productive and reproductive performances of rabbits. The biological background of this phenomenon includes improvements in thermal regulation, liver and kidney functions, hormonal status and balances of water, energy, nitrogen and minerals **(Abaza, 2001)**, and can improve body weight gain, growth performance and mortality rate **(Sabra and Mehta, 1990; Ibrahim *et al.*, 2004),** physical conditions of the gut eco-system (**Guo, 2003**); medicinal plants and herbs can also increase resistance to disease via optimizing the function of the immune system **(Amakye-Anim *et al.*, 2000; Al-Beitawi *et al.*, 2010)**, and antioxidant activity **(Mericili, 1990; Tipu *et al*., 2006)**. Herbs contain phytoestrogens, which are plant chemicals similar to sex hormones **(Sayed *et al.*, 2005)**.

Therefore, the objectives of the present study were to evaluate the effects of some dried medicinal plants such as rosemary (*Rosmarinus officinalis* L.), marjoram *(Origanum majorana* L.) and ginger root (*Zingiber officinale* L.) on productive and reproductive performance and economical efficiency of New Zealand White female rabbits under Sinai conditions.

MATERIALS AND METHODS

The present study was carried out at the Rabbitry Farm, Department of Animal and Poultry Production, Faculty of Environmental Agricultural Sciences, Suez Canal University, EL-Arish, North Sinai, Egypt, during the period from July till November, 2014.

A total of 35 New Zealand White (NZW) female rabbits 10 months old were used in this study. Rabbit were randomly allotted into five equal groups (7 each). Average initial BW was almost the same (3.21 ± 0.062 kg) in all treatment groups.

Rabbits were clinically examined and found to be healthy and free of external and internal parasites. Rabbits were kept under the same managerial and hygienic conditions. The rabbits were housed in galvanized wire cages in a well-ventilated (with open windows and ventilating fans).

The animals were raised in flat deck batteries with universal specification and hygienic control. The batteries were accommodated with feeders and drinkers to provide the animals with pellets according to their treatments.

The does were housed in individual cages of commercial type (40x55x60 cm) allocated in two parallel rows along the Rabbitry, each maternity cage was provided with a metal nest box for kindling and nursing the suckling rabbits by their dams. Each cage has stainless steel nipple for drinking and a feeder. Rabbits were reared inside a building with windows used for natural ventilation and lighting.

A cycle of 16 h light: 8 h dark was used with controlled artificial lighting, which was provided with electric fans, during the experimental period. Three medicinal plants from North Sinai spices markets were used in this study as follows: rosemary (*Rosmarinus officinalis* L.), marjoram (*Origanum majorana* L.), ginger root (*Zingiber officinale* L.). These medicinal plants were ground and then mixed with the diet. Five experimental diets were formulated to cover the nutrient requirements for rabbits according to **(NRC, 1996)**. The animals were fed on pelleted diets were offered all the time *ad libitum* during the experimental period. The ingredients of the pellets used and approximate analysis are

shown in Table 1. Chemical analysis was carried out for medicinal plants and for diet samples according to **AOAC (2005)** (Table 2). All animals received fresh water contained 705 ppm total dissolved solids (TDS) available automatically all the time by stainless steel nipples in each cage.

Body weight (BW) and feed intake (FI) of rabbit does were determined on the first day after kindling and day 30 of lactation. Feed intake was determined during the gestation period and from kindling until d 30 of lactation. Body weights were recorded by weighing the animals at the beginning and at the end of each reproductive stage. All feed given within each stage was recorded the Gestation length from fertile mating to kindling was recorded **(Shetaewi, 1998)**.

Mating was carried out naturally by transferring the doe rabbit to the buck's cage and returning her buck to its own cage after copulation. All does were palpated 10 days post-mating to diagnose pregnancy; those who failed to conceive were re-mated until the pregnancy was established. Litters were checked and recorded for size and weight. Thereafter, litters in the nest were examined each morning during the suckling period to remove the dead young. Young rabbits were weaned at 30 days after kindling and transferred to other cages to be housed in groups of two individuals in standard progeny wire cages equipped with feeding hoppers and drinking nipples.

