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USING SOME OILS OF MEDICAL PLANTS IN DIETS OF RABBITS UNDER HOT CLIMATIC CONDITIONS

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ABSTRACT:

A completely random design of this experiment was conducted to evaluate rocket and onion oils or mixture of these oils in diets of NZW rabbits under climate summer conditions on their productive and reproductive performance traits. Digestibility coefficients and nutritive values, milk yield, some blood serum constitute and economic efficiency, semen characteristics of buck and their offspring performance were estimated. A total number of 48 NZW rabbit does (6 months old) and 12 bucks (6 month old) with nearly similar weights were divided at random into four groups (12 does and 3 bucks in each). Rabbits were fed either basal diets as control diet (G1) or control diet supplemented with either 1 g/kg diet of rocket oil (G2), onion oil (G3) or mixture of these oils (G4). The experiment prolonged during the hot summer conditions started in May to July, 2009. The experimental diet was isonitrogenous (CP=18.5%) and isocaloric (about 2401 kcal/kg DE).

Results showed that *percentages of total unsaturated fatty acids, especially linoleic were higher in onion oil than in rocket oil. The percentage of erucic fatty acid was higher in rocket oil than in onion oil. Does fed G2 diet recorded the highest (P<0.05) values of feed intake, final body ,weight, gain, conception rate, number of parturition, litter size, litter weight, litter weight gain at birth and at weaning. Digestibility coefficient of CP and EE and nutritive value expressed as DCP were the highest (P<0.05) with rabbits fed the rocket oil diet. Average daily milk yield during different lactation weeks and feed conversion ratio to milk production were the highest (P<0.05) for does fed rocket oil diet. However, does fed onion oil diet showed the highest (P<0.05) milk contents at most lactation weeks. Weight at weaning, weight gain and relative growth rate of bunnies were the highest (P<0.05) for does fed rocket oil diet. Mortality rate at birth and during the suckling period was the lowest (P<0.05) for bunnies of does fed onion oil diet. Does received rocket oil diet recorded the lowest (P ≤ 0.05) values of blood serum cholesterol, triglycerides and low density lipoprotein cholesterol (LDL) followed by*

those fed mixture of rocket oil and onion oil. However, control group recorded the highest value. Most physical semen characteristics, including sperm cell concentration, and percentages of motility and dead spermatozoa were the best (P<0.05) for the buck rabbits fed rocket oil diet .Does received rocket oil diet recorded the highest net return and economic efficiency followed by those fed diet supplemented with onion oil or rocket oil plus onion oil.

Results of the experiment showed that addition of 1 g rocket oil /kg diet was more effective than other treatments for improving productive and reproductive performance traits, digestibility coefficients and nutritive values, milk yield of NZW doe and buck rabbits under hot climate of summer season in Egypt.

Keywords: Rocket oil, onion (*Allium cepa*) oil, fatty acids, digestibility coefficients, blood & semen characteristics, economic efficiency.

INTRODUCTION

Hot climate conditions in summer season represent a problem for rabbit production in many countries all over the world, including Egypt (Habeeb *et al.,* 1993 and Marai *et al.,* 1996). Rabbits are very sensitive to heat stress, as it negatively affects production (Fouad, 2005).

Exposure of rabbits to heat stress evokes a series of remarkable changes in their biological function, which ends with impairment of production and reproduction (Marai *et al.,* 2004).

High mortality percentages and reduce fertility were recorded with rabbits exposed to high-temperature environments due to the heat stress which cause a weakness of rabbits and changes in their biological function (Okba and El-Banna, 2003 and Okba *et al*., 2008).

Many attempts have been done to overcome the adverse effects of heat stress by modifying environmental condition through nutritional, managerial and physiological manipulation of rabbits (Bassuny, 1999 and Selim *et al.,* 2003).

Medicinal plant oils such as rocket and onion oils are rich in factors interest in disease prevention and health promotion. These beneficial factors include monounsaturated and polyunsaturated fatty acids, tocopherols, carotenoids and antioxidative phenolic compounds. Also, these plant oils were found to contain natural substances that promote health and ameliorate the body condition against the stress (Eisenberg *et al.,* 1993). This study was carried out to determine the effect of addition of 1.5% of either onion oil, rocket oil or mixture of these oils to the commercial rabbit ration on productive and reproductive performance of NZW doe and buck rabbits under the host condition in summer season in Egypt.

MATERIALS AND METHODS

The present study was carried out at Sakha Research Station, Animal Production Research Institute, Agricultural Research Center, Egypt. The experiment lasted from May to July, 2009.

This experiment was conducted to evaluate rocket and onion oils or mixture of them as supplements in the diets on productive and reproductive performance traits of doe and buck adult New Zealand White (NZW) rabbits. Digestibility coefficients and nutritive values, some blood serum constitutements and economic efficiency and semen characteristics of bucks were also evaluated. In a complete randomized design, a total number of 48 adult NZW rabbit doe and 12 NZW bucks (6 month old) with nearly similar weight, were divided at random into four equal experimental groups (12 does and 3 bucks in each). Rabbits were fed either basal diet (Control) or basal diet supplemented with 1 g rocket oil /kg diet (G2), or onion oil (G3) and combination for these oils (G4). The experimental diet were formulated to be isonitrogenous (18.5% CP) and isocaloric (about 2401 kcal DE /kg) according to NRC (1984) for pregnant does and bucks allowances recommendations.

