

Reproductive and physiological traits of Egyptian Suffolk rams as affected by selenium dietary supplementation and housing heat radiation effects during winter of the sub-tropical environment of Egypt (Short Communication)

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Abstract

The present investigation was a part of a research project that aimed to study the reproductive and physiological traits of the rams as affected by selenium dietary supplementation and, housing heat radiation effect which is the change in animals perception of warmth between the different parts of the building or between indoors and outdoors of the farm measured by the difference in temperature-humidity index (THI) values.

To carry out such work, the animals were divided into four groups (A, B, C and D) of nearly equal average body weights and were raised in one shed, but divided to southern and northern parts. Two groups (A and B) were housed in the southern part of the farm (facing the bright sun day light), while the other two groups (C and D) were housed in the northern part of the farm (facing the cold air flow). One group in each part of the farm was kept without treatment as control (A or C) and the second (B or D) was treated with selenium (0.1 ppm/kg dry matter [DM] of ration as sodium selenate) orally.

The results showed that dietary selenium supplementation improved significantly ($P < 0.01$ or 0.05) most of the ram traits, during winter. Regarding the housing heat radiation effect, the results showed that the southern part was higher than the northern part of the farm with 0.8 THI unit and such change improved significantly ($P < 0.01$ or 0.05) the ram traits, during winter. With regard to the interaction between the studied two factors, there were no significant effects except for the scrotal circumference and scrotal length which were high ($P < 0.01$) in the rams supplemented with selenium and raised in the southern part of the farm, under the sub-tropical environment of Egypt.

Keywords: Egyptian suffolk rams, housing heat radiation effect, physiological reactions, reproductive traits, selenium supplementation

Zusammenfassung

Reproduktions- und physiologische Merkmale bei Suffolk Böcken unter dem Einfluss einer Seleniumzufütterung und höherer Temperaturen während des Winters unter subtropischen Bedingungen Ägyptens (Kurzmitteilung)

Vorliegende Untersuchung ist Teil eines Forschungsprojektes mit dem Ziel, den Einfluss einer Seleniumzufütterung und höherer Temperaturen auf Reproduktions- und physiologische Merkmale bei Schafböcken bei unterschiedlichen Haltungsbedingungen zu untersuchen. Insgesamt 16 Suffolkböcke wurden vier Versuchsgruppen zugeordnet. Jeweils zwei Gruppen wurden in wärmeren südlichen und zwei Gruppen in kälteren nördlichen Standorten gehalten. Jeweils eine dieser Gruppen in den unterschiedlichen Sandorten erhielt Seleniumzufütterung (0,1 ppm/kg Trockenmasse [DM] sodium selenat). Die Ergebnisse zeigten eine signifikante Verbesserung der meisten untersuchten Merkmale im Winter. Bezüglich des Wärmeeffektes d.h. eines höheren Temperatur-Feuchtigkeits-Indexes (THI) bei den südlichen Gruppen verbesserten sich signifikant die untersuchten Merkmale im Winter. Im Zusammenhang mit den beiden untersuchten Einflussgrößen ergaben sich keine signifikanten Zusammenhänge zwischen dem Hodenumfang und der Hodenlänge welche bei den Seleniumgruppen in der Südregion unter subtropischen Bedingungen höhere Werte erreichten.

Schlüsselwörter: Ägypten, Suffolkböcke, Wärmeeffekt, physiologische Merkmale, Reproduktionsmerkmale, Seleniumzufütterung

Introduction

Recently, it happened in a farm that the conception rate reached 19% in a Statal flock of Egyptian Suffolk (1/16 Ossimi.15/16 U.K. Suffolk). When discussing that problem, it was observed that the rams were raised in buildings built of bricks and cement which might cause increase in animals perception of warmth (housing heat radiation effect or housing effect), under the hot sub-tropical conditions. In addition, the animals showed symptoms of selenium deficiency, although the animals were fed according to NRC (1985) requirements. The housing heat radiation effect is the change in animals perception of warmth between the different parts of the building or between indoors and outdoors of the farm, measured by the difference in temperature-humidity index (THI) values.

In this respect, a project of research was planned to investigate the reproductive traits of rams and ewes, as affected by such unfavourable conditions and the methods of its alleviation. Most of the results of the planned project of research were published (MARAI *et al.* 2004, 2006a, 2006b, on ewe traits and MARAI *et al.* 2003, 2006c on ram traits).