Litter size of rabbits was recorded and included dead kids at birth (total), birth (alive), 7, 14, 21, 28 days and at weaning, respectively. All litters were separated from their mothers to permit lactation and then weighed. Litter weights and Mean bunny weights at birth, 7, 14, 21, 28 days and at weaning were recorded, respectively. Records of litters at kindling were taken within 5 hr., from kindling, while other records were taken in time. All weights were recorded to the nearest gram the Mortality rate from birth up to weaning at the 4th week. was estimated. Mortality rate was calculated as the no. of dead offspring up to weaning/No. of all offspring.

Milk yield was estimated by recording the difference in weight of the pups after and before suckling **(Abdel-Samee, 1997).** The increase in pups' weight was used as the doe daily milk yield then milk intake per each bunny was calculated by dividing milk yield/No., of bunnies for each doe. Bunnies were weaned at four weeks of age and then weighed and the bunny weight gain was calculated.

Blood samples were taken in less than two minutes from a marginal ear vein of three rabbit does within each experimental group at 12 hours after mating. Blood samples were collected into heparinized clean centrifuge tubes. Blood plasma was separated by centrifugation at 3000 rpm, for 20 minutes and kept in a deep freezer at (-20°C) until analysis. Blood plasma estradiol 17-β hormone concentration were assessed using RIA technique utilizing Coated tubes Kits purchased from the Diagnostic Production Corporation, Los Angeles, USA.

Economical Efficiency

Calculated by the following:

Selling revenue = total offspring weight, kg X price of kg for live body weight Rabbit.

Net revenue = difference between selling revenue and feed cost.

Economic efficiency (E.E) = (net revenue/ total feed cost) × 100.

Relative economic efficiency (REE), assuming control treatment = 100%.

The price of one kg of weanling live weight for meat, control pelleted without MP, pelleted with RS, pelleted with MR, pelleted with ZR and pelleted with mixture MX were, 32.0, 2.60, 2.79, 2.75, 2.80 and 2.75 LE, respectively during the experimental period (2014).

Table (1): Ingredients of experimental diets used in this study.

Ingredient	Co. diet
Alfalfa hay	30.00
Wheat bran	29.00
Yellow corn	12.50
Soybean meal (44%)	14.00
Barley grain	10.00
Molasses	2.00
Calcium carbonate (lime stone)	0.60
Sodium chloride (salt)	0.30
Vitamins & Mineral Premix*	0.30
DL-Methionine	0.10
Di-Calcium phosphate	1.20
Total	**100.00**
Calculated chemical composition	
Crude protein (CP)	18.128
Ether extract (EE)	2.936
Crude fiber (CF)	12.17
Digestible energy (Kcal/Kg)	2768.3

* One kilogram of premix contain: vit. A 12000 000 IU, vit. D_3 2200 00 IU, vit. E 1000 mg, vit. K_3 2000 mg, vit. B_1 1000 mg, vit. B_2 4000 mg, vit. B_6 100 mg, vit. B_{12} 10 mg, pantothenic acid 3.33 g, biotin 33 mg, folic acid 0.83 g, choline chloride 200 g, Zn 11.79 g, Mn 5 g, Fe 12.5 g, Cu 0.5 g, I 33.3 mg, Se 16.6 mg and Mg 66.7 g.

Table (2): Chemical analysis (%) of medicinal plants and the experimental diets.

Item	DM	(%) DM basis					
		OM	CP	EE	CF	NFE	ASH
Rosemary	91.69	94.59	4.13	11.64	13.37	65.45	5.41
Marjoram	91.41	84.22	14.18	4.14	15.22	50.68	15.78
Ginger root	90.12	94.34	9.38	4.04	11.28	69.64	5.66
Chemical composition of experimental diets given to NZW rabbits							
CO	91.89	89.42	18.21	3.04	12.05	56.12	10.58
RS	92.34	89.58	17.79	3.29	12.09	56.39	10.43
MR	92.33	89.26	18.09	3.07	12.15	55.96	10.74
ZR	90.95	89.65	17.81	3.01	11.86	55.48	10.35
MX	91.87	89.75	17.45	3.05	11.74	54.59	10.25

CO; control, pelleted diet. RS; pelleted diet containing 3% rosemary.
MR; pelleted diet containing 3% marjoram. ZR; pelleted diet containing 1.5 % ginger roots.
MX; Mixture, pelleted diet containing 1% rosemary +1% marjoram + 0.5% ginger root.

