

EFFECT OF DIETARY ARAK (*Salvadora persica*) AND SEASON INTERACTION ON PERFORMANCE OF PRE AND POST-SEXUAL MATURITY OF RABBIT MALES

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*The present study aimed to evaluate the interaction effects of Arak (*Salvadora persica*) as feed additive and season on performance of pre- and post-sexual maturity of rabbit males. Ninety-six weaned New Zealand White (NZW) male rabbits aged 30 days with weighing average 586.4 gm (48 in each season) were used during winter and summer seasons. Within each season, two groups were used (24 in each group); the first group fed to ad libitum with commercial rabbit pellets and kept as control group, while the second group fed the same diet supplemented with 0.2% dried Arak powder. Body weight, daily gain, daily feed intake and feed conversion were recorded from weaning up to 70 days of age. Whereas, four rabbits from each group were slaughtered and genitalia were immediately taken and dissected. Blood samples were collected at 150 days of age from five bucks from each group. At maturity age, several reproductive traits were recorded. **Results showed that** final body weight, daily weight gain, feed intake, feed conversion and weights of genital organs at 70 days of age significantly ($P \leq 0.05$) increased with dietary of Arak supplementation. Serum testosterone concentration at 150 days of age (maturity) significantly ($P \leq 0.01$) increased with Arak inclusion during winter and summer seasons. The minimum maturity age was obtained by 0.2% Arak inclusion during summer season (151 days). Sexual desire, mating activity, semen-ejaculate volume, advanced-sperm motility%, sperm-cell concentration and total-sperm output were significantly ($P \leq 0.01$) affected by Arak inclusion, season and their interactions.*

Conclusively, from these results could be concluded that the addition of 0.2% Arak (*Salvadora persica*) to growing NZW male rabbit diets till sexual maturity age under winter and summer season improved growth and reproductive capabilities.

Key words: Rabbit males, Arak (*Salvadora persica*), reproductive organs, semen quality.

The environmental and nutritional factors are the important factors, which affect the economic of intensive rabbit production, under Egyptian conditions (Marai *et al.*, 2006). In Egypt, due to the negative effects of heat stress of summer season on productive and reproductive performance, the annual breeding season of rabbits normally starts from October till May. Increasing of disease incidence, blood system impaired, mortality, fertility deterioration, reduced reproductive efficiency reduce are the most obvious sings of heat stress (Bani *et al.*, 2005 and Marai *et al.*, 2006), all of which adversely affect production economics. So that, using some natural nutrient additives were practiced to improve the productive and reproductive performances.

Several attempts have been made to improve rabbit production and reproduction using various commercial growth promoters (Ashour *et al.*, 2004 and Osman Noha, 2005). Ibrahim *et al.*, (2005), El-Kholy *et al.*, (2008 a and b) and El-Sawy *et al.*, (2014) showed that Arak can be used as an alternative growth promoter as it enhanced immune function and favored meat quality in growing rabbits.

Arak stems were obtained from the roots of *Salvadora persica*, which generally grows in the Middle East area; it has medicinal value in manifold uses and contains more than 10 different natural chemical compounds such as: fluoride, tannins, resins, alkaloids-Salvadoricine-, volatile oils -sinigrin-, sulfur, vitamin C, sodium bicarbonate, chlorides, calcium, benzy liso thiocyanate and others, including silica-salicylic acid-, sterols, trime thylamine, saponins and flavonoid (Akhtar and Ajmal, 1981 and Hattab, 1997). Five flavonoid compounds (kaempferol, quercetin, quercetrin, rutin and quercetin glucoside) were isolated from the root of this plant (Islam *et al.*, 2000). Flavonoids have antibacterial, astringent, detergent and abrasive properties (Almas and Stakiw, 2000 and Almas, 2002). Besides flavonoids, both polyphenolic compounds and certain alkaloids seem to stimulate immune function, reduce cholesterol level and play a role in the prevention of a number of chronic diseases such as cancer and cardiovascular disease in rabbits (Jeon *et al.*, 2001 and Yousef *et al.*, 2004).

Therefore, purpose of the present study was to evaluate how various reproductive traits and the pre- and post-sexual maturity of NZW rabbit males are affected by season, including Arak (*Salvadora persica*) as a dietary feed additive and their interactions.

MATERIALS AND METHODS

1- Location and seasons:

The present work was carried out in a Rabbitry near El-Hawamdia City, Giza Province, Egypt, during cold season (December to February) and hot climate (June to August).

2- Animals and feeding:

A total number of 96 weaned males (30 days) average 586.4 gm of New Zealand White rabbits (NZW) (48 in each season) were used during winter and summer seasons. Within each season, two groups were used (24 in each group). The first group was kept untreated to serve as a control, while the another group was fed the same diet supplemented with 0.2% dried Arak powder. The Arak roots of the plant were cut into small pieces and allowed to dry at room temperature for 2 days and were then ground to powder in a ball mill. Experimental rabbits were healthy and kept under the same management and hygienic conditions.