Formulation and chemical composition of the experimental diets are presented in Table 1. All does and bucks used in this study were housed during the experimental period in individual galvanized metal wire cages with dimensions of 60 x 50 x 35 cm. All cages were provided with feeding hoppers made of galvanized, stainless steel sheets and automatic nipples for drinking water. Cage of each doe was provided with a metal nest box for kindling. Each buck was mated for 1-4 does of the same breed and each doe was palpated 10 days post-mating, to detect pregnancy. The doe which failed to conceive was returned to the same mating buck.

Bunnies were deprived from suckling for 24 h by separation between the mother and the litters, thereafter, the bunnies were allowed to suckle their mothers. Bunnies were weaned at 28 days. Number of doe copulated, number of mating/group, conception rate (%), parturition, litter size at birth (LSB) and litter size at weaning (LSW), litter weight at birth (LWB), litter weight at weaning (LWW), feed intake, bunny weight at birth (BWB), weaning (BBW), 28 days were recorded. Milk yield at 1^{st}, 2^{nd}, 3^{rd}, 4^{th} week of suckling was estimated by using, doe-suckle weight method (Lukefahr *et al.*, 1983).

The nest box was removed from the doe cage for 24 h, after this time, milk yield is measured by subtracting doe weight before nursing, from the doe weight after nursing. Also, milk yield was measured by subtracting the litter weight before nursing from the litter weight after nursing.

Table 1: Formulation and chemical composition of the experimental diet.

Ingredient	%	Calculated analysis[2] (DM, %)	%
Berseem hay	34.0	Crude protein (CP)	18.55
Barley	11.09	Ether extract (EE)	2.7
Wheat bran	18.00	Crude fiber (CF)	12.21
Yellow corn	9.76	Calcium, %	1.1
Soybean meal 44%	22.0	Total phosphorus, %	0.6
Molasses	2.5	Methionine	0.42
Dicalcium phosphate	1.2	Lysine	0.84
Limestone	0.5	Digestible energy (kcal/kg)[3]	2402.6
DL-Methionine	0.20	Cost (LE) / 100 kg	194.78
Vit. and Min. Premix[1]	0.30	-	-
Salt (NaCl)	0.30	-	-

1. **Each 3 kg vitamin and mineral premix provides**: Vit. A 12000000 IU, Vit. D_3 750000 IU, Vit. E 10000 mg, Vit. K 2000 mg, Biotine 50 mg, Folic acid 1000 mg, Choline choloride 500 mg, selenium 100 mg, Manganese 25 gm, Zinc 50 mg, Fe 60 mg, Cu 2.5 mg, Co 6 mg, Iodine 1 gm and carrier $CaCo^3$ to 3000 gm.
2. According to feed composition tables for Animal Poultry Feedstuffs used in Egypt (2001).
3. Calculated according to De Blas and Mateos (1998).

Feed conversion was estimated as kg total feed intake/ kg total milk yield during lactation. All rabbit were kept under the same managerial, hygienic and environmental conditions. During sucking weeks, milk intake by bunnies of each doe and milk composition were recorded. Milk intake at the first three successive days with each week was determined by the difference in LBW of does before and after suckling, while milk composition was estimated using milko-scan (Model 133 B).

At the end of the experimental period, a digestibility trial was conducted using 4 male rabbits from each treatment group. The rabbits were individually housed in metabolism cages that permit to collect faeces and urine separately. The trial lasted 9 days, 3 days as a preliminary period, followed by 6 days to quantify the daily feed intake and faeces output. Samples of daily faeces of each animal were taken and oven dried at 65 ^{o}C for 24 hours, then ground and stored in plastic bags until the end of the trial. The composite samples of feed offered and faeces output were chemically analyzed according to A.O.A.C.(1999) for crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE) and ash. Metabolizable energy values of the basal diet was calculated according to the equation of Kalogen (1985) as follows:

ME (Kcal/kg diet DM) = (0.588+0.164x) 239.

Where, x is a dry matter digestion coefficient of the basal diet. The total digestible nutrient (TDN) value of the diet was calculated as the sum of

multiplying the digestible ether extract (EE) by the factor 2.25 and multiplying each of digestible crude protein, crude fiber and nitrogen free extract (NFE) by the factor 1.0. Gas-liquid chromatography (GLC) was used for identification and identification of fatty acids composition of rocket and onion oils in the Laboratory of Department of Natural Products Chemistry, National Research Center, Faculty of Agriculture Kafr El-Sheikh, Kafr El-Sheikh University, Egypt.