Statistical Analyses

Data were analyzed by least-squares analysis of variance using the General Linear Model (GLM) procedure of **SAS (2004)** according to **Steel and Torrie (1980)**.

Data on gestation length, litter weight, bunny body weights and body weight gain, and milk traits were analyzed by one-way analysis of variance. Whenever F value was significant ($P<0.05$) means were compared using the least significant difference (LSD) test.

Data on kindling rate; No. of kits born and mortality rate of kits were analyzed using the categorical model procedure "CATMOD" of **SAS (2004)** which partitions the variation among the response functions in the above mentioned sources of variations using Chi-Square tests. It tests the hypothesis that the distribution is the same across different groups.

RESULTS AND DISCUSSION

Reproductive Performance

Data presented in Table 3 reveal that feeding diet supplemented with medicinal plants did not affect body weight of does at mating, pre- and post-natal weights ($P>0.05$) compared with the control group.

Gestation length did not differ significantly due to feeding medicinal plants (Table 3). In contrary, kindling rate was increased in does of RS, ZR and MX groups; MR did not differ from the control (Table 3). This may be due to increased levels of sex hormones by feeding medicinal plants.

This effect may in part depend on sex hormones receptors in the female. **Morakinyo *et al.* (2008)** and **Kamtchouing *et al.* (2002)** suggested that extract of *Zingiber officinale* possesses pro-fertility properties in rats through its potent antioxidant properties and androgenic activities. Also, **Doust *et al.* (2010)** found in rats that *Matricaria Chamomila* flower extract can increase serum estradiol level. From a functional view, the effects of *Matricaria Chamomila* flower are similar to effects of estrogen and progesterone hormones **(Rosenberg *et al.*, 2001; Kassi *et al.*, 2004)**. Concerning the effects of Marjoram may be due to low the sex drive **(Chevallier, 1996)**. Marjoram is emmenagogue **(Mahran, 1967; Chopra *et al.*, 1999)**, it is taken internally in the treatment of painful Menstruation **(Bown, 1995)**.

Because it can promote menstruation, it should not be used medicinally by pregnant women **(Bown, 1995; Chevallier, 1996)**. This could explain the effects of marjoram on kindling rate and gestation length of doe rabbits recorded in the present study.

The present results are in agreement with those obtained by **Ibrahim (2010)** who found that feeding diets containing 1% ginger to NZW rabbit does did not affect ($P>0.05$) mating and pre-natal weights while, post-natal weight was decreased ($P<0.05$). He Also, found that gestation length was decreased ($P<0.05$) by 1.8% but, kindling rate was increased ($P<0.05$). In contrary, these results are in disagreement with the results of **Seleem *et al.* (2007)** who found that adding 3% marjoram (*Origanum majorana*) to the diets of rabbit does, significantly ($P\leq0.05$) increased kindling rate compared with untreated does. They found that kindling rates for treated and untreated does were 80.92 and 60.53%.

Concentration of Estradiol 17-β Hormones

Data in Table 3 show that values of blood plasma estradiol 17-β concentration of NZW rabbit does were significantly ($P\leq0.05$) higher in RS and MX compared with CO, whereas the MR and ZR did not differ ($P>0.05$) either for the CO or the other groups. **Amr and Hamza (2006)** demonstrated that *Z. officinale* treatment has a potent androgenic activity. In rats,

Table (3): Reproductive performance and estradiol 17-β concentration of NZW rabbit does naturally mated as affected by supplementation with medicinal plants (LS-means ±SE).

Item	Experimental diet					±SE
	CO	RS	MR	ZR	MX	
Mating weight (kg), aged 44 wk.	3.274	3.318	3.316	3.337	3.291	74.0
Pre-natal weight (kg)	3.599	3.841	3.704	3.630	3.663	96.8
Post-natal weight (kg)	3.284	3.401	3.286	3.302	3.259	91.1
Gestation length (day)	31	30.4	29.7	30.1	30.3	0.32
Kindling rate* %	77.8	87.5	77.8	87.5	87.5	--
Estradiol 17-β (pg/ml)	12.97^{cd}	19.3^{a}	10.7^{d}	15.83^{bc}	17.9^{ab}	1.02

[a, b ….d]: Means within the same row with different superscripts differ (P<0.05), SE= standard error.
* Using Chai-Square.
CO= Control; RS=Rosemary; MR= Marjoram; ZR= Ginger; MX= mixture of RS, MR and ZR.

