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Physiological and reproductive performance of male Baladi rabbits fed on diet supplemented with sea algae during the summer season

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ABSTRACT

Eighteen adult male red baladi rabbits were used to evaluate the effect of feeding a diet supplemented with 1% sea algae *(Ulva lactuca* and *Gntromorpha intestinalis)* on semen characteristics and some selected biochemical properties of seminal plasma as well as on some hematological and biochemical parameters of blood plasma of red baladi rabbits. The average maximum and minimum ambient temperature during the experiment (summer season) were 34.3 °C and 27.3 °C, while the average relative humidity was 72.2 %. Results revealed that motile sperm/ejaculate was significantly ($P<0.05$) increased during treatment. Sperm motility, motile sperm/ml, packed sperm volume (PSV) and total functional sperm fraction (TFSF) were significantly ($P<0.01$) increased for rabbits offered the diet supplemented with *Gntromorpha intestinalis*. Initial fructose was elevated ($P<0.05$) in the T1 group compared with control. Meanwhile, percent of dead and abnormal sperm, and altered acrosomes were significantly ($P<0.01$) decreased by treatment. Ejaculate volume, sperm concentration and sperm output were not significantly affected by treatment. Biochemical analyses of seminal plasma showed that total lipids, ALP and blood plasma testosterone were significantly ($P<0.01$) increased by treatment. Overall means revealed that total lipids was elevated in the T2 group. While, seminal plasma ALP and blood plasma testosterone were elevated in both treatment groups. Total protein, albumin, globulin, cholesterol, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were not significantly affected by treatment. Overall means for body weight gain and total lipids were significantly ($P<0.05$) decreased in the T2 group, while the overall means of blood Hb, PCV, MCH and glucose were significantly ($P<0.05$) increased in the T2 group. Water and feed intake was significantly ($P<0.05$) decreased, while blood plasma total protein, globulin, urea and creatinine were significantly ($P<0.05$) increased in the T1 group. Meanwhile, red blood cells (RBCs), mean corpuscular volume (MCV),

mean corpuscular hemoglobin concentration (MCHC), albumin and cholesterol were not significantly affected by treatment.

INTRODUCTION

Algae are autotrophic organisms, which have potential source of food and feed for man and animals. They are rich in protein (50-60%), lipids (2-22%), vitamins and minerals (e.g., zinc, selenium, iodine, ...etc.). Amino acid composition of algae is comparable to that of egg protein (Chowdhury *et al.*, 1994). Zinc is an essential trace element and many physiological processes are impaired if it is not supplied in sufficient quantities in the diet. Some of the loss in testicular growth was found to be associated with reduced zinc intake (Martin and white, 1992), where a role for zinc in the control of testosterone synthesis or secretion has been proposed (Root *et al.*, 1979 and Prasad, 1985). Zinc deficiency may lead to a biochemical lesion in the pathways controlling steroid synthesis (Lei *et al.*, 1976). Trace elements are known to be essential for the function of various enzymes and other proteins. Zinc is required for normal protein synthesis, and is necessary for reproduction, growth and wound healing (Leonhard-Marek, 2000). In addition, iodine plays an important role in male fertility, and its deficiency causes a decline in libido and a deterioration in semen quality (Rajendran *et al.*, 2002). It was suggested that zinc deficiency causes impairment in the development of the smooth endoplasmic reticulum in the Leydig cells, the site of testosterone synthesis (Hesketh, 1982), or a malfunction in the LH receptors mechanism controlling storage and release of testosterone (Kellokumpu and Rajaniemi, 1981).

Utilization of land for the production of food staples is and will continue to have the highest priority in areas with high population density. In this situation, where sustainable growth in animal production is required, new approaches are needed to identify alternative feed resources which are environmentally friendly and efficient utilization of natural resources (e.g., solar energy, land and water) at a minimum cost (Preston and Murgueitio, 1993). The idea of using algae as a source of food for animal production is unique in the sense that they can use nature's gifts of abundant solar energy and high ambient temperature for their growth. In addition their use appears to be sustainable economically, ecologically, sociologically and etiologically (Halama, 1990 and Phang, 1992). Therefore, the objective of this study was to evaluate the effects of feeding a diet supplemented with 1% of two types of sea algae *(Ulva lactuca* and *Gntromorpha intestinalis)*

on semen characteristics and some selected biochemical properties of seminal plasma, as well as on some hematological and biochemical parameters of blood plasma of red baladi rabbits.

MATERIALS AND METHODS

This experiment was carried out at the Institute of Graduate Studies and Research, Alexandria University. During the experimental period (two and half months extended from 1st July to 15th September) the rabbits were individually housed in Universal galvanized wire batteries with feed and fresh tap water offered *ad libitum*. Eighteen adult male red baladi rabbits were weighed and divided into three groups of 6, homogeneous in age, weight and paternity. The first group was given a commercial balanced pelleted ration for breeding rabbits containing 18% crude protein, 14% crude fiber, 2% fat and 2600 kcal DE/kg and served as control (C). The second (T1) and third (T2) groups were fed the same diet for control but were supplemented with 1% sea algae of two types (*Ulva Lactuca* and *Gntromorpha intestunalis*), respectively. Sea algae were obtained from Mediterranean sea (El-Max and Abou-Talat areas) Alexandria Governorate. The algae were analyzed at the Department of Soil and Water Sciences, Faculty of Agriculture, and at the Central Laboratory, Faculty of Science, Alexandria University.

Semen collection was performed weekly using an artificial vagina at about 9 am. Volume of semen ejaculates were recorded, and ejaculates were placed on water bath at 38 °C. Determination of initial seminal fructose was carried out immediately after collection according to the method of Mann (1948). Percentages of spermatozoal progressive motility were subjectively estimated at X 400 magnification using light microscope equipped with warm stage. Sperm cell concentrations were measured using hemocytometer slide. The percentages of dead and abnormal spermatozoa were assessed according to Blom (1983). Acrosome integrity was evaluated according to the method of Bryan and Akruk (1977). Total functional sperm fraction (TFSF) parameter was calculated as the product of multiplying sperm count by motility by normal morphology (Correa and Zavos, 1996).