Blood samples were taken from four female rabbits at the end of experimental period from each treatment to study the influence of experimental diets on some blood constituents. Blood samples were individually taken from ear vein of each female rabbit into dry glass tube (5 ml). Blood serum was separated by centrifugation at 3000 r.p.m. for 15 minutes. Serum was separated in plastic vials and stored frozen at -20 ^{o}C until the biochemical analysis. Stored serum samples were analyzed for total protein, albumin, cholesterol, triglycerides and HDL using the suitable commercial chemical kits. Globulins were estimated by subtraction of albumin value from total protein value of each sample.

Semen was collected from each buck rabbit, one week after natural mating of the females (which were a subject of a similar study), twice a week for three times by means of an artificial vagina using a female teaser rabbit. At each semen collection (n=5 for each buck), ejaculate volume (ml), sperm-cell concentration (x10^{6} /ml), percentage of sperm motility, percentage of dead and abnormal spermatozoa were determined according to Smyth and Gordan (1967).

Data were subjected to one-way analysis of variance applying SAS program (SAS, 2003) using General Linear Model Procedures (GLMP). Significant differences among treatment means were separated using Duncan's multiple range procedure (Duncan, 1955).

RESULTS AND DISCUSSION

Fatty acids composition of onion and rocket oils:

Results presented in Table (2) showed that the percentages of total unsaturated fatty acids, especially polyunsaturated fatty acids (linoleic) in onion oil were higher than in rocket oil.

However, the percentage of fatty acids with C22:1 Erucic acid was higher in rocket oil than in onion oil. These results indicate that either onion oil or rocket oil are good sources for the essential fatty acids in rabbit diets. Also, the experimental diets containing onion and rocket oils gave the satisfied contents of monounsaturated fatty acids (MUSFAs) and polyunsaturated fatty acids (PUFAs).

Does performance traits:

Body weight and gain of does at the first mating and at the end of experimental period as affected by feeding diet supplemented with rocket and

Table 2: Fatty acid composition of onion oil and rocket oil.

Type of fatty acids	Carbon atoms	Onion oil	Rocket oil
Saturated fatty acids (%):			
Myrstic	14:0	0.08	0.24
Palmatic	16:0	6.75	4.83
Stearic	18:0	2.10	0.62
Arochidic	20:0	0.30	21.56
Behenic	22:0	0.17	0.52
Total saturated fatty acids (TSFA)		9.40	27.77
Unsaturated fatty acids (%):			
Palmitoleic	16:1	0.20	0.39
Oleic	18:1	24.40	13.19
Linoleic	18:2	64.60	11.21
Linolenic	18:3	0.20	0.35
Eicosaenoic	20:1	0.40	0.52
Erucic	22:1	0.80	46.57
Total unsaturated fatty acids (TUSFAs), %		90.60	72.23
Monounsaturated fatty acids (MUSFAs), %		25.80	60.67
Polyunsaturated fatty acids (PUSFAs), %		64.80	11.56
Total fatty acids (TFAs), %		**100**	**100**

onion oils or mixture of these oils are presented in Table 3. Results showed that, NZW rabbits does received diet with rocket oil recorded the highest ($P<0.05$) values of final body weight and gain as compared to the control group. These results are in agreement with those reported by El-Tohamy and El-Kady(2007), who found that live body weight and daily weight gain of rabbits significantly increased by feeding diet containing 50% rocket seed meal of dietary CP supplied by soybean meal in control diet. Also, Zeweil *et al.* (2009) found that feeding rabbits on diet contained 10.5% rocket seed meal (RSM) during the whole experimental period resulted in significant ($P<0.01$) improvement in total weight gain by 15.1% as compared to the control (1042 vs.905 g), Moreover, addition of water-cress up to 3% in rabbit diets significantly ($P<0.01$) improved body weight gain (Soad Ahmed *et al*., 2005). This may be due to that rocket seeds contain health promoting agents, including carotenoids, vitamin C, fibers, glucoerucin and flavonoids (Barillari *et al*., 2005). The major constituent of rocket seed volatile oil is isothiocyanates, which has antioxidant, antimicrobial and anticarcinogenic activities (Badee *et al.*, 2003; Barillari *et al.*, 2005 and Haristory *et al*., 2005). In general, rocket (*Eruca sativa*) is one of the medicinal plants known as on a phrodisiac (Zohara *et al*., 1998).

Table (3) show also that conception rate, number of parturition as well as, litter size, litter weight and litter weight gain at birth and weaning were significantly ($P<0.01$) the highest for does fed rocket oil as compared with other

groups. The observed improvement in reproductive performance in terms of conception rate and litter size at birth of does fed rocket oil diet may be attributed to the higher content of TSFA in rocket, which improved reproductive performance of does than those fed the other experimental diets (Table 2). In addition, improving litter weight at weaning produced from the same does may be due to the increase of doe milk yield (Table 5). Furthermore, does fed rocket oil diet showed significantly ($P<0.05$) the highest digestibility coefficients of CP and consequently the highest DCP content. These results are in agreement with those reported by Bassuny (1999) who found marked increase in conception rate, litter size, litter weight and gain of bunnies at birth, 21 and 28 days with the increase of DE and CP contents in the diet. Similar results were obtained by Struklec and Kermiouner (1995).