Rabbits fed *ad libitum* with commercial rabbit pellets containing 17.0% CP, 13.3% CF and 2500 kcal DE/kg diet according to NRC (1977). Chemical composition of Arak was determined in duplicate according to AOAC (2006), containing (% DM): 27.9 ash, 12.4 crude protein, 1.75 ether extract, 50.0 nitrogen free extract and 7.95 crude fiber.

3- Housing:

Weaned bunnies were housed in metal cages with diameters of 40×40×30 cm (two bunnies/cage), while adult male rabbits were housed separately in individual cages with diameters of 50×60×35cm of conventional universal galvanized wire batteries. All cages were equipped with feeding hoppers, which were made of galvanized steel sheets, and nipples for automatic drinking. The batteries were located in a well ventilated building. Averages of ambient temperature (AT, °C), relative humidity (RH %) were daily recorded, then, the temperature humidity index (THI units) was calculated using the equation proposed by Marai *et al.*, (2001) as follow:

$$THI = db \text{ } ^\circ C - [(0.31 - 0.31 \times RH \%) \times (db \text{ } ^\circ C - 14.4)]$$

Where: db °C =Dry bulb temperature in Celsius, RH%=Relative humidity percentage.

The values obtained are then classified as absence of heat stress (<27.8), moderate heat stress (27.8-28.8), severe heat stress (28.9-29.9) and very severe heat stress (≥ 30.0) as shown in Table 1.

Table 1: Averages of ambient temperature (AT, °C), relative humidity (RH %) and temperature humidity index (THI units) during experimental period

Season	Months	AT (°C)	RH (%)	THI (Units)
Winter	December	18.0 ± 0.44	71.0 ± 1.00	17.7 ± 0.43
	January	19.5 ± 0.45	72.3 ± 1.01	19.1 ± 0.44
	February	20.2 ± 0.42	71.2 ± 1.03	19.7 ± 0.44
	Average	19.2 ± 0.43	71.5 ± 1.02	18.8 ± 0.43
Summer	June	29.6 ± 0.52	69.3 ± 0.61	28.2 ± 0.57
	July	29.8 ± 0.51	71.0 ± 0.57	28.4 ± 0.56
	August	31.6 ± 0.55	68.5 ± 0.68	29.9 ± 0.55
	Average	30.3 ± 0.53	69.6 ± 0.63	28.8 ± 0.56

Measurements:

1- At 70 days of age:

Body weight (BW, g), daily body weight gain (DBWG, g) and daily feed intake (DFI, g) were recorded for each rabbit during the growing period from weaning (30 days of age) up to slaughtering commercial age (70 days of age). Feed conversion (FC) was calculated as a ratio of g feed/g gain.

Four growing rabbit males from each experimental group were randomly slaughtered (by bleeding). Genitalia were immediately taken after slaughter and dissections were performed. Weights of pituitary gland, testes, epididymis and sexual accessory glands were recorded. Their relative weights were expressed with respect to live body weight, as described by (Meshreky Samia *et al.*, 2005).

2- Blood parameters:

2-1- At slaughter test:

Blood samples of growing rabbits were collected into dry clean centrifuge tubes during slaughter. Serum was separated by centrifugation at 3000 r.p.m. for 20 minutes and kept in a deep freezer at -20 °C until biochemical analysis. Total protein (TP, g/dl); albumin (Alb, g/dl) were determined and globulin (Glob, g/dl) was obtained by subtracting the values of albumin from the corresponding values of total protein. The activities of

alanine aminotransferase (ALT, U/l) and aspartate aminotransferase (AST, U/l) were estimated.

2-2- At puberty and sexual maturity:

At 150 days of age three ml of blood samples were collected between 08.00 and 09.00 am from the marginal ear vein of five bucks from each group. Serum was separated by centrifugation at 3000 r.p.m. for 20 min and kept at -20 °C until hormonal assay. Serum testosterone (T) (ng/ml) hormone concentration of the rabbit males was determined using RIA kits (Immunotech, A Coulter Co., Czech Republic) in accordance with the manufacturer's information. The minimum detectable limit was 0.20 ng/ml and inter-&-intra-assay coefficients of variation for T assay were 10.8 and 5%, respectively. All samples were run in duplicate and assayed by the same operator, which was blind to the experimental situation.

3- At sexual maturity:

At sexual maturity (6 months), the body weight and age of fifteen rabbit bucks from each group were recorded. Scrotal circumference (n = 15 rabbits per group) was measured by the method described by Boiti *et al.*, (2005). Testicular index (length × width × depth) (n = 15 rabbits per group) was calculated in cubic centimeters as recorded by Castellini *et al.*, (2006).