Seminal plasma was separated from ejaculates by centrifugation at 5,000 rpm for 10 min. The recovered seminal plasma fraction was further centrifuged at 10,000 rpm for 15 min at 4 ^{0}C. Fractions of two-weeks seminal plasma were pooled and stored at –20 °C until analysis. Seminal

plasma total protein (TP) was measured by the Biuret method as described by Armstrong and Carr (1964) and albumin concentration was determined according to Doumas *et al.* (1971). Globulin concentration was calculated as the difference between seminal plasma total protein and seminal plasma albumin. Total lipids (TL) were determined as described by Frings *et al.* (1972), and total cholesterol concentration was measured according to (Watson, 1960). Transaminase activities (aspartate amino transaminase, AST and alanine amino transaminase, ALT), and alkaline phosphatase (ALP) were measured by the method of Reitman and Frankel (1957). All previous biochemical parameters were determined using commercial kits obtained from Bio ADWIC, Egypt. Lactate dehydrogenase (LDH) was determined according to Stroev and Makarova (1989).

Blood samples were obtained from each animal every other week from the ear vein in heparinized tubes and were placed immediately on ice. Plasma was obtained by blood centrifugation at 3,000 rpm for 20 min and stored at -20 °C until used. Whole blood was used shortly after collection for hematological analysis. Hemoglobin (Hb), packed cell volume (PCV), red blood cell (RBC) counts and white blood cell (WBC) counts were determined using the conventional methods. Plasma was used for the determination of total protein (TP), albumin, total lipids (TL), cholesterol, glucose, urea and creatinine using commercial kits. Blood plasma testosterone was determined by Enzyme Linkage Immuno Sorbent Assay (ELISA) kits obtained from Bio-source Europe S.A. Belgium.

Statistical Analysis: Statistical analysis was performed using the general linear model (GLM) produced by Statistical Analysis Systems Institute (SAS, 1999). Significant differences among means were evaluated using Duncan's Multiple Range Test of SAS (1999).

RESULTS AND DISCUSSION

The averages of maximum and minimum ambient temperature during the experiment (summer season) were 34.3 °C and 27.3 °C, while the averages of relative humidity was 72.2% (Fig. 1). Analyses of the two algae *(Ulva lactuca* and *Gntromorpha intestinalis)* are presented in Table (1). It is obvious from the chemical analyses that *Gntromorpha intestinalis* is higher mainly in zinc, selenium, copper, iron manganese and iodine than *Ulva lactuca* which contains higher levels of lead and cadmium.

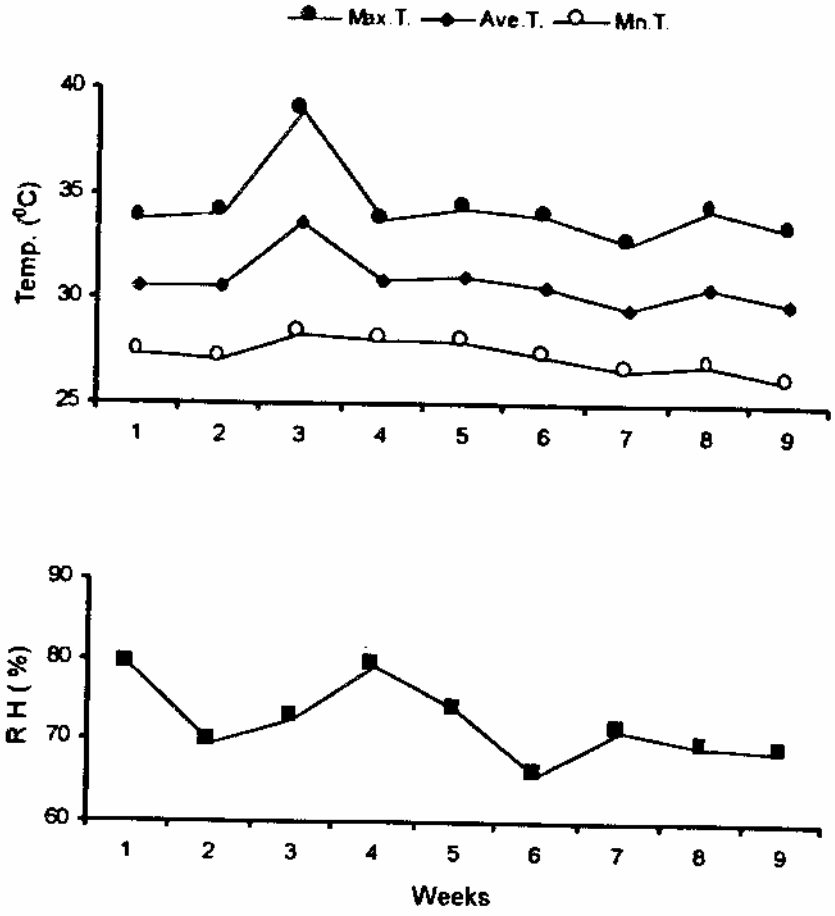

Figure (1): Changes in maximum (max.), minimum (min.), average (aver.) ambient temperature (temp.) and relative humidity (RH) during the experimental period.

Table (1): Chemical composition of sea algae extracts used as feed supplement for red Baladi male rabbits during the experimental period.

Items	*Ulva lactuca* (T1) Ppm	*Gntromorpha intestinalis* (T2) Ppm
EC ds/m	89	88
Major Cations:		
Sodium	197.8	89.7
Potassium	97.8	148.6
Calcium	70.1	80.2
Magnesium	207	634
Major Anions:		
Carbonate	0.00	0.00
Bicarbonate	0.00	0.00
Phosphorus	312.3	90.3
Iodine	185	320
Minor Cations:		
Lead	0.07	0.00
Cadmium	0.035	0.019
Iron	2.137	4.095
Cupper	0.118	0.572
Manganese	0.083	0.976
Selenium	1.15	2.50
Zinc	0.783	2.139