Results in Table (3) revealed that average weekly or total feed consumption during different weeks of the suckling period was significantly ($P<0.05$) the highest for does fed rocket diet and the lowest for groups fed onion oil and control diets. Similar results were observed by Ibrahim (2005) when the basal diet of rabbits was supplemented with 1% rocket seeds. Moreover, Magda El-Tohamy *et al.* (2010) declared that daily feed intake for rabbits showed a significant ($P<0.01$) variation and rocket diet revealed an increment by 10.9% compared to control diet. Increasing feed consumption of rocket oil diet may be due to its beneficial effect for stimulating and activating the digestive system by improving the diet palatability and enhancing appetite. Radish rocket and mixed meals gave the best feed conversion values that may be attributed to the properties of these materials that act not only as antibacterial, antiprotozoal and antifungal but also as antioxidant (Bardley, 1992).

Digestibility coefficients and nutritive values:

Data in Table (4) cleared that only digestibility coefficient of CP and EE was affected significantly ($P<0.05$) by dietary addition, being the highest for rocket diet, followed by rocket plus onion diet. However, digesion of DM, OM, CF and NFE was not affected significantly by dietary addition. Also, inclusion of rocket oil or combination with onion oil in the diets of rabbits significantly ($P<0.05$) improved the nutritive value expressed as DCP compared with the other treatments and control diet. These results are in harmony with those of Soliman *et al.* (2006), who reported that feeding of rocket seed meal diet had no adverse effect on digestibility coefficient and nutritive values. Also, Bassuny (1999) noticed significant ($P<0.05$) increase in EE and NFE, nutritive values (TDN and DCP) with the increase of DE and CP contents in the diet. Soad Ahmed *et al.* (2005) showed that addition of water-cress up to 3% in rabbit diets significantly ($P<0.01$) improved apparent digestibility coefficients of most nutrients.

Table 3. Productive and reproductive performance of NZW doe rabbits fed diet supplemented with oil of rocket, onion or combination of them.

Items	Dietary groups			
	Control	Rocket oil	Onion oil	Rocket oil+ onion oil
No. of does	8	8	8	8
Initial weight, g	2990.0±17.42	2963.75±21.21	2985±18.66	2982±19.43
Final weight, g	3701.25±17.4^{b}	3793.75±18.1^{a}	3726±19.7^{b}	3751±20.2^{ab}
Weight gain of doe, g	711.25±28.56^{b}	830.00±21.0^{a}	741.3±29.5^{b}	768.8±29.1^{ab}
Conception rate, %	75.37±0.55^{c}	79.52±0.53^{a}	77.72±0.56^{b}	78.78±0.46^{ab}
No. of parturitions /doe	3.57±0.08^{c}	4.14±0.04^{a}	3.73±0.08^{bc}	3.94±0.08^{ab}
Litter size at birth	7.57±0.12^{c}	8.54±0.12^{a}	7.95±0.12^{b}	8.15±0.12^{b}
at weaning	7.11±0.06^{c}	8.07±0.05^{a}	7.74±0.05^{b}	7.88±0.05^{b}
Litter weight at birth, g	416.90±4.56^{c}	475.74±6.15^{a}	438.72±5.70^{b}	453.06±4.10^{b}
at weaning, g	5837.53±50.8^{d}	6991.40±51.5^{a}	6769.15±54.0^{b}	6594.07±52.1^{c}
Litter weight gain (g)	5420.62±54.2^{d}	6515.66±52.7^{a}	6330.43±54.8^{b}	6141.01±55.3^{c}
Weekly feed intake (g)/doe				
1st wk of lactation	263.75±2.29^{ab}	268.88±2.22^{a}	257.88±2.26^{b}	266.13±2.21^{a}
2nd wk of lactation	310.13±1.60^{c}	322.25±1.22^{a}	300.13±1.60^{d}	315.13±1.60^{ab}
3rd wk of lactation	351.25±3.13^{b}	368.25±3.13^{a}	335.38±3.12^{c}	347.88±3.38^{b}
4th wk of lactation	436.50±2.93^{ab}	441.13±2.94^{a}	429.50±2.93^{b}	430.50±3.46^{b}
Total feed intake (g) during lactation period	9531.38±42.2^{b}	9803.50±44.0^{a}	9260.13±41.6^{c}	9517.38±41.6

Means having different letters within the same row are differ significantly (P<0.05).

Table 4: Digestion coefficient and nutritive values of rabbit as affected by dietary addition of rocket and onion oils or their combination of them.

Items	Dietary groups			
	Control	Rocket oil	Onion oil	Rocket oil+ onion oil
Digestion coefficient (%):				
DM	63.53±0.78	66.33±0.74	64.85±0.86	65.76±0.91
OM	66.23±1.15	70.26±1.09	68.05±1.13	69.25±1.18
CP	72.01±0.27^{c}	74.36±0.24^{a}	72.90±0.37^{bc}	73.48±0.34^{ab}
CF	29.95±1.04	30.51±1.02	31.21±1.01	29.79±1.11
EE	74.95±0.76^{c}	78.89±0.87^{a}	76.12±0.61^{bc}	77.81±0.79^{ab}
NFE	71.39±0.58	72.17±0.60	72.89±0.63	71.82±0.64
Nutritive values (%):				
TDN	65.95±0.34	67.30±0.47	67.40±0.54	66.77±0.63
DCP	13.36±0.05^{c}	13.79±0.04^{a}	13.52±0.07^{bc}	13.63±0.06^{ab}
DE	2921.58±14.9	2981.40±20.9	2985.62±24.0	2957.80±27.8

Means having different letters within the same row are differ significantly (P<0.05).