The objectives of the present work were to study the reproductive and physiological traits of Egyptian Suffolk rams as affected by selenium dietary supplementation and housing heat radiation effect during winter season, under Egyptian sub-tropical conditions.

Material and methods

The present study was conducted in the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. The experimental work was carried out at El-Gemmaiza Experimental Station located in mid Nile Delta (30.5°N) and the laboratory work was conducted in the Department of Sheep and Goats Research, both belonging to Animal Production Research Institute, Ministry of Agriculture, Egypt. The present

investigation was a part of a project of study on the reproductive traits of sheep as affected by the unfavourable sub-tropical conditions of Egypt.

A total number of 16 rams of Egyptian Suffolk sheep of 1.5-2.5 years of age and 60-70 kg body weight raised in a 3 lambings/2 years system were used in the present study, during December-February (winter season). The animals were divided into four groups (A, B, C and E) of nearly equal average body weights and were raised in one shed, but divided to southern and northern parts. Two groups (A and B) were housed in the southern part of the farm (facing the bright sun day light), while the other two groups (C and D) were housed in the northern part of the farm (facing the cold air flow). One group in each part of the farm was kept without treatment as control (A or C) and the second (B or D) was treated with selenium (0.1 ppm/kg DM as sodium selenate) orally.

All animals were healthy and clinically free of external and internal parasites and were kept, maintained and treated in adherence to accepted standards for the humane treatment of animals.

Requirements of selenium were 0.1 to 0.2 ppm/kg DM (NRC 1985). In the experimental diet, selenium was determined on DM basis as 0.09 ppm/kg DM, which was nearly similar to the requirements for sheep according to NRC (1985).

The animals were offered their nutritional requirements according to NRC (1985). Additional diet was offered to rams, 15 days before and after beginning of the breeding season (35 days). The additional diet was composed of 1.0 kg concentrates, 0.25 kg barely and *ad lib* rice straw. Each kg of the concentrate contained: 450 g yellow maize, 350 g decorticated cottonseed meal, 150 g wheat bran, 3 g molasses, 1 g calcium carbonate and 1 g salt. Proximate analysis of the concentrates and roughages (Table 1) was carried out according to AOAC (1980). The animals had access to water daily three times in winter at 9.00, 13.00 and 18.00 h.

Table 1
Chemical analyses of the diets used in experimental trails

Chemische Analyse der eingesetzten Futtermittel

Items	DM, %	CP, %	CF, %	EE, %	NFE, %	OM, %	Ash, %	Se, %	Car, %
Concentrates	90.46	18.50	13.46	4.85	53.69	90.50	9.50	0.095	1.46
Barely	90.00	7.78	10.00	2.23	76.56	96.57	5.34	0.097	2.00
Rice straw	92.30	3.47	35.10	1.41	39.65	79.63	20.37	0.084	2.00

DM dry matter, CP crude protein, CF crude fibre EE ether extract, NFE nitrogen free extract, OM organic matter, Se Selenium, Car Carotene

Rams were housed in soil floored, semi-open i.e. partially wooden roofed parts. The partial roofs were in the northern side of the southern part and in the southern side in the northern part. The height of the north wall of the southern part which is the south wall of the northern part of the farm was 2 m. Either the southern or the northern parts of the farm were divided into two partitions, each of 3 × 8 m and surrounded by walls of 2 m height. All the walls were constructed by bricks and cement.

The methods used in the study were the same as those described by MARAI *et al.* (2003).

Ambient air temperature and relative humidity (RH%) were recorded (Table 2) in the sheds at the times of carrying out the physiological and scrotal measurements and

semen collection. Ambient air temperature was recorded using Mercury thermometer to the nearest 0.1°C. Maximum and minimum temperatures were recorded using thermometer. Relative humidity was recorded using hair-hygrometer to the nearest 1%.

THI was estimated (Table 2) according to the following equation (MARAI *et al.* 2000):

$$THI = db^{\circ}C - \{(0.31 - 0.31RH)(db^{\circ}C - 14.4)\} \quad (1)$$

where is $db^{\circ}C$ the dry bulb temperature in Celsius and $RH = RH\%/100$. Then the obtained values of THI were classified as follows: <22.2 =absence of heat stress, 22.2 - <23.3 =moderate heat stress, 23.3 - <25.6 =severe heat stress and ≥ 25.6 =very severe heat stress (MARAI *et al.* 2000).