Doust *et al.* (2010) found that *Matricaria chamomila* flower extract can increase serum estradiol level. From a functional view, the effects of *Matricaria chamomila* flower are similar to the effects of estrogen and progesterone hormones (**Rosenberg *et al.*, 2001; Kassi *et al.*, 2004).**

Litter size and weight

Data presented in Table 4 show that the effect of treatment on litter size at birth, 14 d and 30 d (weaning). Litter size at birth was higher (P<0.05) for the RS group compared with the CO but the other groups did not differ significantly.

No. of kits at 14d was higher (P<0.05) for RS and MR groups compared to the CO group, whereas the ZR and MX groups did not differ (P>0.05) either for the CO or the other groups. Moreover, No. of kits weaned was higher (P<0.05) for RS, MR and MX groups compared to the CO group, whereas the ZR group did not differ (P>0.05) either for the CO or the other groups.

Data presented in Table 4 showed that the effect of treatment on litter weight at birth, 14 d and 30 d (weaning). Litter weight at birth was higher (P<0.05) for the RS and MR groups compared with the CO but the other groups did not differ significantly. Moreover, Litter weight at 14 d was higher (P<0.05) for medicinal plants groups compared to the CO group. In addition, Litter weight at 30 d (weaning) was higher (P<0.05) for RS, MR and MX groups compared to the CO group, whereas the ZR group did not differ (P>0.05) either for the CO or the other groups. **Ching *et al.* (2001)** reported that the improvement of litter traits may attributed to the maternal active substance transferred to the fetus during the late gestation period.

These results agree with the results of **Ibrahim (2010)** who found that feeding diets containing 1% ginger to NZW rabbit does increased (P<0.05) litter size and litter weight from birth to weaning. Also, **Seleem *et al.* (2007)** found that adding 3% *Origanum majorana* (marjoram) to the diets of rabbit does significantly increased litter size and litter weight at birth (7.3 and 311.5) compared with the untreated does (5.1 and 230.9), respectively. Moreover, **Shehata *et al.* (2007)** found that feeding (*Matricaria chamomila*) flower in Zaraibi does ration had positive effect on new born kids weight.

Table (4): Litter size and weight at different ages of NZW rabbit does naturally mated and fed diets supplemented with medicinal plants (LS-means ±SE).

Item	Age	Experimental diet					±SE
		CO	RS	MR	ZR	MX	
No. of kits	born a total	6.00^{b}	7.43^{a}	7.29^{ab}	6.14^{ab}	6.86^{ab}	0.49
	born a live	5.71^{b}	7.29^{a}	7.14^{ab}	6.14^{ab}	6.57^{ab}	0.49
	at 14 days	5.29^{b}	7.14^{a}	6.57^{a}	6.00^{ab}	6.43^{ab}	0.40
	weaned (30 d)	5.00^{b}	6.71^{a}	6.43^{a}	5.71^{ab}	6.29^{a}	0.41
Litter weight (g)	Birth (a live)	319^{b}	406^{a}	406^{a}	325^{b}	384^{ab}	22.3
	14 days	1199^{c}	1983^{a}	1873^{a}	1504^{b}	1979^{a}	98.9
	Weaning (30d)	3020^{b}	4461^{a}	4465^{a}	3671^{b}	4505^{a}	250

$^{a, b, \text{and } c}$: Means within the same row with different superscripts differ (P<0.05), SE= standard error.

CO= Control; RS=Rosemary; MR= Marjoram; ZR= Ginger; MX= mixture of RS, MR and ZR.

Bunny body weight gain

Body weight of bunnies did not differ significantly between treatments at birth. However, means were different (P>0.05) at 14 d and 30 d (weaning) with the control group had lowest means and MX the highest (Table 5).