Milk yield of does:

The results presented in Table (5) show that the average daily milk yield during different lactation weeks or total milk yield for all the lactation weeks was significantly (P<0.05) the highest for does fed rocket oil diet, followed by does fed rocket plus onion oils, while does fed the control diet recorded the lowest milk yield. Does fed rocket oil plus onion oil diet ranked the second for milk production. Average daily milk yield (g/doe) increased during the third week of suckling by about 76.27% as compared with those at the first week.

Table 5. Milk yield (MY) NZW of does rabbits fed diet supplemented with either rocket and onion oils or combination of them.

Items	Dietary groups			
	Control	**Rocket oil**	**Onion oil (g/**	**Rocket oil+ onion oil**
Average daily milk yield/doe:				
1st	110.82±0.60[d]	120.84±0.58[a]	113.02±0.66[c]	116.77±0.63[b]
2nd	148.11±1.03[d]	160.92±1.04[a]	151.08±1.01[c]	156.38±0.93[b]
3rd	195.52±1.46[d]	212.60±1.11[a]	199.68±1.45[c]	205.59±1.42[b]
4th	117.08±0.58[c]	126.89±0.57[a]	117.95±0.63[c]	123.06±0.58[b]
Overall means (all weeks)	142.88±0.77[d]	155.31±0.73[a]	145.43±0.77[c]	150.45±0.74[b]
Total MY for weeks	4000.73±21.6[d]	4348.70±20.3[a]	4072.09±21.5[c]	4212.61±20.7[b]
Feed conversion	2.38±0.010[b]	2.25±0.014[a]	2.27±0.009[a]	2.26±0.009[a]

Means having different letters within the same row are differ significantly (P<0.05).

The increased in milk yield and total milk yield, may be due to the highest feed intake and the higher TDN and DCP of does fed rocket oil diet (Table 4). Similarly, Xiccato *et al.* (2004) reported that the milk production increase is a response to the higher live weight and feed intake capacity of multiparous does. Also, Bassuny (1999) reported that high DE and/or DCP intake stimulate milk production.

Concerning the results of feed conversion ratio to milk production, the present results in Table (5) clearly showed that rocket oil group had significantly (P<0.05) the best feed conversion, followed by rocket plus onion oils, and onion oil group alone, whereas control group had the lowest feed conversion ratio, These results were mainly related to higher milk yield rather than feed intake.

Milk composition of does:

Milk composition including percentages of fat, protein, lactose, total solids and solids not fat are presented in Table 6. Results revealed that does fed onion oil diet showed significantly (P<0.05) the highest milk contents at most lactation weeks, although does in all groups showed nearly similar trend of changes throughout the lactation weeks. The trend of change in milk fat content was in negative relationship with milk yield at the 3rd and 4th week (Goerg, 2005). The observed decrease in milk contents of does fed rocket oil diets may

Table 6. Percentage of milk contents produced by does fed diet supplemented with rocket and onion oils or combination of them.

Milk content	Weeks	Dietary groups			
		Control	Rocket oil	Onion oil	Rocket oil+ onion oil
Fat (%)	1st	8.98±0.18	9.29±0.12	9.21±0.15	8.18±1.07
	2nd	9.18±0.17^{b}	9.98±0.10^{a}	10.11±0.07^{a}	9.65±0.21^{ab}
	3rd	9.59±0.09^{c}	10.36±0.13^{b}	11.87±0.18^{a}	10.15±0.10^{b}
	4th	10.09±0.06^{d}	11.01±0.03^{b}	12.88±0.08^{a}	10.56±0.19^{c}
Protein (%)	1st	3.45±0.13^{c}	4.09±0.07^{b}	4.63±0.12^{a}	3.77±0.14^{bc}
	2nd	4.84±0.11^{b}	5.29±0.10^{a}	5.36±0.12^{a}	5.03±0.04^{ab}
	3rd	6.76±0.11^{b}	6.44±0.11^{c}	7.06±0.05^{a}	6.03±0.05^{d}
	4th	7.23±0.13	7.45±0.14	7.75±0.11	7.30±0.10
Lactose (%)	1st	0.67±0.07^{b}	0.93±0.08^{a}	0.98±0.08^{a}	0.90±0.02^{a}
	2nd	1.47±0.08^{a}	1.00±0.01^{b}	1.40±0.07^{a}	1.01±0.03^{b}
	3rd	0.96±0.03^{c}	1.10±0.01^{a}	1.11±0.01^{a}	1.02±0.01^{b}
	4th	1.01±0.01^{d}	1.41±0.01^{a}	1.19±0.01^{c}	1.26±0.01^{b}
Total solids (%)	1st	19.84±0.10	21.56±0.13	20.31±0.05	20.40±0.08
	2nd	21.71±0.11b	21.89±0.07^{b}	22.77±0.08^{a}	20.88±0.08^{c}
	3rd	23.50±0.10b	23.08±0.10^{c}	25.65±0.15^{a}	23.67±0.13^{b}
	4th	25.03±0.06b	24.66±0.13^{b}	26.71±0.42^{a}	23.89±0.08^{c}
Solids not fat (%)	1st	14.10±0.08	13.66±0.12	13.93±0.08	14.72±0.16
	2nd	15.38±0.06^{a}	14.27±0.12^{c}	15.46±0.11^{a}	14.88±0.09^{b}
	3rd	15.84±0.10^{c}	16.47±0.12^{ab}	16.78±0.12^{a}	16.14±0.11b^{c}
	4th	17.87±0.09	17.44±0.13	17.13±0.08	18.05±0.08