The effect of feeding two different kinds of sea algae (*Ulva lactuca* and *Gntromorpha intestinalis*) on semen quality are presented in Table 2 and Figs. 2 & 3. There were insignificant increases in ejaculate volume, sperm concentration and sperm output due to the supplement of rabbit diet with 1% of sea algae. These results agree with the finding of (Rajendran *et al.*, 2002 and Darwish *et al.*, 1974). However, sperm motility was significantly ($P<0.01$) increased during treatment period (Fig. 2). Motility is involved in defining the ability of the spermatozoa to ascent the reproductive tract to the site of fertilization, as well as the act of fertilization itself, particularly the penetration of the vestments surrounding the oocyte, including the cumulus oophorus and zona pellucida. In view of the significance of sperm motility, it is not surprising that this criterion of sperm function has a central role in

the routine clinical diagnosis of male fertility (Hidiroglou *et al.*, 1978). Packed sperm volume (PSV) and total functional sperm fraction (TFSF) of T2 were significantly ($P<0.01$) higher during treatment compared with control (Fig. 3). The increase of PSV was partly attributed to higher sperm output. High quality and quantity of spermatozoa during feeding sea algae was an evident from the calculation of TFSF which was higher in rabbits fed diet supplemented with 1% *Gntromorpha intestinalis* sea algae (T2).

Table (2): Overall means ± SEM of semen characteristics of male rabbits during treatment with sea algae *Ulva lactuca* and *Gntromorpha intestinalis*.

Parameters	Control	Treatment		SEM
		T_1	T_2	
Ejaculate Volume (ml)	0.37	0.45	0.55	0.07
Sperm Motility (%)	23.0^{c}	30.2^{b}	39.8^{a}	2.64
Motile Sperm / ml ($\bullet 10^6$)	11.0^{b}	15.5^{b}	24.8^{a}	1.74
Motile Sperm / Ej. ($\bullet 10^6$)	31.0^{b}	38.3^{a}	36.9^{a}	3.74
Dead Sperm (%)	11.5^{a}	8.7^{b}	8.7^{b}	0.44
Abnormal Sperm (%)	10.2^{a}	7.8^{b}	8.1^{b}	0.37
Sperm Conc. ($\bullet 10^6$/ml)	42.9	52.4	52.4	3.46
Sperm Output ($\bullet 10^6$/ej)	132.6	142.9	155.2	11.4
Altered Acrosomes (%)	8.6^{a}	6.5^{b}	6.1^{b}	0.27
Packed Sperm Volume (%)	12.2^{b}	12.3^{b}	14.8^{a}	0.50
TFSF ($\bullet 10^6$)	28.2^{b}	37.6^{b}	78.1^{a}	4.89

a,b,c Within rows, means with different superscript letters differ significantly ($P<0.05$)

On the other hand, percent of dead and abnormal sperms and altered acrosomes were significantly ($P<0.01$) decreased during treatment periods (Fig. 2 & 3). Selenium present in algae act as an antioxidant to improve semen quality through maintaining sperm integrity. Moreover, antioxidants

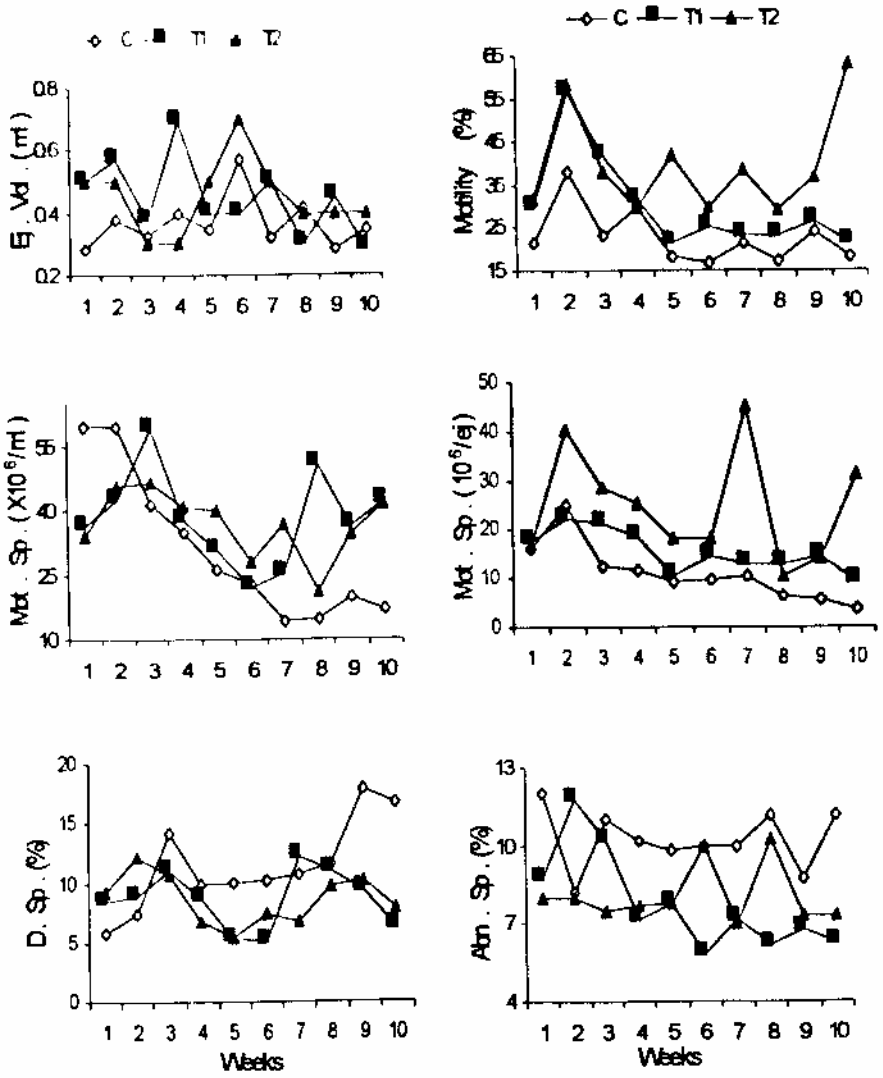

Figure (2): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on ejaculate volume (Ej Vol.), sperm motility, motile sperm per milliliter (Mot. Sp./ml), motile sperm per ejaculate (Mot. Sp./Ej) , dead sperm percent (D. Sp.%) and abnormal sperm percent (Abn. Sp.%) of red Baladi male rabbits during treatment period.