Average daily gain of bunnies at 1 - 14 days was higher (P<0.05) for medicinal plant groups compared to the CO group. In contrary, average daily gain of bunnies did not differ significantly between treatments at 15 - 30 days. However, means were different (P>0.05) at birth to 30 d (weaning) wherein the control group had lowest means and MX was the highest (Table 5). The improvements in bunny weight gain may be attributed to increased feed intake and feed conversion and, milk yield, and to enhance in the metabolism of essential and volatile oils included in medicinal plants **(Evans and Pharm, 1975)**. The present results are in agreement with **Ibrahim (2010)** found that feeding diets containing 1% ginger to NZW rabbit does increased (P<0.05) mean bunny weight and bunny weight gain at different ages from birth to weaning day. Also, **El-Kholy *et al.* (2012)** found that Black Baladi rabbit does supplemented with cinnamon (*Cinnamomum zeylanicum*) powder had significantly (P≤0.05) higher bunny weight at birth and at weaning than the control group.

Milk yield doe rabbits

Effect of feeding medicinal plants on milk yield of NZW rabbits are presented in Table 6. Does rabbits fed medicinal plants had the highest (P<0.05) values of total milk yield during the 1st wk, 2nd wk and 3rd wk compared with the control rabbits. In addition, total milk yield during the 4th wk was higher (P<0.05) for RS, MR and MX groups compared to the CO group, whereas the ZR group did not differ (P>0.05) either for the CO or the other groups. This may be due to medicinal plant effects. Medicinal plant possess a lactogenic activity with a favorable enhancement ability in increasing serum prolactin level which is the principal lactogenic hormone secreted by anterior pituitary **(Okasha *et al.*, 2008; Gaya *et al.*, 2009)**.

In this respect, this may lead to increased milk secretion and its yield in treated rabbits. Besides, the increase in milk production may be due to increase in litter size at birth, where there was a positive correlation between the litter size at birth

Table (5): Bunny body weight at different ages of NZW rabbit does naturally mated and fed diets supplemented with medicinal plants (LS-means ±SE).

Period, day	Experimental diet					±SE
	CO	RS	MR	ZR	MX	
	Mean bunny weight (g/hd)					
Birth	54.94	54.71	55.83	53.16	56.11	1.97
14	227^{d}	278^{b}	286^{b}	252^{c}	309^{a}	5.4
Weaning (30)	603^{d}	665^{bc}	699^{ab}	645^{c}	719^{a}	14.1
	Average daily gain of bunny rabbits (g/hd)					
1-14	12.27^{d}	15.94^{b}	16.44^{b}	14.21^{c}	18.09^{a}	0.39
15-30	23.53	24.18	25.83	24.54	25.62	0.77
Average (Birth– 30)	18.27^{d}	20.33^{bc}	21.45^{ab}	19.72^{c}	22.10^{a}	0.47

[a, b .... d]: Means within the same row with different superscripts differ (P<0.05), SE= standard error.

CO= Control; RS=Rosemary; MR= Marjoram; ZR= Ginger; MX= mixture of RS, MR and ZR.

Table (6): Milk yield and milk conversion of NZW rabbit does naturally mated and fed diets supplemented with medicinal plants (LS-means ±SE).

Item	Period (wk.)	Experimental diet					±SE
		CO	RS	MR	ZR	MX	
Milk yield (g)	1^{st} wk.	695^{c}	1065^{a}	1005^{ab}	878^{b}	1055^{a}	56.9
	2^{nd} wk.	1685^{c}	2585^{a}	2390^{ab}	2059^{b}	2485^{a}	125
	3^{rd} wk.	2950^{c}	4515^{a}	4190^{ab}	3588^{bc}	4334^{a}	222
	4^{th} wk.	3225^{b}	4955^{a}	4650^{a}	3923^{b}	4729^{a}	250
Milk conversion*	Birth – 21d	1.78	1.69	1.63	1.65	1.52	0.07
	Birth-weaning	1.27	1.32	1.23	1.29	1.21	0.05

[a, b, and c]: Means within the same row with different superscripts differ (P<0.05), SE= standard error

*Milk conversion ratio during lactation period was calculated (total milk yield /litter weight gain from birth to 21 and 30 days).