Means having different letters within the same row are differ significantly (P<0.05).

be related to increasing milk production as compared to those fed the other diets. Also, there was a relationship between fat and content of total solids in milk of all groups. In this respect, Pascual *et al.* (1996) reported that the highest values of DM content in milk of doe were mainly related to fat content. Increasing fat content in milk of does fed onion oil compared with rocket oil or their combination in the diet may be due to increasing percentage of poly unsaturated fatty acids (PUSFA) in onion than in rocket oils.

Bunny performance:

Data shown in Table (7) clear that average bunny weight at birth was not affected significantly by dietary additives. However, weight at weaning, weight gain and relative growth rate of bunnies were higher for treated groups than the control one, being significantly (P<0.05) the highest for bunnies produced from does fed rocket oil diet, followed by those fed rocket plus onion oils diet and onion oil only, while the control group had the lowest values. Superiority of bunnies produced from does fed rocket oil diet may be associated with increasing milk yield of these does as compared to those in the other groups. In accordance with the present results, Kowalsk (2008) showed that oil supplemented diets increased kit weight at birth, 21 days and 35 days of age (P<0.01) in the three

Table 7: Productive performance traits of bunny produced from does fed diet supplemented with rocket, onion oils or combination of them.

Items	Dietary groups			
	Control	Rocket oil	Onion oil	Rocket oil+ onion oil
Bunny weight: at birth	55.12±0.60	55.58±0.60	55.65±0.60	55.73±0.60
at weaning	821.44±2.15^{d}	875.11±2.15^{a}	837.32±2.15^{c}	866.19±2.15^{b}
Bunny weight gain	766.32±2.21^{d}	819.53±2.04^{a}	781.67±2.21^{c}	810.46±1.94^{b}
Relative growth rate	174.85±0.26^{b}	176.11±0.23^{a}	175.07±0.25^{b}	175.82±0.22^{a}
Mortality rate at birth	7.48±0.15^{a}	6.45±0.10^{b}	4.27±0.13^{d}	5.04±0.11^{c}
Pre-weaning mortality rate	10.09±0.21^{a}	8.43±0.15^{b}	5.28±0.14^{c}	7.13±0.10^{b}

Means having different letters within the same row are differ significantly (P<0.05).

reproductive cycles. Also, Bassuny (1999) reported that the increase of nutritional components contents (DE and CP) was more than 110% of NRC requirements for does under heat stress which led to improving the weight and gain of produced bunnies at birth, 21 and 28 days and post- weaning gain. However, Hoda A. Shabaan *et al.* (2006) indicated that cumn oil (medicinal herbs oil) supplemented and fed diet to rabbit does had no significant effect on litter weight at birth, 21 days and weaning.

Results in Table (7) also revealed that mortality rate at birth and during the suckling period was significantly (P<0.05) lower in bunnies of does in all treated groups as compared to the control group, being the lowest for bunnies of does fed onion oil diet, followed by those fed combination of rocket plus onion oils diet and rocket oil diet, respectively.

Such trend was mainly attributed to improving milk composition of does fed onion oil diet, in particular fat and lactose contents. The increase of nutritional components contents led to improving mortality rate (4.2, 4.0, 2.0 and 1.96%), respectively (Bassuny, 1999). Also, the observed high viability rate of bunnies of all treated does may be due to that the tested oils rich in factors beneficial to health including natural substances that promote health and ameliorate the body condition to counteract the illness. In addition, the main causes of mortality were the proliferation of conditionally pathogenic Escherichia coli, responsible for enteritis and the presence of Streptococci, which are relatively or conditionally pathogenic bacteria (Kowalsk, 2008).

Effect of experimental diets on blood biochemistry:

Protein fractions of does at the end of experimental period as affected by diets containing different types of rocket oil, onion oil or mixture of this oil under hot summer conditions are presented in Table 8. Since albumin and globulin are components of serum proteins, because albumin is synthesized in the liver, one element is used to monitor the liver function (Friedeman *et al*. 1980). NZW rabbit does received rocket plus onion oils to diets recorded the highest ($P \leq 0.05$) values of serum total protein and albumin followed by rocket oil. However, control group

Table 8. Blood biochemistry of does fed diet supplemented with rocket and onion oils or combination of them.