4- Semen quality:

Semen was artificially collected twice a week from ten bucks at 6 months of age for four weeks from each group by an artificial vagina as described by Boiti *et al.*, (2005). Immediately after collection, semen ejaculate volume (ml), advanced sperm motility%, live spermatozoa%, morphological normal spermatozoa%, acrosomal damages%, sperm-cell concentration ($N \times 10^6$ /ml) and total-sperm output ($N \times 10^6$ /ejaculate) were estimated according to Boiti *et al.*, (2005) and Castellini *et al.*, (2006). Libido (sexual desire) was assessed in terms of reaction time in seconds estimated from the time of introducing doe to the buck until the buck started to mount (Castellini *et al.*, 2006). Mating activity (frequency of mating within 15 minutes) of ten bucks was determined using sexually receptive does.

Statistical analysis:

Data of the experiment was statistically analyzed according to SPSS (2012) computer program using the following fixed model:-

$$Y_{ijk} = \mu + S_i + T_j + ST_{ij} + e_{ijk},$$

Where: Y_{ijk} =An observation, μ =The overall mean, common element to all observations; S_i =The fixed effect of the season (i=1&2); T_j =The fixed effect

of treatment ($j=1&2$); ST_{ij} = The interaction effect ($ij=1,2,3,4$); e_{ijk} = Random error component assumed to be normally distributed.

Data presented as percentages were transformed to the corresponding arcsine values (Warren and Gregory, 2005) before being statistically analyzed. The differences among means were tested using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Climatic conditions:

Averages of AT, RH% and THI units during the whole experimental period are shown in Table 1. The THI values clearly indicated an absence of heat stress conditions (less than 27.8) during winter season. While during summer season rabbits were exposed to moderate heat stress (28.8). It was suggested that the optimal temperature humidity index for the rabbit husbandry is 27.8 (Marai *et al.*, 2001).

Productive and reproductive performances:

1- Growth performance:

1-1. Effect of season:

Results in Table 2 showed significant differences ($P \leq 0.05$) between season groups in body weight, body weight gain (DBWG) and feed efficiency of weaned NZW rabbits. Elevating THI, during summer season significantly ($P \leq 0.05$) decreased growth performance traits and feed efficiency of growing NZW rabbits. These results agreed with those of Ondruska *et al.*, (2011) and El-Sawy *et al.*, (2014). On the other hand, Daader *et al.*, (1999) reported that difference in BWG between winter and summer was not significant. However, feed intake decreased by 40-50% at 30-32 °C (Rafai and Papp, 1984 and Wittorf *et al.*, 1988) and by 30% in summer than in winter (Marai *et al.*, 1994) and in hot (>32 °C) conditions (Hermes *et al.*, 1999). The reduction of DFI under summer hot conditions in the present study may be due to that the high ambient temperature stimulates the thermal receptors center in the hypothalamus causing a decrease in feed intake as mentioned by Marai *et al.*, (1994 and 2006). In contrast, the increased feed intake during winter may be due to the appetite increase of rabbits (Ashour *et al.*, 2005). Exposure to high ambient temperature pushes rabbits to balance the excessive heat load by using different means to dissipate, as much as possible, their latent heat. If such means fail, rabbits use strategies that include: depression in feed intake (Okab *et al.*, 2008). The reduction in BWG during summer season was due

to a drastic decrease in rabbit FI and FC as compared with winter season, which might have led to less protein biosynthesis and less fat deposition (Okab *et al.*, 2008 and Ogunjimi *et al.*, 2008). In addition, Bahga *et al.*, (2010) showed that heat stress leads to decreased performance of growing rabbits in terms of decreased growth rate and FI.

1-2. Effect of Arak treatment:

Data presented in Table 2 showed that, FBW, DBWG at 70 days, and feed conversion values of growing NZW rabbits fed diet supplemented with 0.2% Arak were significantly ($P \leq 0.05$) higher during winter and summer season as compared with control groups while, no effect was detected on DFI. These results are similar to that reported by Ibrahim *et al.*, (2005); El-Kholy *et al.*, (2008a) and El-Sawy *et al.*, (2014).

Table 2: Effect of Arak (*Salvadora persica*), season and their interaction inclusion on some growth performance traits of NZW rabbit males from 30 to 70 days of age