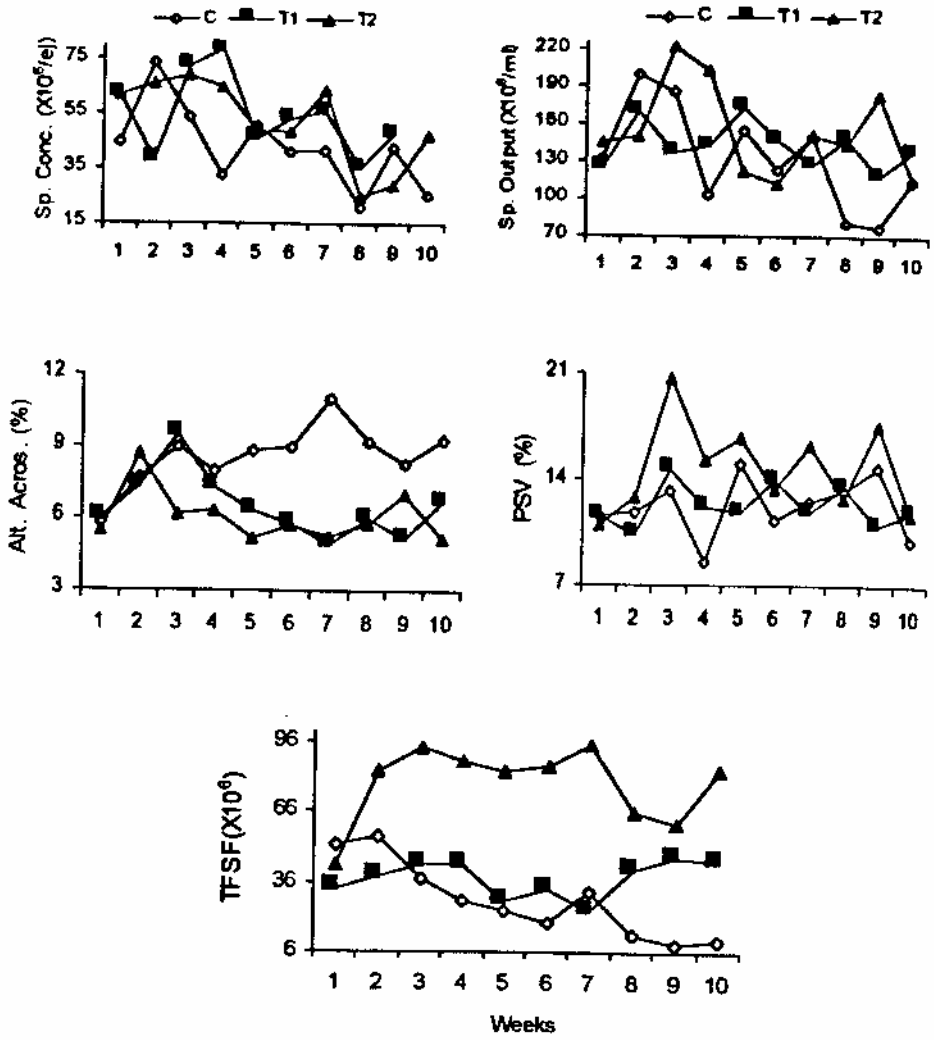

Figure (3): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on sperm concenteration (Sp. Conc), sperm output (Sp. Output), alterd acrosomes (Alt. Acros.), packed sperm volume (PSV) and total functional sperm fracton (TFSF) of red Baladi male rabbits during treatment period.

improve the motility of ram sperm and integrity of their acrosomes (Maxwell and Stojanov, 1996). Dead spermatozoa are substantial source of reactive oxygen species (ROS) due to the breakdown of their membrane and the continued availability of unsaturated membrane fatty acids to

peroxidation (Kessopoulov *et al.*, 1992), which leads to loss of sperm motility and reduced fertilizing ability of many species (Aitken, 1994 and Lenzi *et al.*, 1996). The antioxidant system of the cells is not potent enough to prevent lipid peroxidation completely. However, the main beneficial effects of antioxidant supplement may reside in the delay of the sperm membrane destabilization associated with sperm aging (Maxwell and Watson, 1996) and maintenance of spermatozoal motility (Aitken, 1995).

Biochemical analyses of seminal plasma showed that, initial fructose, total lipids, ALP and blood plasma testosterone were significantly ($P<0.01$) increased by treatment (Table 3). Comparison of means revealed that initial fructose was elevated in T1, total lipids in T2, and ALP and testosterone in both treatment groups, meanwhile initial fructose was lowered in T2 ($P<0.05$) compared with control. However, lactate dehydrogenase (LDH) was significantly ($P<0.01$) decreased by T1 treatment. Fructose formation by the accessory glands is dependent upon the secretion of testosterone by

Table (3): Overall means ± SEM of some major seminal plasma biochemical constituents of male rabbits during treatment with sea algae *Ulva lactuca* and *Gntromorpha intestinalis*.

Parameters	Control	Treatment		SEM
		T_1	T_2	
Total Protein (gm/dl)	3.10	2.76	2.92	0.19
Albumin (gm/dl)	0.94	0.80	0.95	0.08
Globulin (gm/dl)	2.17	1.96	1.90	0.15
Total Lipids (gm/dl)	3.93^{b}	4.22^{b}	5.31^{a}	0.20
Cholesterol (mg/dl)	243.6	252.5	239.4	12.5
Initial Fructose (mg/ ml)	1.81^{b}	2.43^{a}	1.42^{c}	0.09
AST (IU/L)	212.3	226.5	232.0	13.3
ALT (IU/L)	18.1	18.0	17.4	11.9
ALP (IU/L)	3616^{b}	4653^{a}	4676^{a}	227
LDH (IU/L)	3.0^{a}	2.7^{b}	2.9^{a}	0.06
Blood Plasma Testosterone (ηg/dl)	4.29^{b}	12.50^{a}	14.25^{a}	0.92

a,b Within rows, means with different superscript letters differ significantly ($P<0.05$)