Table 2
Microclimatic data during the whole experimental period
Mikroklimadaten während der Versuchsperiode

	South of the farm				North of the farm				DLL, h
	Air temperature, °C		RH, %	THI, max	Air temperature, °C		RH, %	THI, max	
	min	max			min	max			
December-February (Winter)	10.0	20.1	78.4	19.7	9.2	18.8	80.5	18.9	10.5

DLL day light length

Statistically, the model used to study effects of housing heat radiation (THI of the parts of the building; north and south), treatment with selenium and their interaction on semen traits, physiological parameters, scrotal measurements and blood components in rams, was as follows:

$$Y_{ijk} = \mu + s_i + t_j + st_k + e_{ijk} \quad (2)$$

where is μ the overall mean, s_i the effect due housing part (i =north and south), t_j the fixed effect of j -th treatment (j =1 and 2), st_k the interaction between housing part and treatment and e_{ijk} the unexplained variation assumed to be randomly and independently distributed. The statistical analysis was computed using analysis of variance procedure described in SAS (1995).

Results and discussion

Physiological parameters, libido, semen characteristics and scrotal measurements as affected by dietary selenium supplementation

Tables 3 and 4 show that dietary selenium supplementation improved significantly ($P < 0.01$ or 0.05) libido, semen ejaculate volume, sperm motility percentage, sperm-cell concentration ($\times 10^9/ml$) and scrotal circumference, and decreased significantly ($P < 0.01$) percentages of dead spermatozoa, sperm abnormalities and acrosomal damage. The plasma creatinine was lower significantly ($P < 0.05$) in rams fed diet containing selenium than in those fed a diet without selenium. The other traits were insignificantly affected with the same treatment.

Table 3

Least square means (\pm SE) of physiological parameters, libido, semen characteristics and scrotal measurements in Egyptian Suffolk rams as affected by selenium treatment and housing heat radiation, during winter season
Mittelwerte der physiologischen, Hoden- und Spermamermale bei unterschiedlichen Versuchsgruppen

Variables	Selenium			Housing effect		
	Without (A+C)	With (B+D)		South (A+B)	North (C+D)	
Physiological parameters						
Rectal temperature, °C	38.44 \pm 0.07	38.33 \pm 0.07	ns	38.70 ^a \pm 0.07	38.07 ^b \pm 0.07	**
Skin temperature, °C	36.47 \pm 0.13	36.52 \pm 0.13	ns	36.68 \pm 0.13	36.32 \pm 0.13	ns
Scrotal skin temperature, °C	27.93 \pm 0.22	27.91 \pm 0.22	ns	28.19 \pm 0.22	27.65 \pm 0.22	ns
Libido and semen characteristics						
Reaction, Libido s	13.33 ^a \pm 0.55	10.50 ^b \pm 0.55	**	11.10 ^b \pm 0.55	12.70 ^a \pm 0.55	*
pH	6.81 \pm 0.02	6.8 \pm 0.02	ns	6.81 \pm 0.02	6.8 \pm 0.02	ns
Semen ejaculate volume, ml	0.84 ^b \pm 0.04	0.97 ^a \pm 0.04	*	0.96 \pm 0.04	0.85 \pm 0.04	ns
Sperm motility, %	71.04 ^b \pm 0.86	76.88 ^a \pm 0.86	**	75.62 ^a \pm 0.86	72.29 ^b \pm 0.86	**
Dead spermatozoa, %	19.83 ^a \pm 0.71	13.50 ^b \pm 0.71	**	15.06 ^b \pm 0.71	18.27 ^a \pm 0.71	**
Sperm abnormalities, %	14.69 ^a \pm 0.62	9.67 ^b \pm 0.63	**	11.31 ^b \pm 0.63	13.04 ^a \pm 0.63	*
Acrosomal damage, %	10.44 ^a \pm 0.54	6.23 ^b \pm 0.54	**	7.85 \pm 0.54	8.81 \pm 0.54	ns
Sperm-cell concentration, $\times 10^9$ /ml	1.14 ^b \pm 0.16	1.75 ^a \pm 0.16	**	1.69 ^a \pm 0.16	1.20 ^b \pm 0.16	*
Scrotal measurements						
Scrotal circumference, cm	32.08 ^b \pm 0.55	34.24 ^a \pm 0.55	**	32.74 \pm 0.55	33.57 \pm 0.55	ns
Scrotal length, cm	13.00 \pm 0.28	13.85 \pm 0.28	ns	13.87 \pm 0.28	12.93 \pm 0.28	ns
Testes length, cm	11.50 \pm 0.29	10.96 \pm 0.29	ns	12.04 ^a \pm 0.29	10.41 ^b \pm 0.29	**

group A/B without/with selenium in southern part of the farm, group C/D without/with selenium in northern part of the farm, means bearing different letters within the same row, differ significantly ($P < 0.05$), ** $P < 0.01$, * $P < 0.05$, ns not significant