Factors	Parameters ¹				
	IBW	FBW	DBWG	DFI	FC
Season effect	*	**	**	*	*
Winter (W)	606.34 ±10.22	1722.15 ±17.71	27.90 ±1.09	92.47 ±2.53	3.32 ±0.09
Summer (S)	590.95 ±11.75	1552.99 ±22.92	24.05 ±1.30	85.31 ±2.86	3.55 ±0.09
Arak treatment effect	NS	**	*	NS	**
Control (C)	599.79 ±11.21	1603.43 ±18.04	25.09 ±1.16	87.41 ±2.74	3.48 ±0.09
Treatment (T)	597.50 ±11.26	1671.71 ±20.60	26.86 ±1.27	90.37 ±2.77	3.37 ±0.09
Interaction effects	NS	**	**	NS	**
W × C	607.63 ±17.03	1677.65 ^{ab} ±19.97	26.75 ^b ±1.40	90.26 ±3.53	3.37 ^{bc} ±0.01
W × T	605.04 ±11.70	1766.65 ^a ±22.82	29.04 ^a ±1.62	94.68 ±3.67	3.26 ^c ±0.01
S × C	591.94 ±14.26	1529.21 ^c ±19.66	23.43 ^d ±1.68	84.56 ±4.01	3.61 ^a ±0.01
S × T	589.95 ±19.00	1576.77 ^b ±31.57	24.67 ^c ±1.89	86.06 ±4.16	3.49 ^{ab} ±0.01

¹IBW: Initial body weight; FBW: Final body weight; BWG: Daily weight gain; FI: Daily feed intake; and FC: Feed conversion

a,b,c Means with different letters within the same section and column differ significantly.

NS= Not Significant; * = $P \leq 0.05$; ** = $P \leq 0.01$.

The significant ($P \leq 0.05$) increase in DBWG for rabbits received Arak at 0.2% level could be due to the better absorption of protein (Ibrahim *et al.*, 2005), bactericidal, antimycotic or antifungal properties of Arak as reported by Al-Samh and Al-Bagieh (1996). Also, vitamin C, which is presence in Arak, has important role in various metabolic processes in the body via its regulation effect on thyroid and adrenal glands functions (McDowell, 2000). This fact can explain the increase in LBW of treated groups. Beside that, sodium bicarbonate showing growth promoting response in most instances when included in diets of rabbits (Al-Shanti, 2003). On the other hand, the minerals content in Arak (calcium, fluorine, and sulphur) can form structural components of body organs and tissues (Suttle, 2010).

1-3. Effect of interactions:

Interactions between season and Arak supplementation effects were significant ($P \leq 0.01$) on FBW, DBWG and FC of NZW rabbits (Table 2). The magnitude of improvement was the highest with Arak treatment in winter. At the same time, there were a negative interaction effects of the Arak treatment on the DFI in the two seasons. It is interesting to observe the insignificant differences in FBW between treated rabbits under summer season (S×T) and those untreated under winter season (W×C). Beside that, Arak addition for rabbits reared, during summer season (S×T) recorded insignificant differences in FC compared to those received the same treatment, under winter season (W×T). The same pattern of these results was observed by El-Sawy *et al.*, (2014). So, dietary addition of heat-stressed growing rabbits with 0.2% Arak restored the loss pertaining to heat stress and surpassed the winter control in DBWG, FC and FBW.

2. Blood biochemical traits:

2-1. Effect of season:

Blood biochemical parameters (within normal range) such as serum TP, Alb, Glob, ALT and AST were significantly ($P \leq 0.05$) higher in winter season than in summer one (Table 3). These changes in the blood biochemical parameters due to season effect was similar to that of Abdel-Monem *et al.*, (2013) and El-Sawy *et al.*, (2014) who found that blood biochemical traits were significantly lower ($P \leq 0.01$) in rabbits exposed to heat stress in summer season as compared to those reared in winter one.

The decrease in serum TP for weaned NZW rabbits in summer season group may be due to the decrease in DFI (as mentioned before) and dilution of serum proteins or both (Ondruska *et al.*, 2011). They add that, the decrease in the protein synthesis can be due to a depression of anabolic hormonal

Table 3: Effect of Arak (*Salvadora persica*), season and their interactions on some blood metabolites of NZW rabbit males at 70 day of age

Factors	Parameters				
	Total protein (TP,g/dl)	Albumin (Alb, g/dl)	Globulin (Glob, g/dl)	ALT (U/l)	AST (U/l)
<i>Season effect</i>	*	*	*	*	*
Winter(W)	7.81 ±0.50	5.25 ±0.42	2.56 ±0.13	16.43 ±0.64	25.30 ±1.73
Summer (S)	6.32 ±0.28	4.15 ±0.24	2.17 ±0.09	14.16 ±0.78	22.36 ±1.15
<i>Arak treatment effect</i>	*	*	*	*	*
Control (C)	6.60 ±0.31	4.36 ±0.25	2.25 ±0.12	14.25 ±0.80	21.49 ±1.57
Treatment (T)	7.53 ±0.48	5.05 ±0.41	2.48 ±0.11	16.33 ±0.62	26.18 ±1.31
<i>Interaction effects</i>	**	**	*	*	*
W × C	7.70 ^a ±0.45	5.20 ^a ±0.35	2.50 ^a ±0.18	15.90 ^a ±0.96	24.85 ^a ±2.59
W × T	7.92 ^a ±0.90	5.30 ^a ±0.77	2.62 ^a ±0.18	16.95 ^a ±0.85	25.75 ^a ±2.37
S × C	5.50 ^c ±0.27	3.51 ^c ±0.19	1.99 ^b ±0.14	12.60 ^b ±1.19	18.12 ^b ±1.47
S × T	7.13 ^b ±0.35	4.79 ^b ±0.31	2.34 ^{ab} ±0.13	15.71 ^a ±0.91	26.60 ^a ±1.17

a, b, c Means bearing different letters in the same column significantly differed within each factors ($P \leq 0.05$). NS= Not Significant; * = $P \leq 0.05$; ** = $P \leq 0.01$.