Items	Dietary groups			
	Control	Rocket oil	Onion oil	Rocket oil+ onion oil
Total Protein (g/dl)	5.52±0.25[b]	6.25±0.16[a]	5.90±0.20[ab]	6.34±0.22[a]
Albumen (g/dl)	2.77±0.09 [b]	3.42±0.18 [a]	3.31±0.19 [a]	3.50±0.25 [a]
Globulin (g/dl)	2.75±0.31	2.83±0.09	2.59±0.13	2.83±0.19
Cholesterol (mg/dl)	84.82±6.95 [a]	60.82±6.58 [b]	63.26±6.76 [b]	62.04±5.64 [b]
Triglycerid(mg/dl)	91.28±6.45 [a]	67.21±5.49 [b]	71.20±7.67 [b]	68.43±7.55 [b]
LDL (mg/dl)	94.57±8.67 [a]	65.90±4.34 [b]	69.82±6.19 [b]	67.13±3.59 [b]

Means having different letters within the same row are differ significantly (P<0.05)

recorded the lowest value. These results were in agreement with Hussein *et al*. (2007) who found that Garlic and onion oils improved serum total protein and albumin. In the current study, significant increase in serum total protein and albumin was observed in rocket and onion oils co-administered NZW rabbit does, that indicates the ability of these oils to stimulate the regeneration of hepatic tissue which increase protein synthesis in liver and improvement of the functional status of the liver cells.

Does received rocket oil diet recorded the lowest ($P \leq 0.05$) values of cholesterol, triglycerid and LDL followed by rocket oil plus onion oil. However, control group recorded the highest value (Table 8). These results were in agreement with Mukherjee *et al.*(2004) and Yazdanparast *et al.* (2008) intragastric administration of Nasturtium officinale (Rocket) (500 mg/kg body weight per day) to groups of hypercholesterolaemic rats for 30 days lowered their blood total cholesterol (TC), triglyceride (TG), and low density lipoprotein cholesterol (LDL-C) levels by 37, 44 and 48%, respectively. The mechanism of action was suggested by Sodimu *et al.*(1984) who indicated that garlic oil prevented an increase of cholesterol, triglyceride and total lipids by inactivation of thiol group enzymes as HMG-CoA reductase and CoASH, the rate limiting enzyme for cholesterol biosynthesis and the multi-enzyme complex for fatty acid biosynthesis.

Semen characteristics:

Results in Table (9) show that most physical semen characteristics, including sperm cell concentration, and percentages of motility and dead spermatozoa significantly (P<0.05) improved by feeding rabbit bucks on rocket oil or onion oil diets, being the best for those fed rocket oil diet. However, semen ejaculate volume and percentage of sperm abnormality were not significantly affected in buck by feed additives. Soad Ahmed *et al.* (2005) showed that using water-cress improved (P<0.01) semen ejaculate volume, sperm motility, sperm cell concentration and decreased the percentage of dead and abnormal spermatozoa compared with the control group. The author added that the tests of

Table 9. Some physical semen characteristics of buck rabbits fed diet supplemented with rocket and onion oil or combination of them.

Semen characteristics	Dietary groups			
	Control	Rocket oil	Onion oil	Rocket oil+ onion oil
Semen volume (ml)	0.76±0.04	0.90±0.04	0.85±0.04	0.89±0.04
Sperm conc. ($x10^9$/ml)	228.66±0.87^{c}	235.21±0.87^{a}	233.47±0.87^{ab}	230.81±0.87^{bc}
Sperm motility (%)	73.66±0.73^{b}	80.50±0.87^{a}	78.72±0.67^{a}	75.44±0.73^{b}
Sperm abnormality (%)	15.66±0.72	13.54±0.74	13.96±0.72	14.13±0.72
Dead spermatozoa (%)	9.48±0.64^{a}	6.24±0.23^{b}	7.43±0.64^{b}	7.77±0.64^{ab}

Means having different letters within the same row are differ significantly (P<0.05).

buck feed diets containing water-cress had more mature somniferous tubules with mature spermatocytes than those of the control bucks. El-Tohamy and El-Kady (2007) using radish, rocket and black cumin meal in adult male diets improved semen quality and gave the best results in case of reaction time, latency period, volume, motile sperm percentage, sperm concentration per ml, total sperm per ejaculate, total motile sperm and total function sperm fraction. Feeding radish or mixture meals significantly decreased free radicals production in the seminal plasma.

Economic efficiency:

Data shown in Table (10) clear that rabbits fed diet rocket oil recorded the highest net return and best economic efficiency followed by those fed onion oil and rocket oil plus onion oil diets, however control group had the lowest net return and economic efficiency.

Table 10. Economical efficiency and relative economical efficiency of rabbits fed diet supplemented with rocket and onion oil or combination of them.