The above results were in agreement with those obtained by UNDERWOOD (1977), DYASHENKO and KATROSHENCO (1990), UDALA *et al.* (1995), SCOTT *et al.* (1998), KOLODZTEJ and JACYNO (2005) and BALICKA-RAMISZ *et al.* (2006). Improvement of semen quality is due to its improvement of testes function (UNDERWOOD 1977). Selenium affects the interstitial cells of testes directly and via the effect on the anterior pituitary hormones secretion indirectly (YOUSEF *et al.* 1990).

The increase in scrotal circumference in rams supplemented with selenium may be due to the beneficial effect of selenium on the interstitial cells of testes and protection of testes cells from damage. These results agreed with those reported by YOUSEF *et al.* (1990) and BURTIS and ASHWOOD (1996). SARLOS *et al.* (1996) and POTI *et al.* (1999) found a seasonal effect in scrotal circumference in which the testicular volume showed a minimum in winter.

Blood components as affected by dietary selenium supplementation

Table 4 shows that the plasma creatinine was lower significantly ($P < 0.05$) in rams dietary supplemented with selenium than in those fed a diet without selenium. The decrease in plasma creatinine in rams with selenium may be due to improvement of protein anabolism, decrease of protein catabolism, and decrease in the glucocorticoid hormones such as cortisol and increase in T3 hormone. BALICKA-RAMISZ *et al.* (2006) reported similar results.

Generally, selenium is considered an essential nutrient for animals. It is implied in the functions of the body, connected with immunity (LARSEN 1993) and protects the animal

from the white muscle disease (PEHRSON 1993). It is also implied in metabolism of thyroid hormones and other functions (BEHNE *et al.* 1990). Biochemically, selenium acts as a component of the enzyme glutathion peroxidase activity, an enzyme that catalyzes the degradation of organic hydroperoxidase. Its absence is correlated with a loss of glutathion peroxidase (GSH-Px) activity and is associated with damage to cell membranes. Cell membrane damage and normal cells are replaced with fibroblast. This condition which is known with damage to cell membranes is due to accumulation of free radicals (BURTIS and ASHWOOD 1996). Deficiency of selenium declines fertility of livestock (SANDERS 1984). BUCK *et al.* (1981) reported that selenium deficiency may lead to reproductive dysfunctions such as retained placenta and reduced fertility in ewes. SANDERS (1984) added that diseases due to selenium inadequacy in livestock are of a worldwide distribution.

Table 4

Least square means (\pm SE) of blood components in Egyptian Suffolk rams, as affected by selenium treatment and housing heat radiation, during winter season