secretion such as growth hormone, thyroxin and insulin. In addition, Amici and Merendino (1996) showed that the decrease of TP has to be considered as an important biological indicator of deficiency in activity of the immune system function in heat stressed rabbits.

Serum ALT and AST means were significantly higher during winter than summer that may be related with feed intake, which has the same trend. The more feed intake provides the body with more amino acids by protein digestion. This result came in harmony with El-Maghawry *et al.*, (2000) who found that ALT and AST are dependent on alanine and glutamine taken by the liver and reflect metabolism changes in liver which associated with glucose synthesis.

2-2. Effect of Arak treatment:

The effect of treatment with Arak during winter and summer on some blood parameters were presented in Table 3. The data showed that treatment with Arak significantly ($P \leq 0.05$) increased serum TP and its fractions (Alb and Glob) and liver enzymes of ALT and AST as obtained by Ibrahim *et al.*, (2005) and El-Kholy *et al.*, (2008b). Arak (*Salvadora persica*) includes some immunity stimulators such as flavenoids, polyphenolic compounds and certain alkaloids (Fortun-Lamothe and Drouet-Viard, 2002). The important biochemical indices that can be used to assess the health status of the liver are the serum levels of alb and glob. Albumin, which was manufactured by the liver, is a major protein that circulates in the blood stream (Tietz, 1986). Increasing serum TP and their fractions (Alb and Glob) within the normal range may reflect an increase in the hepatic function (El-Harairy *et al.*, 2003). This phenomenon was observed in treated groups as compared to control group. As mentioned before, Arak increased the levels of ALT and AST but both increases were still within the normal ranges as indicated by the non-sign of toxicity. In addition, the increased values of blood biochemical traits in the treated groups as mentioned later, may be the reason of increased growth performance, whereas, Al-Eissa (2011) showed that biochemical parameters could be used to assess the metabolic condition of rabbits.

2-3. Effect of interactions:

It is evident from Table 3 that each of TP, Alb, Glob, ALT and AST significantly ($P \leq 0.01$ and $P \leq 0.05$) affected by season \times treatment interaction and the highest estimates were by W \times T and the lowest ones were by S \times C. These results were in a good agreement with those of Ibrahim *et al.*, (2005) and El-Kholy *et al.*, (2008a). The increase in globulin concentration with Arak inclusion in the heat stressed rabbit's diet as observed in the present study may be an indication of increased immunity in the rabbits since the liver will be able to synthesize enough globulins for immunologic action as mentioned by Sunmonu and Oloyede (2007). Increase of glob concentration than alb is important for immunologic responses (Tietz, 1986).

3. Genitalia traits at 70 days of age:

3-1. Effect of season:

Table 4 revealed that, season had high significant effect ($P \leq 0.01$) on FBW and all internal genitalia organs weight, except that insignificant effect on REW. Where, all those means were higher in winter than summer. These the increase in growth performance. Therefore, pre-slaughter weight is

Table 4: Effect of Arak (*Salvadora persica*), season, and their interaction on body and internal genitalia organs weights of NZW rabbit males at 70 days of age