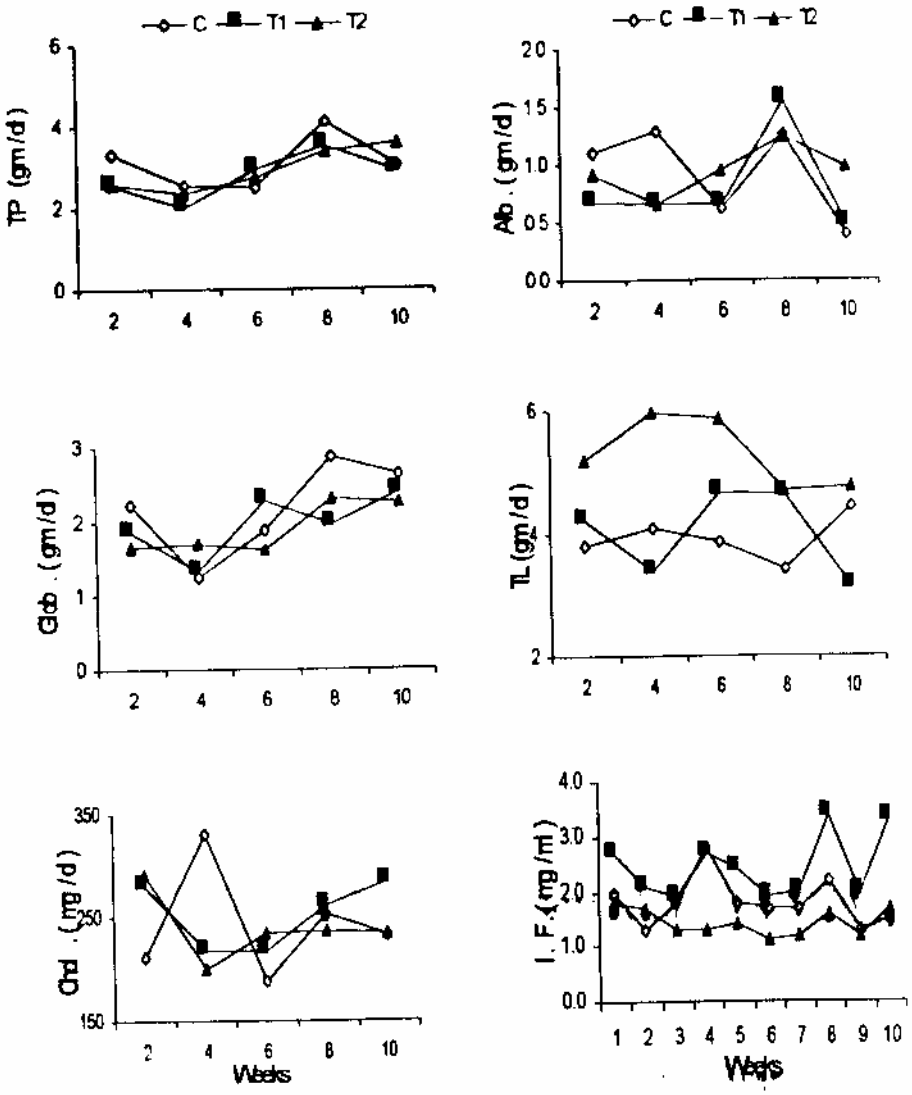

Figure (4): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on seminal plasma total protein (TP), albumin (Alb.), globulin (Glob.), total lipids (TL), cholesterol (Chol.) and initial fructose (I. F.) of red Baladi male rabbits during treatment period.

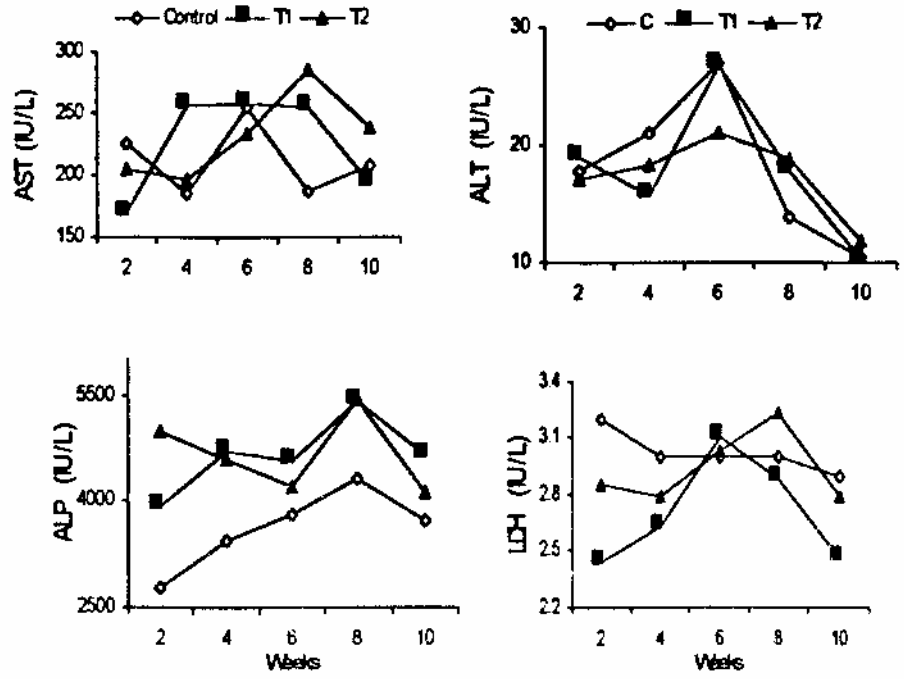

Figure (5): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on seminal plasma aspartate amino transferase (AST), alanine amino transferase (ALT) alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) of red Baladi male rabbits during treatment period.