CO= Control; RS=Rosemary; MR= Marjoram; ZR= Ginger; MX= mixture of RS, MR and ZR.

and milk yield **(Rommers *et al.,* 2001).** Moreover, milk production of the domestic rabbit was affected by many factors such as breed of doe **(Lukefahr *et al.,* 1983)**, parity **(Abo-El-Ezz *et al.*, 1981)** nutrition and remating intervals **(Rashwan, 1990),** temperature **(Nasr, 1994)** litter size and number of kits suckling **(Lukefahr *et al.*, 1983).**

The improvements of rosemary on milk yield may be attributed to "bio-functional compounds" affects milk positively and alleviates the stress associated with lactation in animals **(Chiofalo *et al.,* 2012)**.

The present results are in agreement with **Seleem *et al.* (2007)** found that adding 3% marjoram (*Origanum majorana*) to the diet of rabbit does increased significantly milk yield/doe compared with untreated does. In addition, **Ibrahim (2010)** found that feeding diets containing 1% ginger (*Zingiber officinale*) to NZW rabbit does increased ($P<0.05$) total milk yield during the 1st 7 days, 1st 14 days, 1st 21 days and the 1st 28 days period. In sheep, **Chiofalo *et al.* (2012)** found that rosemary *Rosmarinus officinalis* extract supplementation to dairy ewes affected ($P<0.05$) milk yield, and quantitative production of protein and casein, lactose and fat in their milk.

Milk conversion, presented in Table 6 revealed that feeding the doe rabbits on medicinal plants did not differ ($P>0.05$) milk conversion from birth to 21 d and birth to weaning. **Ibrahim (2010)** found that milk conversion during the 1st wk, 2nd wk, 3rd wk and 4th wk was not affected when the doe rabbits was treated with ginger (*Zingiber officinale*). This increase in most of the reproductive traits of does could be due to increase of doe milk yield as a result of increase feed intake.

Mortality rate

Concerning mortality rate, Table 7 demonstrated that feeding the rabbit does on medicinal plants did not differ ($P>0.05$) mortality rate in all different measured intervals from birth to weaning compared with the control.

Reducing mortality rate may be attributed to the improvement in immune response and consequently in disease resistance during physiological stress and adverse environmental conditions **(McDowell, 1989)**. The lowest and pronounced decrease of mortality rate (%) in offspring's treated rabbit does may be discussed from the view which demonstrated by **Fortun-Lamothe and Boullier (2004)** who showed that, in the young rabbit a passive immunity occurs due to mother's immuno-globulins transmission by the colostrum and to a lesser extent by the milk. In addition, it has been shown that adding medicinal plants to the diet induced improves the immune system **(Savage *et al.,* 1996).** So, this is sufficient to provide protection against infections.

In this respect, medicinal plants may be have an essential role in reduced mortality rate by its role in modify pH of rabbit digestive tract promoting useful bacteria and inhibit the harmful ones **(Pinheiro *et al.,* 2004).** Furthermore, the possible antimicrobial activity of the medicinal plants may be accounted for by their growth-promoting effects on bifidobacteria and lactobacilli. These bacteria can reinforce the barrier function of the intestinal mucosa, helping in the prevention of the attachment of pathogenic bacteria, essentially by crowding them out. These bacteria may also produce antimicrobial substances and stimulate antigen specific and nonspecific immune responses **(Roberfroid, 2000)**.

This may due to the increase in concentration of the total volatile fatty acids in caecum **(Padilha *et al.,* 1999)** and this may be indication to the high proportions in rapidly fermentable polysaccharides stimulates the maturation of microbial activity and reduce the occurrence of diarrhea **(Gidenne**

Table (7): Mortality rate of NZW rabbit does naturally mated and fed diets supplemented with medicinal plants (LS-means ±SE).

Item	Age (wk.)	Experimental diet					±SEM
		CO	RS	MR	ZR	MX	
Mortality Rate (%)	1st wk.	9.44	1.59	5.67	1.79	4.08	2.59
	2nd wk.	1.78	1.78	3.83	0.0	1.59	1.86
	3rd wk.	2.05	1.79	2.04	2.38	0.0	1.98
	4th wk.	3.57	3.63	0.0	1.78	1.79	2.69
	Birth-weaning	16.84	8.79	11.54	5.95	7.46	4.61

CO= Control; RS=Rosemary; MR= Marjoram; ZR= Ginger; MX= mixture of RS, MR and ZR.