Factors	Parameters ¹								
	FBW	TW g	RTW %	EW g	REW %	SGW g	RSGW %	PGW g	RPGW %
<i>Season</i>	*	*	*	*	NS	*	*	*	*
Winter (W)	1703.63 ±22.25	5.60 ±0.19	0.329 ±0.01	1.02 ±0.16	0.06 ±0.04	3.48 ±0.18	0.204 ±0.04	3.24 ±0.13	0.199 ±0.07
Summer (S)	1553.13 ±37.41	4.40 ±0.37	0.282 ±0.02	0.79 ±0.15	0.05 ±0.07	2.86 ±0.22	0.184 ±0.06	2.89 ±0.24	0.173 ±0.08
<i>Treatment:</i>	*	*	*	*	*	*	*	**	*
Control (C)	1591.75 ±69.17	447 ±0.47	0.279 ±0.02	0.82 ±0.09	0.05 ±0.04	2.98 ±0.20	0.187 ±0.06	2.99 ±0.21	0.175 ±0.08
Treatment (T)	1665.00 ±47.44	5.52 ±0.24	0.332 ±0.06	0.99 ±0.10	0.6 ±0.05	3.36 ±0.07	0.202 ±0.04	3.13 ±0.10	0.197 ±0.06
<i>Interactions</i>	**	**	**	*	NS	**	*	**	*
W × C	1672.25 ^a ±40.61	5.35 ^a ±0.32	0.320 ^a ±0.02	0.92 ^a ±0.07	0.06 ±0.05	3.33 ^b ±0.11	0.199 ±0.05	3.16 ^{ab} ±0.17	0.189 ^{ab} ±0.01
W × T	1735.00 ^a ±22.25	5.85 ^a ±0.22	0.337 ^a ±0.09	1.11 ^a ±0.09	0.06 ±0.05	3.63 ^b ±0.11	0.209 ^a ±0.05	3.31 ^a ±0.10	0.208 ^a ±0.07
S × C	1511.25 ^b ±50.84	3.60 ^b ±0.15	0.238 ^b ±0.01	0.73 ^b ±0.11	0.05 ±0.07	2.63 ^a ±0.21	0.174 ^b ±0.09	2.82 ^b ±0.16	0.160 ^b ±0.08
S × T	1595.00 ^{ab} ±28.94	5.20 ^a ±0.20	0.326 ^a ±0.06	0.86 ^a ±0.29	0.05 ±0.01	3.09 ^b ±0.10	0.194 ^{ab} ±0.07	2.95 ^{ab} ±0.15	0.185 ^b ±0.09

FBW: Final body weight; TW: Testes weight (g); RTW: Relative testes weight; EW: Epididymis weight (g); REW: Relative epididymis weight; SGW: Sexual-accessory glands weight (g); RSGW: Relative sexual-accessory glands weight; PGW: Pituitary gland weight (g); RPGW: Relative pituitary gland weight.

a,b,c Means bearing different letters in the same column significantly differed within each factors ($P \leq 0.05$). NS= Not Significant; * = $P \leq 0.05$; ** = $P \leq 0.01$.

findings are in agreement with Meshreky Samia *et al.*, (2005). These might be due to reduced testosterone levels (Table 5) or feed consumption and deterioration of DBWG (Table 2) resulted in stressful hot conditions during summer season.

3-2. Effect of Arak treatment:

Table 4 showed that values of relative weights of testes, epididymis and sexual-accessory gland weight increased significant ($P \leq 0.05$) with dietary Arak inclusion. These results were similar to those observed in mice where the inclusion of 800 mg/kg of an extract of *Salvadora persica* (Arak) increased the relative weight of the testes (Darmani, 2003). The increase in internal genitalia organs weights for treated group may be mainly related to

considered to be one of the most important factors affecting on internal genitalia organs weight in rabbits.

3-3. Effect of interactions:

Concerning, season and dietary of Arak supplementation interactions, it is clear that treated rabbits with Arak led to insignificant differences between both of seasons for each values of relative weights of testes, sexual-accessory glands and pituitary gland (Table 4). Moreover, these values did not differ than that of (W×C) group. This result is another evidence of the privilege of Arak during summer season than the winter season.

4. Reproductive performance at maturity:

4-1. Effect of season:

Results in Table 5 showed significant differences ($P \leq 0.05$) among season groups for weight and age at maturity, testicular index and testosterone concentration at 150 days of age for male NZW rabbits. These results agreed with those of Meshreky Samia *et al.*, (2005). The adverse effect of summer season on late of age at maturity, testicular index and testosterone concentration may be related to decrease on relative of testes weight for rabbits reared under summer season. El-Sobhy (2000) found that the testes of heat exposed animal's revealed significant focal degeneration in both seminiferous tubules and interstitial cells. However, Katongola *et al.*, (1974) reported that decline in testosterone level during summer season causing disorders in accessory glands secretion and spermatogenesis. In addition, Jegou *et al.*, (1984) mentioned that the reduction in testosterone level during summer season resulted from reduction in the ability of leydig and sertoli cells responding to luteinizing hormone.

4-2. Effect of Arak treatment:

The early maturity age was recorded with Arak groups either in winter or in summer seasons (Table 5). This result could be related to the maximum final body weight obtained with Arak dietary and also to the improving effect of Arak on testosterone concentration that leads to faster maturity. The early of age at maturity observed in the present results were similar to that observed in previous studies in rabbits with either other growth promoters (Amin *et al.*, 2002 and Marai *et al.*, 2006) or Arak supplementation (El-Kholy *et al.*, 2008a). Similar results were obtained by Meshreky Samia *et al.*, (2005), who found that age at maturity was related to testosterone concentration.