Semen characteristics	Dietary groups			
	Control	Rocket oil	Onion oil	Rocket oil+ onion oil
Total FI/doe (Kg), during lactation	9.53	9.80	9.26	9.52
Price of Kg diet	1.948	1.957	1.964	1.961
Cost of FI (L.E) during lactation	18.57	19.19	18.19	18.66
LWW (Kg) doe	5.84	6.99	6.77	6.59
Selling price of Kg gain	93.44	111.84	108.32	105.44
pups/doe **	74.87	92.65	90.13	86.78
Net return (L.E)	403.3	482.8	495.6	465.0
Economical efficiency				

Price of kg live body weight was 16.0 L.E,

Price of kg rocket oil, onion oil and rocket plus onion diets were 100,170 and 135 L.E at experimental time ** at weaning (28 days).

Conclusively, from theses results it could be concluded that addition of 1 g rocket oil /kg diet was more effective than other treatments for improving productive and reproductive performance traits, digestibility coefficients and nutritive values, milk yield of NZW doe and buck rabbits under hot climate of summer season in Egypt.

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استخدام بعض الزيوت النباتية الطبية في علائق الأرانب تحت ظروف المناخ الحار

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- أجريت تجربة ذات تصميم عشوائى تام لتقييم زيت الجرجير والبصل أو خليط من هذه الزيوت في ظل ظروف مناخ الصيف فى مصر على الأداء الإنتاجي والتناسلي ، ومعاملات الهضم والقيم الغذائية، إنتاج الحليب، وبعض مكونات الدم والكفاءة الاقتصادية للأمهات الأرانب النيوزيلندي، خصائص السائل المنوي للذكور وأداء نتاج الأرنب .
- استخدم فى التجربة عدد ٤٨ أم وعدد ١٢ ذكر أرنب نيوزيلندي أبيض (٦ أشهر من العمر) متساوية تقريبا في متوسط وزن الجسم قسمت عشوائيا إلي أربع مجموعات (١٢أم ، ٣ ذكور لكل منها) تم تغذيتها علي عليقه المقارنة (المجموعة الأولي) ، عليقه مقارنة مضاف إليها ١ جرام زيت جرجير/كجم عليقه (المجموعة الثانية) ، عليقه مقارنة مضاف إليها ١ جرام زيت بصل/كجم عليقه (المجموعة الثالثة)، خليط من هذه الزيوت(المجموعة الرابعة) في ظل ظروف مناخ الصيف بداية من شهر مايو - يوليو ٢٠٠٩. احتوت عليقه التجارب علي ١٨,٥% بروتين ، ٢٤٠١ طاقة ممثلة كيلو كالوري/ كجم.
- وبينت النتائج أن مجموع النسب المئوية للأحماض الدهنية الغير مشبعة وخاصة اللينوليك في زيت البصل كان أعلى منه في زيت الجرجير.و كانت النسبة المئوية للحامض ألدهني الإيروسيك في زيت الجرجير أعلى منه في زيت البصل.
- سجلت إناث المجموعة الثانية (زيت الجرجير) اعلي قيم لوزن الجسم النهائي، وللزيادة الوزنية، ومعدل الحمل، وعدد الولادات وعدد ووزن خلفه البطن والزيادة الوزنيه عند الميلاد والفطام وللعليقه المستهلكه تحسن معنوي (علي مستوي معنوية ٠,٠٥) فقط معامل هضم البروتين الخام والدهون ومعامل هضم البروتين الخام لمجموعه زيت الجرجير.
- سجلت الإناث التي غذيت علي عليقه زيت الجرجير اعلي (علي مستوي معنوية ٠,٠٥) كميات من اللبن واعلي معدل تحويل للغذاء بالنسبة لإنتاج اللبن بينما سجلت الإناث التي غذيت علي عليقه زيت البصل اعلي محتوي حليب في معظم أسابيع الرضاعة.
- سجل اعلي (علي مستوي معنوية ٠,٠٥) وزن عند الفطام ووزن النسبي للخلفات للإناث التي غذيت علي زيت الجرجير. وكان معدل النفوق عند الولادة وخلال فتره الرضاعة للنتاج اقل للإناث التي غذيت علي زيت البصل.
- سجلت الإناث التي غذيت علي زيت الجرجير اقل قيم لكل من الكولسترول والجلسريات الثلاثية والكولسترول منخفض الكثافة ثم مجموعه زيت الجرجير مع زيت البصل بينما سجلت مجموعه المقارنة اعلي قيم لهم.
- تحسنت معظم خصائص السائل المنوي الطبيعية للذكور التي غذيت علي زيت الجرجير بما في ذلك زيادة تركيز الحيوانات المنوية الطبيعية والحركة التقدمية وانخفاض نسبة الحيوانات المنوية الميتة وانعكس ذلك على معدل خصوبة الذكور.
- سجلت الإناث التي غذيت علي زيت الجرجير اعلي عائد وزن صافي وكذلك اعلي كفاءة اقتصادية يتبعها مجموعه زيت الجرجير مع زيت البصل بينما سجلت مجموعه المقارنة اقل القيم.

التوصية: توصي الدراسة بإضافة ١ جم زيت جرجير / كجم عليقه لتحسن أداء الصفات الإنتاجية والتناسلية لاناث وذكور الارانب النيوزلندى الابيض المرباة تحت ظروف المناخ الحار فى فصل الصيف فى مصر..