Mittelwerte der Blutkomponenten bei unterschiedlichen Versuchsgruppen

Variables	Selenium				Housing effect	
	Without (A+C)		With (B+D)		South (A+B)	North (C+D)
Total proteins, g/dl	7.87 \pm 0.31	8.11 \pm 0.31	ns	8.24 \pm 0.31	7.74 \pm 0.31	ns
Albumin, g/dl	4.20 \pm 0.20	4.30 \pm 0.20	ns	4.53 \pm 0.2	3.97 \pm 0.2	ns
Globulin, g/dl	3.67 \pm 0.13	3.81 \pm 0.13	ns	3.71 \pm 0.13	3.77 \pm 0.13	ns
Creatinine, mg/L	23.98 ^a \pm 0.91	20.81 ^b \pm 0.91	*	21.53 \pm 0.91	27.26 \pm 0.91	ns
Glucose, mg/dl	13.72 \pm 1.86	14.67 \pm 1.86	ns	11.31 ^b \pm 1.86	17.08 ^a \pm 1.86	*
Alkaline phosphatase, U/L	1294.16 \pm 10.98	1317.30 \pm 10.98	ns	1314.04 \pm 11.00	1297.44 \pm 10.98	ns
Lactate dehydrogenase, U/L	612.30 \pm 44.10	743.86 \pm 44.1	ns	751.79 ^a \pm 44.10	604.37 ^b \pm 44.1	*
SGOT, U/L	87.67 \pm 4.62	86.00 \pm 4.63	ns	92.17 \pm 4.62	81.50 \pm 4.62	ns
SGPT, U/L	26.00 \pm 3.79	22.33 \pm 3.79	ns	21.50 \pm 3.79	26.83 \pm 3.79	ns
Inorganic phosphorus, ng/dl	9.69 \pm 2.13	7.83 \pm 2.13	ns	9.34 \pm 2.13	8.17 \pm 2.13	ns
Zinc, μ g/dl	327.35 \pm 58.67	354.52 \pm 58.67	ns	290.79 \pm 58.67	391.10 \pm 58.67	ns
Testosterone, ng/dl	3.96 \pm 0.54	7.41 \pm 0.54	ns	6.77 \pm 1.55	4.59 \pm 1.55	ns
Estradiol, Pg/dl	15.51 \pm 3.57	20.48 \pm 3.57	ns	19.32 \pm 3.57	16.67 \pm 3.57	ns
T3, ng/dl	121.06 \pm 12.86	126.20 \pm 12.86	ns	94.17 ^b \pm 12.86	153.10 ^a \pm 12.9	**
Cortisol, μ g/100 ml	2.44 \pm 0.73	1.55 \pm 0.70	ns	0.95 \pm 0.73	3.04 \pm 0.73	ns

group A/B without/with selenium in southern part of the farm, group C/D without/with selenium in northern part of the farm, means bearing different letters within the same row, differ significantly ($P < 0.05$), ** $P < 0.01$, * $P < 0.05$, ns not significant

Physiological parameters, libido, semen characteristics and scrotal measurements as affected by housing heat radiation

Tables 3 and 4 show that the rectal temperature, libido, sperm motility percentage, sperm cell concentration ($\times 10^9$ /ml) and testes length, percentages of dead spermatozoa and sperm abnormalities were improved significantly ($P < 0.01$ or 0.05) in the rams kept in the southern than in those kept in the northern part of the farm during winter season. Rectal temperature was significantly ($P < 0.01$) affected by housing heat radiation.

The housing heat radiation effect is the change in perception of warmth between the different parts of the farm or between indoors and outdoors measured in THI values.

The estimated THI values were 19.7 and 18.9 in the south and north parts, respectively, of the farm, indicating that THI values were higher with 0.8 THI unit in the southern than in the northern part of the farm. Length of daylight was 10.5 h (Table 2).

The significant increase in testes length in rams kept in the southern than in those kept in the northern part of the farm, may be due to suitability of the ambient temperature more in the southern (20.1 °C) than in the northern (18.8 °C) part of the farm, during winter.

Blood components

Table 4 shows that plasma glucose and T3 hormone were higher significantly ($P < 0.01$ or 0.05), while LDH activity was lower significantly ($P < 0.05$) in rams kept in northern than in those kept in southern part of the farm. The increase in glucose and T3 hormone levels and decrease in LDH activity may be due to the decrease in THI in the northern than in the southern part of the farm. These results were similar to those obtained in T3 by YOUSEF and JOHNSON (1985) and MARAI *et al.* (1997b) and in LDH by SHAFFER *et al.* (1981) and SALEM *et al.* (1998) and in glucose by HABEEB *et al.* (1992).

The interaction effect

There were no significant interaction effects, except for the scrotal circumference and scrotal length which were high ($P < 0.01$) in the rams supplemented with selenium and raised in the southern part of the farm. Such results confirmed that the southern part (with more 0.8 unit) is more suitable for the animals than the more cold northern part of the farm, during winter. This phenomenon was translated to that the scrotal circumference and the scrotal length were significantly higher in rams supplemented with selenium in the southern (facing the bright sun day light) than in the northern part of the farm (facing the cold air flow), during winter.

Conclusions

Selenium dietary supplementation (with 0.1 ppm/kg DM as sodium selenate) improved most of the ram traits, during winter. The southern part of the building (facing the bright sun day light) increased with 0.8 THI unit than the northern part of the building (facing the cold air flow), and such change improved the ram traits, during winter, under the sub-tropical environment of Egypt.

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