Table 5. Effect of Arak (*Salvadora persica*), season and their interaction on some reproductive traits of NZW rabbit bucks at 150 days of age

Factors	Parameters				
	Weight at maturity (g)	Age at maturity (day)	Scrotal circumference, (cm)	Testicular index (cm ³)	Testosterone, ng/mL
Season	*	*	NS	**	*
Winter (W)	2802.47 ±14.28	153.37 ±0.87	7.18 ±0.06	5.99 ±0.13	4.48 ±0.26
Summer (S)	2715.50 ±40.11	162.87 ±4.01	7.07 ±0.07	5.28 ±0.22	3.61 ±0.32
Treatment:	*	**	*	**	**
Control (C)	2717.20 ±40.05	164.27 ±3.86	7.02 ±0.05	21.48 ±1.57	3.40 ±0.26
Treatment (T)	2800.77 ±14.79	151.97 ±0.92	7.23 ±0.07	26.18 ±1.31	4.68 ±0.30
Interactions	*	**	NS	**	**
W × C	2774.60 ^{ab} ±18.87	154.53 ^b ±1.08	7.10 ±0.07	5.74 ^b ±0.16	4.15 ^b ±0.32
W × T	2830.33 ^b ±19.43	152.20 ^b ±1.34	7.25 ±0.09	6.25 ^b ±0.17	4.80 ^b ±0.40
S × C	2659.80 ^a ±76.28	168.63 ^a ±6.87	6.93 ±0.07	4.46 ^a ±0.19	2.66 ^a ±0.35
S × T	2771.20 ^{ab} ±20.11	157.10 ^b ±1.30	7.20 ±0.11	6.09 ^b ±0.17	4.55 ^b ±0.46

a,b,c Means bearing different letters in the same column significantly differed within each factors ($P \leq 0.05$).

NS= Not Significant; * = $P \leq 0.05$; ** = $P \leq 0.01$.

The increase in serum testosterone concentration in treated groups can be attributed mainly to the increase in sexual accessory gland activity with dietary Arak inclusion (El-Kholy, 2008a). This can affect the secretion of testosterone from the interstitial tissues of the testes (Al-Sobayil and Khalil, 2002). Also, Castro *et al.*, (2002) mentioned that testosterone is needed to initiate spermatogenesis at puberty and for the maintenance of this process in the adult. El-Sherbiny (1994) found that the onset of puberty involves the appearance of the first spermatozoa in the caudal epididymis of rabbit males. Moreover, the testicular index significantly increased ($P \leq 0.05$) in treated group as compared to control one (Table 5), obtaining a maximum value at winter season. Testicular size is the best primary assessment of spermatogenesis, since the tubules and germinal elements account for approximately 98% of the testicular mass (Sherines and Howards, 1978). The testicular index also reflects spermatogenesis and testosterone

production (El-Mougy *et al.*, 1991). Arak inclusion had a significant effect on scrotal circumference (Table 5).

4-3. Effect of interactions:

The interaction effects between season and treatment groups were significant on weight and age at maturity, testicular index and testosterone concentration, while it was insignificant on scrotal circumference (Table 5). It was also observed that the insignificant differences were found among (W×C), (W×T) and (S×T) groups for weight and age at maturity and testicular index. These results could be a reflection of testosterone concentration, which had the same trend. So, this is sufficient to prove that Arak addition was more efficient and beneficial under the Egyptian summer condition.

5. Libido, mating activity and physical semen quality:

5-1. Effect of season:

It is evident from Table 6 that the libido, mating activity and the physical semen quality of NZW rabbit bucks during the winter season were highly significant ($P \leq 0.01$) better than those observed in the summer season. These results agree with the findings of Safaa *et al.*, (2008) and Lavara *et al.*, (2013). It was established that semen volume increased and motility indexes decreased during summer (Roca *et al.*, 2005). Also, Finzi *et al.*, (1995) reported that the daily exposure of rabbits in a climatic chamber to high ambient temperature (30 °C) and humidity (70%) for 21 hr over a 60 days period increased the number of abnormal spermatozoa. Male rabbits are extremely sensitive to heat stress therefore a rise in testicular temperature in rabbits leads to reduced spermatogenesis; temporary sterility; decreased sexual desire, ejaculate volume, motility, sperm concentration, and total number of spermatozoa in an ejaculate; and increased sperm abnormalities and dead sperm (Marai *et al.*, 2001).

5-2. Effect of Arak treatment:

As regard to Table 6 the treatment effects were significant ($P \leq 0.01$) on all studied traits where the lowest values were for libido and acrosomal damage while the highest values were for mating activity, semen-ejaculate volume, advanced-sperm motility, live spermatozoa, morphological normal spermatozoa, sperm-cell concentration and total-sperm output, respectively. These increases are close to those obtained by El-Kholy *et al.*, (2008a).

The increase in sexual accessory gland weight in treated rabbits (Table 4) suggests that an increase in ejaculate volume occurred, since the accessory glands and spermatogenesis are controlled by the testosterone concentration, which was higher in treated rabbits. The observed effects on sperm concentrations and motility in the present trial are in agreement with those of Fields *et al.*, (1979), who observed that sperm concentration was positively correlated with motility and testicular size in young bulls. The decrease in acrosomal damage in the treated groups could be attributed to the antioxidant activity of Arak due to flavonoids, which can protect the plasma membrane that surrounds the acrosome and the tail. Accordingly, it seems that Arak may display an indirect role in rabbit spermatogenesis.