SE= standard error mean.

***et al.*, 2004)**. So, supplementation of Rosemary, Marjoram and Ginger as antioxidant substrates, antiseptic, immune and gastric stimulant for facing mortality may be beneficial (**Tipu *et al*., 2006; Mericili, 1990)**.

The present results are in agreement with **Seleem *et al.* (2007)** found that adding 3% marjoram *(Origanum Majorana*) to the diets of rabbit does decreased (P≤0.05) mortality rate from birth to weaning compared with untreated does. Moreover, **Erdelyi *et al.* (2008)** found that mortality of young grower rabbits was very high between the 5th and 7th weeks of age in control group (32%) compared with the 0.15% rosemary (*R. officinalis*) essential oil treated group (24%). **Ibrahim (2010)** found that feeding diets containing 1% ginger to NZW rabbit does decreased (P<0.05) mortality rate from birth to weaning.

Productive traits and economic efficiency

Data presented in Table 8 show that, feed intake of doe rabbits was higher (P>0.05) during lactation than that during pregnancy in all treatment groups. Within treatment groups feed intake did not differ (P>0.05) during pregnancy, but was significantly different during lactation.

Does of RS and MX groups had the highest means. The same trend was observed for daily feed intake; does of RS and MX had the highest means. These results agreed with those of **Omage *et al.* (2007)** who indicated that feed intake increased significantly in rabbits fed ginger over those of the control diet. Also, **Ibrahim *et al.* (2009)** found that adding 1% of herb mixture containing marjoram significantly (p<0.05) increased feed intake in rabbits. Total feed cost increased due to feeding medicinal plants treatments compared with the control (Table 8). However, the net revenue, EF and REF were increased due to feeding the medicinal plants supplemented diets (Table 8).

Similarly, **Ibrahim (2010)** reported that feeding diets containing 1% ginger to NZW rabbit does increased (P<0.05) total feed cost, net revenue and relative economic efficiency. He also, found that relative economic efficiency was 138.3% better than that of the control. On the other hand, **Vogt and Rauch (1991)** found that, when the diet of broilers was supplemented with thyme that feed cost did not increase and **Ahmed *et al.* (2005)** indicated that chicks fed diets supplemented with thyme at levels of 0.1% decreased economic and relative efficiency.

Table (8): Productive performance and economic efficiency of NZW rabbit does naturally mated as affected by supplementation with medicinal plants (LS-means ±SE).

Item	Experimental diet					±SE
	CO	RS	MR	ZR	MX	
Feed intake, kg						
Pregnant Does	6.327^{abc}	6.575^{a}	5.976^{c}	6.095^{c}	6.480^{ab}	146
Lactating Does	7.774^{b}	8.840^{a}	8.141^{b}	7.930^{b}	8.625^{a}	135
Daily feed intake (g/ doe)	232^{b}	255^{a}	236^{b}	233^{b}	257^{a}	3.2
Cost of kg feed* (L.E)	2.6	2.79	2.75	2.80	2.75	---
Total feed cost (L.E)	257	301	272	275	291	---
Total No. of weaned offspring	35	47	45	40	44	---
Total offspring weight, kg	21.11	31.24	31.26	25.80	31.64	---
Selling revenue (L.E)**	676	1000	1000	826	1012	---
Net revenue (L.E)	419	699	728	551	721	---
EF* (%)**	163	232	268	200	248	---
REF** (%)**	100	143	164	123	152	---

a, b, and c: Means within the same row with different superscripts differ (P<0.05), SE= standard error.
CO= Control; RS=Rosemary; MR= Marjoram; ZR= Ginger; MX= mixture of RS, MR and ZR.
* According to the price of different ingredients available in the market at the experimental time 2014.
** According to the local market price the experimental period.
*** Net revenue per unit cost
**** Assuming that the relative economic efficiency (REF) of control diet equals to 100.

Conclusion

The medicinal plants, rosemary (*Rosmarinus officinalis*), marjoram (*Origanum majorana*), ginger root (*Zingiber officinale*) and their mixture could be added to NZW rabbit diets to improve the productive and reproductive performances of females and to increase relative economic efficiency under Sinai conditions their addition within the limits recorded in this study is practically applicable, safe and beneficial.