the testes (Moon and Bunge, 1971). The present findings are further confirmation of an improvement in plasma testosterone level of rabbits due to feeding a diet supplemented with 1% sea algae which contain suitable level of iodine, these results agree with the finding of Rajendran *et al.* (2002). The elevation in seminal plasma initial fructose in T1 than T2 may contribute to the shortening of sperm liveability, because fructose represents the main source of energy for spermatozoa (Atterwill and Steele, 1987). Therefore, level of fructose in seminal plasma reflects testosterone action and quality of semen (Taha *et al.*, 2000). Lipids are basic components of semen contributing to the membrane structure of spermatozoa, the metabolism of the sperm cells and to their ability to capacitate and fertilize the female gametes (Mann and Lutwak-Mann, 1981). The presence of high concentrations of long chain polyunsaturated fatty acids within the lipid structure of sperm cells requires efficient antioxidant systems to diminish

peroxidative damage and associated sperm dysfunction (Selley *et al.*, 1991; Aitken, 1994). Thus, the maintenance of high fertility appears to require the presence of optimal concentrations of polyunsaturated fatty acids together with associated antioxidant capacity (Kelso *et al.*, 1997). Alkaline phosphatase (ALP) showed elevated overall mean values than the control group, while LDH showed low overall mean values in the T1 group (Table 3). Pursel *et al.* (1968) reported that one of the consequences of acrosomal damage is the leakage of enzymes from the sperm. The leakage of ALP reveales a positive correlation between enzyme release and sperm cell integrity and acrosomal damage (Chauban *et al.*, 1993). The present study showed that TP, albumin, globulin, cholesterol, AST and ALT were not significantly affected by treatment (Table 3 and Fig. 4 , 5 & 6).

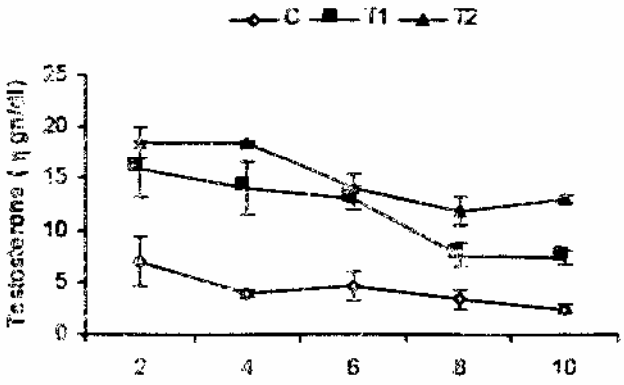

Figure (6): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on blood plasma testosterone of red Baladi male rabbits during treatment period.

Physiological parameters revealed that, feed intake, water intake and body weight were significantly ($P<0.01$) decreased by treatment (Table 4 and Fig. 7). Overall mean comparisons indicated that feed intake was reduced ($P<0.05$) in both treatment groups, water intake was reduced ($P<0.05$) in the T1 group only compared with control, while body weight gain was reduced ($P<0.05$) in the T2 group. The decrease in body weight gain could be attributed to the noted decrease in feed intake. The hazardous effect of zinc (at high level) contained in the algae on feed intake may be due to its effect on CNS, particularly the hypothalamus which contains a

Table (4): Overall means ± S. E. M. of feed intake, water intake, body weight gain, whole blood and blood plasma parameters of male rabbits during treatment with sea algae *Ulva lactuca* and *Entromorpha intestinalis*.

Parameters	Control	Treatment		SEM
		T_1	T_2	
Feed Intake (gm/day)	74.8[a]	70.2[b]	67.8[b]	1.65
Water Intake (ml/day)	281[a]	236[b]	269[a]	10.4
Body Weight Gain (gm/head/day)	1.96[a]	1.97[a]	1.85[b]	0.28
Red Blood Cells ($\times 10^6$/mm^3)	5.4	5.3	5.3	0.13
Hemoglobin (gm/dl)	13.0[b]	13.3[b]	14.1[a]	0.18
PCV (%)	45.3[b]	45.7[b]	47.2[a]	0.45
MCV (cu μ)	86.2	87.9	90.5	2.24
MCH (pg)	24.8[b]	25.7[ab]	26.9[a]	0.70
MCHC (%)	28.8	29.2	29.8	0.37
Total Protein (gm/dl)	6.1[b]	7.2[a]	7.0[ab]	0.44
Albumin (gm/dl)	2.7	2.7	2.6	0.10
Globulin (gm/dl)	3.4[b]	4.5[a]	4.4[a]	0.43
Total Lipids (gm/dl)	3.2[a]	3.5[a]	2.4[b]	0.20
Cholesterol (mg/dl)	209.9	217.9	225.3	12.5
Urea (mg/dl)	39.9[b]	46.5[a]	41.6[b]	3.03
Creatinine (mg/dl)	0.68[b]	1.04[a]	0.70[b]	0.05
Glucose (mg/dl)	108.0[c]	155.7[b]	212.9[a]	7.12

a,b,c Within rows, means with different superscript letters differ significantly ($P<0.05$)

center governing feed and water consumption (Shull and Cheeke, 1983). Hematological studies showed that Hb, PCV and MCH were significantly ($P<0.01$) increased by treatment (Fig. 8 and Table 4). These hematological changes is known to be associated with an increase in the oxygen carrying capacity of the blood accompanied with an increase in the respiration rate, indeed, the hematological changes have an important role in adjusting the different functions of the animal to the existing environmental conditions (Samak *et al.*, 1986).