5-3. Effect of interactions:

Arak treatment \times season interaction had significant ($P \leq 0.01$) effect on libido, mating activity and all physical semen quality. Untreated rabbit bucks during the summer season had the lower ($P \leq 0.01$) values of libido, mating activity, semen-ejaculate volume, advanced-sperm motility, live spermatozoa, morphological normal spermatozoa, sperm-cell concentration and total-sperm output, respectively while the higher ($P \leq 0.01$) value of acrosomal damage than the other three interactions as shown in Table 6. It is interesting to see the insignificant differences between the treated rabbit bucks during summer season and the untreated one during winter in mating activity, semen-ejaculate volume, advanced sperm motility and live spermatozoa. This is another confirmation that treatment with Arak was more efficient and beneficial during summer season rather than winter season.

Conclusively, it could be concluded that dietary supplementation of NZW growing rabbit males till sexual maturity with 0.2% Arak powder improved some production and physical semen characteristics especially in the hot period of the year in Egypt.

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تأثير التداخل بين إضافة مسحوق الأراك للعليقة وموسم الإنتاج على الأداء الفسيولوجي قبل وبعد النضج الجنسي لذكور الأرانب

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تهدف هذه الدراسة إلى تقييم تأثير إضافة الأراك للعليقة وموسم الإنتاج والتداخل بينهما على الإستجابة الإنتاجية والفسيولوجية لذكور الأرانب النيوزيلاندى الأبيض قبل وبعد النضج الجنسي. أُستخدم في هذه الدراسة 96 أرنب ذكر نيوزيلاندى أبيض عمر 30 يوماً بمتوسط وزن 586.4 جم أثناء موسم الشتاء والصيف (48 بكل موسم). تم تقسيم كل الأرانب إلى مجموعتين (بكل مجموعة)، حيث غذيت المجموعة الأولى بصورة حرة على عليقة أساسية غير معاملة (المجموعة الضابطة) أما المجموعة الثانية فغذيت على نفس العليقة ومُضاف إليها 0.2% مسحوق نبات الأراك. تم حساب معدل زيادة الوزن والغذاء المأكول حتى عمر 70 يوماً (عمر التسويق التجاري). كُفم ذبح أربعة ذكور من كل مجموعة عند عمر 70 يوماً وأخذت الأعضاء التناسلية. جُمعت عينات الدم في عمر 120 و150 يوماً من خمسة ذكور من كل مجموعة وتم تسجيل عدّة تقديرات خاصة بالأداء التناسلي في عمر النضج الجنسي.

أظهرت النتائج أن:

- 1- قيم كل من الزيادة اليومية في وزن الجسم ومعدل تحويل الغذاء وكذلك وزن الجسم النهائى عند عمر 70 يوماً للذكور أرانب النيوزيلاندى الأبيض النامية كانت أعلى معنوياً (عند مستوى 0.05) في المجموعة المعاملة بمسحوق نبات الأراك تحت ظروف موسمي الشتاء والصيف مقارنة بمجموعة المقارنات لم تتأثر كمية الغذاء المأكول نتيجة المعاملة بالأراك.
 - 2- زاد وزن الغدد الجنسية المُساعدة في عمر 70 يوماً معنوياً (على مستوى معنوي 0.05) في المجموعة المعاملة عن مجموعة المقارنة.
 - 3- زاد تركيز هرمون الذكورة (من عمر 120 يوماً إلى سنّ النضج الجنسي) بشكل معنوي (0.05) بإضافة الأراك.
 - 4- كان أدنى عُمر للبلوغ الجنسي في المجموعة المعاملة في فصلي الشتاء والصيف.
 - 5- تأثر كل من الرغبة الجنسية، حجم القذفة، الحركة التقدمية للحيوانات المنوية، تركيز الحيوانات المنوية والنواتج الكلى للحيوانات المنوية بصورة معنوية (على مستوى معنوي 0.05) نتيجة لتأثيرات كل من الموسم والمعاملة والتداخل بينهما.
 - 6- أدت إضافة مسحوق الأراك للأرانب في موسم الصيف إلى إقتراب نتائجها من الأرانب الغير معاملة والمرباه في موسم الشتاء.
- التوصية:** أوضحت أن إضافة مسحوق نبات الأراك بنسبة 0.2% لعلائق ذكور الأرانب النامية وحتى مرحلة النضج الجنسي كان له تأثيراً محفزاً للنمو وكذا للصفات التناسلية للأرانب بوجه عام في موسمي الشتاء والصيف وقد ظهرت أهمية ذلك جلياً فصل الصيف.