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الملخص العربى

تأثير التغذية على الحصالبان والبردقوش والزنجبيل على الأداء التناسلى لإناث الأرانب النيوزيلندى البيضاء تحت ظروف سيناء

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أجريت هذه الدراسة بمزرعة الأرانب التابعة لقسم الانتاج الحيوانى والداجنى، كلية العلوم الزراعية البيئية بالعريش، جامعة قناة السويس، خلال الفترة من يوليو حتى نوفمبر٢٠١٤م. وكان الهدف منها دراسة تأثير إضافة بعض النباتات الطبية (الحصالبان والبردقوش والزنجبيل وخليطهم) إلى علائق أمهات الأرانب النيوزيلندى الأبيض على الأداء التناسلى تحت ظروف سيناء، استخدم عدد ٣٥ من الإناث عمر ١٠ شهور (٣,٢١ ± ٠,٠٦٢ كجم) تم تقسيمها عشوائيا إلى خمس مجاميع متماثلة (٧ لكل مجموعة) غذيت على خمسة علائق تجريبية متوازنة حتى الشبع، العليقة الأولى كنترول بدون إضافة أى نباتات طبية، والعليقة الثانية محتوية على ٣% حصالبان، الثالثة ٣% بردقوش، الرابعة ١,٥% زنجبيل والخامسة خليط من هذه النباتات بنسب (١% حصالبان + ١% بردقوش + ٠,٥% زنجبيل) وقد أوضحت النتائج المتحصل عليها ما يلى: فترة الحمل لم تختلف معنويا بين المعاملات، نسبة الولادات كانت أعلى معنويا فى مجاميع الحصالبان والزنجبيل والخليط (٨٧,٥%) مقارنة بالكنترول والبردقوش (٧٧,٨%)، حجم ووزن الخلفة عند الفطام (٣٠ يوم) كانت أعلى معنويا فى مجاميع الحصالبان (٦,٧١ و٤٤٦١) والبردقوش (٦,٤٣ و٤٤٦٥) والخليط (٦,٢٩ و٤٥٠٥) عنها فى مجموعتى الكنترول (٥,٠ و٣٠٢٠) والبردقوش (٥,٧١ و٣٦٧١). متوسط الزيادة اليومية فى وزن الخلفات من الولادة حتى الفطام كان أعلى معنويا فى مجاميع النباتات الطبية عن مجموعة الكنترول، إنتاج اللبن الإجمالي خلال فترة الرضاعة إرتفع معنويا فى مجاميع النباتات الطبية عن مجموعة الكنترول، مستوى هرمون الاستراديول فى دم الأمهات كان أعلى معنويا فى مجموعتي الحصالبان والخليط (١٩,٣ و١٧,٩ بيجوجرام/مل) عنها فى الكنترول والبردقوش والزنجبيل (١٢,٩٧، ١٠,٧ و١٥,٨٣)، على التوالى، معدل نفوق الخلفات خلال الفترة من الولادة حتى الفطام إنخفض (غير معنويا) فى مجاميع الحصالبان والبردقوش والزنجبيل والخليط (٨,٧٩، ١١,٥٤، ٥,٩٥ و٧,٤٦% على التوالى) عن الكنترول (١٦,٨٤%)، الكفاءة الاقتصادية النسبية ارتفعت فى مجاميع الحصالبان والبردقوش والزنجبيل وخليطهم إلى ١٤٣، ١٦٤، ١٢٣ و١٥٢ %، على التوالي مقارنة مع (١٠٠%) للكنترول، ومن النتائج السابقة يمكن التوصية بإضافة النباتات الطبية الحصالبان، البردقوش والزنجبيل وخليطهم الى علائق إناث الأرانب النيوزيلندى الأبيض بالنسب المذكورة كمصدر غير تقليدي متوفر وآمن الإستخدام ومفيدا لتحسين الأداء الإنتاجي والتناسلى ولخفض تكلفة الإنتاج.

الكلمات الاسترشادية: إناث الأرانب، الحصالبان، البردقوش، الزنجبيل، الأداء التناسلي، سيناء، مصر.

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