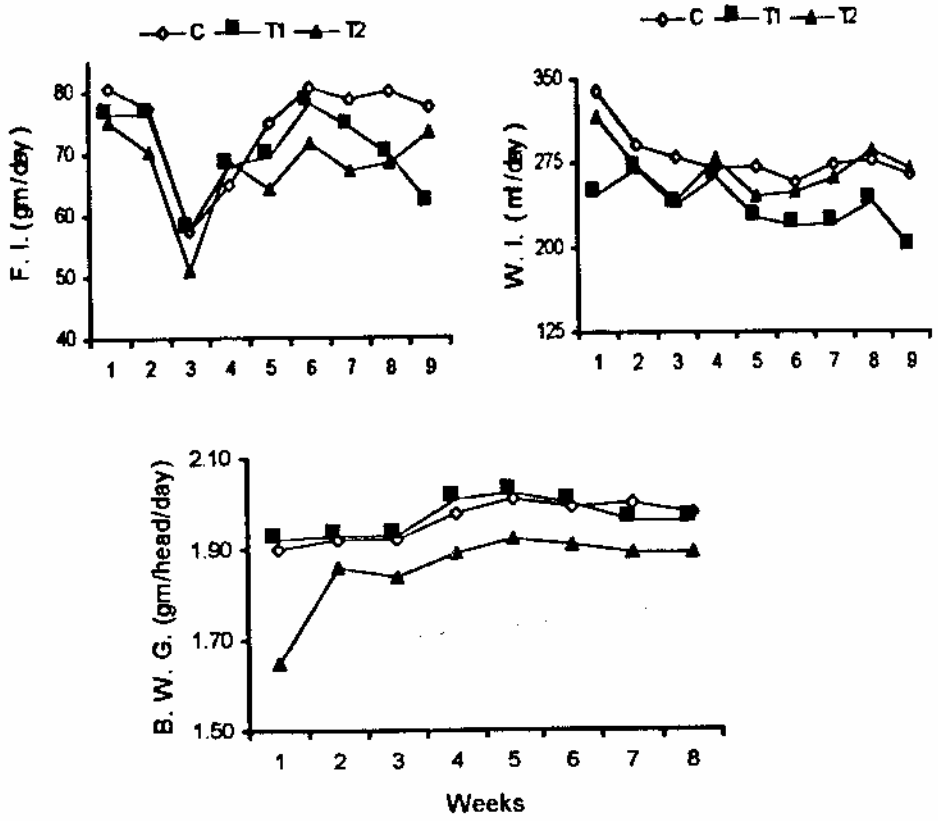

Figure (7): Effect of feeding with sea algae (*Ulva sp. and Gentromorpha sp.*) on feed intake (F. I.), water intake (W. I.) and body weight gain (B. W. G.) of red Baladi male rabbits during treatment period.

Biochemical analysis of blood plasma indicated significant increases in total protein ($P<0.05$), globulin, blood glucose and blood urea and creatinine ($P<0.01$) by treatment, while total lipids were significantly ($P<0.01$) decreased by treatment in the T2 group (Table 4 and Figure 9 & 10). Prasad (1996) found that Zinc deficiency influences DNA syntheses, cell division and protein syntheses. Total protein in plasma generates a colloid osmotic pressure which controls the flow of water between blood and tissue fluids (Solouma, 1999). Cordova (1994) reported a direct relation between glucose and zinc levels in blood and also an increase in the zinc and glucose rate in

excreted by the kidney, therefore changes in their levels in blood stream would reflect the insufficiency of kidney tubules or kidney malfunction (Miller, 1966).

The present results indicated that in spite of the decreased fertility of rabbits during hot season, the use of the two species of sea algae may improve the reproductive performance of treated rabbits than the control group. It can be concluded that the use of *Gntromorpha intestinalis* is better than *Ulva lactuca* as a feed additive in rabbit diets, where it improved sperm motility, increased the percent of live and normal sperms and decreased the percent of dead and abnormal sperms. Also it decreased the numbers of altered acrosomes and increased the total functional sperm fraction. Thus, it could improve the reproductive performance of rabbits.

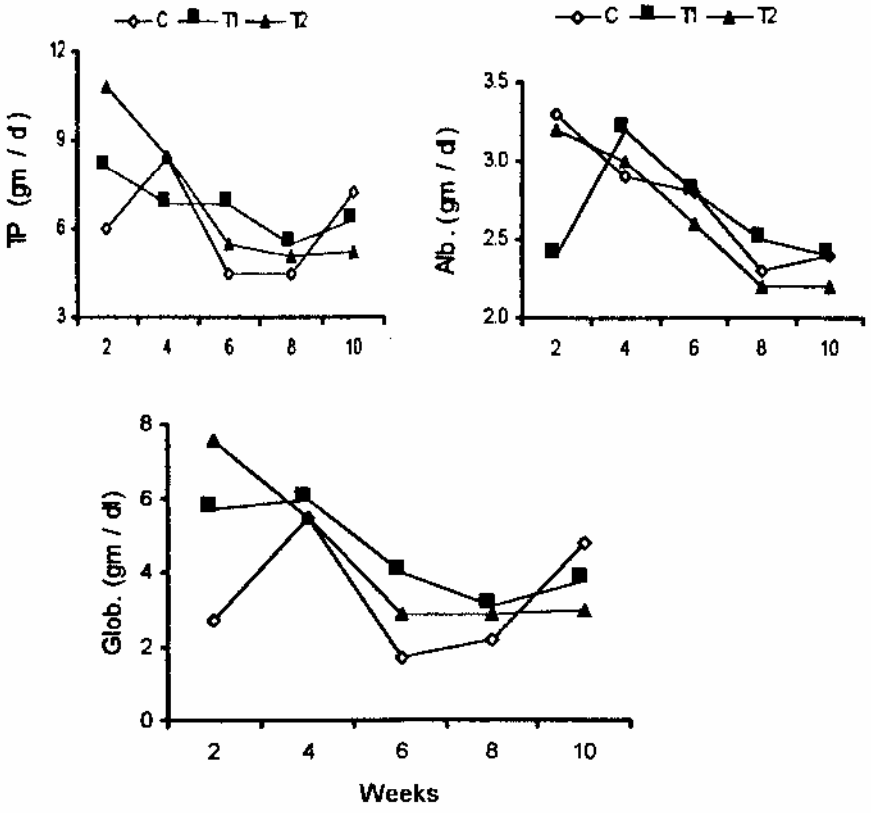

Figure (9): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on blood plasma total protein (TP), albumin (Alb.) and globulin (Glob.) of red Baladi male rabbits during treatment period.

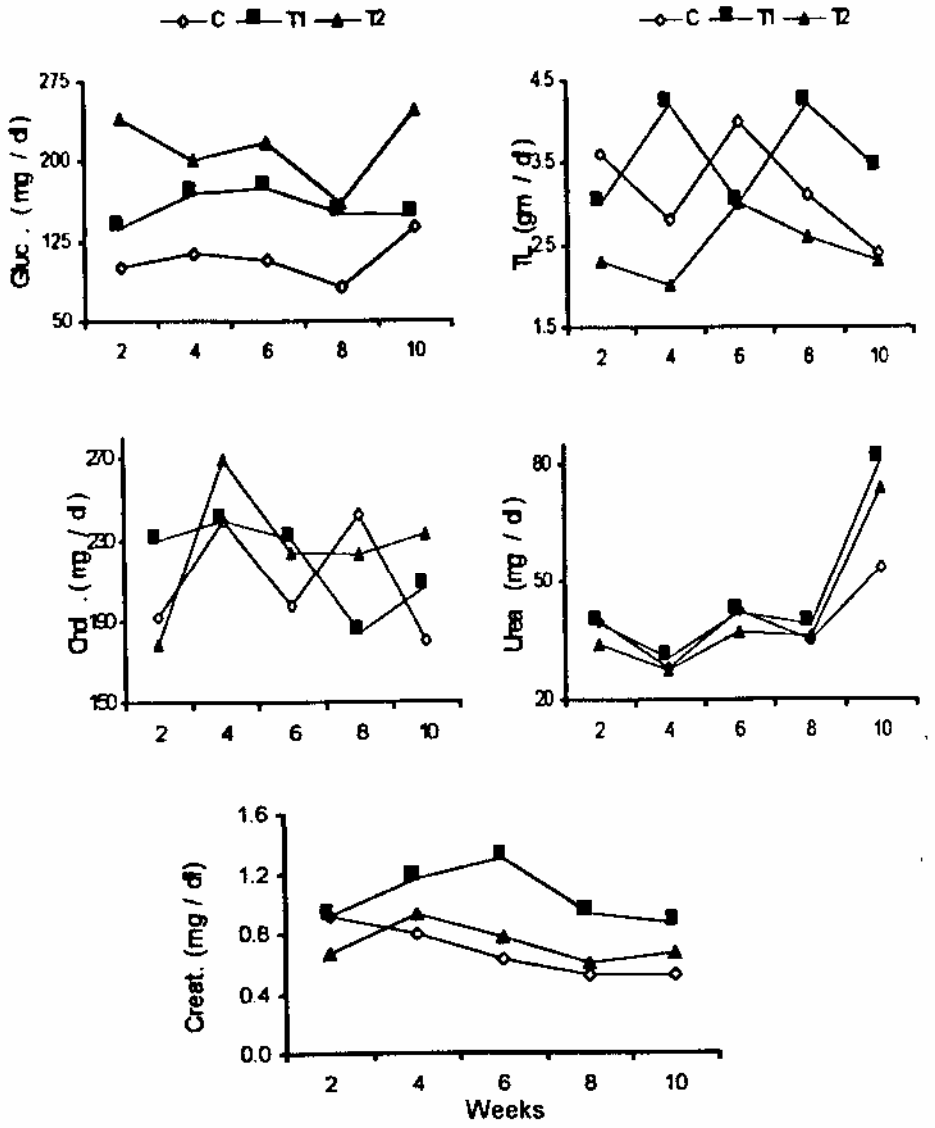

Figure (10): Effect of feeding sea algae (*Ulva sp. and Gentromorpha sp.*) on blood plasma glucose (Gluc.), total lipids (TL), cholesterol (Chol.), urea and creatinine (Creat.) of red Baladi male rabbits during treatment period.

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تأثير إضافة الطحالب البحرية للغذاء على الأداء التناسلي و الفسيولوجي لذكور الأرانب البلدي

علي بسيوني عقاب
قسم الدراسات البيئية بمعهد الدراسات العليا والبحوث جامعة الإسكندرية

استخدمت في هذه الدراسة ١٨ من ذكور الأرانب البلدي الحمراء لتقدير تأثير التغذية بطريقة مضاف إليها نوعين مختلفين من الطحالب البحرية (*Ulva lactuca* and *Gntromorpha intestinalis*) بنسبة ١% على خواص السائل المنوي وبعض القياسات البيوكيميائية لبلازما السائل المنوى والدم.

أجريت هذه الدراسة خلال موسم الصيف (من ١ يوليو حتى ١٥ سبتمبر) حيث كان متوسط درجات الحرارة القصوى ٣٤,٣ °م بينما متوسط درجات الحرارة الدنيا ٢٧,٣ °م، أما متوسط الرطوبة النسبية ٧٢,٢% خلال فترة التجربة.

بينت نتائج هذه الدراسة لرتفاع نسبه حركة الحيوانات المنوية وتركيز الحيوانات المنوية المتحركة لكل قذفة وتركيز الحيوانات المتحركة لكل ملي لتر وحجم الحيوانات المنوية المعيا وعدد الحيوانات المنوية الصالحة مظهريا. كما أوضحت النتائج انخفاض النسبة المئوية للحيوانات المنوية الميتة والمشوهة وكذلك الحيوانات المنوية المتغيرة الاكروسوم في الحيوانات المعاملة عن الكنترول. أما بالنسبة لحجم القذفة وتركيز الحيوانات المنوية والعدد الكلي للحيوانات المنوية لم يتأثر بالمعاملة. كما بينت التحليلات البيوكيميائية لبلازما السائل المنوي أن تركيز الفركتوز والدهون الكلية ونشاط إنزيم الفوسفاتيز القلوي زادت في الحيوانات المعاملة. أما تركيز البروتينات الكلية والألبيومين والجلوبيولين والكولستيرول ونشاط انزيمى الأسبارتيت أمينو ترانسفيريز والالنين أمينو ترانسفيريز لم تتأثر بالمعاملة.

بينت تحليلات الدم والبلازما زيادة تركيز الهيموجلوبين وحجم كرات الدم الحمراء المعبأ ومتوسط محتوى كرات الدم الحمراء من الهيموجلوبين والبروتينات الكلية والجلوبيولين والجلوكوز واليوريا والكرياتينين وتركيز هرمون التستوستيرون في بلازما الدم، بينما انخفض معدل تناول الغذاء والماء وكذلك وزن الجسم والدهون الكلية في بلازما الدم في الحيوانات المعاملة.

ويمكن من هذه الدراسة استنتاج أنه على الرغم من انخفاض خصوبة الأرانب أثناء موسم الصيف إلا أن استخدام نوعي الطحالب أدى إلى تحسن الأداء التناسلي في الأرانب المعاملة في كلا المجموعتين عن الكنترول. ولكن من الملاحظ أن النوع الثاني من الطحالب (*Gntromorpha intestinalis*) أدى إلى نتائج أفضل من النوع الأول (*Ulva lactuca*) في معظم المعايير التي تم تقديرها في السائل المنوي والدم.