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PHYSIOLOGICAL RESPONSES OF FRIESIAN CALVES TO THYROID EXTRACT SUPPLEMENTATION DURING COLD WINTER CONDITIONS

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SUMMARY

Ten Friesian calves, averaged 90 kg live body weight and aged six months, were randomly allocated into two equal groups. One group (G1) was supplemented orally with a single dose of thyroid extract (60 mg/head / week) for 12 weeks and the other group (G2) served as a control. Animals were housed outdoors during cold winter conditions. No significant effect of thyroid treatment on daily gain and feed conversion was observed. Thyroid treatment resulted in metabolic changes that was reflected by an increase ($P< 0.05$) in plasma albumin, glucose, potassium, triiodothyronine and thyroxin (T_4), in addition to an increase ($P<0.05$) in rectal temperature and respiration rate. No significant differences were found due to thyroid treatment on plasma total protein, globulin, albumin/globulin ratio, cholesterol, total bilirubin, GOT, GPT, sodium, leukocytes count, blood packed cell volume or hemoglobin concentration. The results indicated insignificant effects of thyroid extract supplementation on growth performance of growing calves under cold environmental conditions.

Keywords: Friesian, cold stress, calves, thyroid extract, physiological

INTRODUCTION

Friesian cattle have been imported into Egypt for milk production . Most of those imported Friesian cattle are located in the Delta, while a few are located in upper Egypt (eg. Minia governorate, which is confined between the eastern and western desert of Egypt). The weather in such areas is characterized by very low ambient temperature in winter (El-Barody, 1987) averaging 2.1° C in early morning, (1.3°C in December) with 70.2 - 71.3% relative humidity (December through February).Under such conditions Friesian cattle suffer environmental cold stress (Kotby *et al* ., 1987 and Tong *et al.*,1987) which has negative effect on animal growth (Slee, 1985 and Young, 1985).Cold stress also has negative effect on milk and reproductive performance as reported by Lee *et al.* (1975) and Shafie (1985 & 1993). Lower ambient temperature results in a significant decrease in rectal temperature (RT) and respiration rate (RR) , (El-Barody, 1987). Meanwhile, Scibilia *et al.* (1987), found that, weight gain, RT, RR, water intake, and concentration of plasma glucose and prolactin were lower for calves housed at -4°C than those housed at 10°C. Moreover, those calves housed at -4°C required 32% more energy for maintenance than calves housed at 10°C. Friend *et al.* (1987) postulated that, exposing Holestein Friesian male calves to cold stress resulted in an increase of triiodothyronine (T_3), thyroxine (T_4) and adrenocorticotrophic concentrations that induced cortisol release.

Alleviation of cold stress may help in keeping the animals within or close to the range of their thermoneutral Zone, Therefore, growth, milk yield and reproductive efficiency are expected to be increased.

Injection of thyroxine hormone in rabbits increased significantly live body weight, daily body gain, feed efficiency and body temperature (Marai *et al.*, 1994). On the other hand, it decreased significantly each of total lipids and their fractions and increased total proteins, albumin, globulin and plasma T_4 concentration. Injection of triiodothyonine hormone in cold stressed lambs did not affect serum antibody, blood leukocyte counts, or plasma free fatty acids, cerulopasmin and cholesterol concentrations but significantly increased plasma glucose concentration and decreased plasma urea (Cole *et al.*,1994). In particular no available data on the effect of thyroid extract supplementation in cold stressed calves. Therefore, The present study was designed to investigate the physiological response of Friesian calves to thyroid extract administration to adapt with the cold conditions.

MATERIALS AND METHODS

This study was carried out at the Animal Production Department, Faculty of Agriculture, Minia University. Ten Friesian male calves, averaged 90 kg in body weight were used during winter months (December, February). They were randomly allocated into two equal groups. Animals of the first group (GI) were supplemented orally with a single dose (60 mg/head) per week of thyroid extract (produced by Nile company for pharmaceuticals and chemical industries) for 12 weeks. The second group (G2) served as a control .

Animals were housed outdoor and were individually provided daily with concentrate mixture and Berseem (*Trifolium alexandrinum)* according to Tomi (1963) while sugar cane bagasse was offered *ad lib* .Composition of ration fed

(Table 1) was determined according to AOAC (1990). Water was available all the day.

Table 1. Proximate analysis of experimental rations (DM basis)

Item	Concentrate mixture	Sugar cane bagasse	Berseem
Dry matter %	87.01	76.45	13.00
Crude protein %	14.24	3.01	16.62
Crude fiber %	16.01	35.15	15.20
Ether extract %	4.12	0.14	2.64
Ash %	10.54	4.01	13.00
NFE %	55.09	57.69	52.54
Organic matter %	89.46	95.99	87.00

The concentrate mixture used in formulating the experimental rations contained 18% soybean meal; 42% wheat bran; 17% barely; 20% yellow maize; 2% limestone and 1% common salt.

Animals of the two groups were kept under the same managerial and hygenic conditions. The animals were weighed weekly and feed conversion was calculated.

Rectal temperature (RT) and respiration rate (RR,) were recorded at 6:00 a.m. and 3:00 p.m. on the last day of each week for 12 weeks.

Air temperature was recorded daily throughout the experimental period using a thermometer hanged at a level of about two meters from the floor with a psychrometer for the relative humidity (RH,%) recording. Averages of air temperature and RH% throughout the experimental period is illustrated in Table 2.

Table 2. Maximum, minimum and average of air temperature and relative humidity during the experimental period

Month	Maximum	Minimum	Average
		Air temperature (°C)	
Dec.	24.1 ± 0.8	8.6 ± 0.6	15.7 ± 0.6
Jan .	17.9 ± 0.6	3.0 ± 0.4	10.1 ± 0.3
Feb .	20.0 ± 1.0	2.3 ± 0.5	10.9 ± 0.7
		Relative Humidity (%)	
Dec .	92.0 ± 0.9	54.2 ± 1.0	71.6 ± 1.0
Jan .	96.0 ± 0.9	46.8 ± 1.2	73.4 ± 1.0
Feb .	94.9 ± 1.2	35.3 ± 1.7	65.3 ± 1.5

Heparinized blood samples (about 10 ml) were weekly obtained from the jugular vein before feeding. Blood packed cell volume (%) was determined using microhaematocrite tubes and a microhaematocrite centrifuge (1200 r/m). Hemoglobin concentration (Hb) was determined using Haemoglobinmeter .

Counting of white blood cells (WBC) was carried out by Neubaur chamber, using gentiana violet.

Plasma was obtained by centrifugation of the blood samples for 20 minutes at 3000 rpm. Plasma glucose, total cholesterol, bilirubin, glutamic oxalloacetic transaminase (GOT), glutamic pyruvic tranasminase (GPT), total protein and albumin concentration were determined using bio Merieux Rains Kits. Globulin was calculated by subtracting albumin from total protein concentration. Plasma Na^+ and K^+ was carried out using flamephotometer. Plasma T_3 and T_4 were analyzed using RIA technique (Rumsey *et al.*, 1990). Intra and inter assay coefficient of variation were 6.4 and 7.9% for T3 and 5.7 and 6.9% for T_4, respectively. Lower limits of sensitivity were 0.26 ng/ml for T_4 and 0.13 ng/ml for T_3. Data were statistically analyzed using the general liner model (GLM) (SAS,1989).

RESULTS AND DISCUSSION

A- Growth Performance

Results illustrated in Table (3) show that thyroid extract supplementation (TES) to Friesian calves during cold winter conditions did not affect significantly (P>0.05) growth rate or feed conversion as compared to unsupplemented animals. These findings are in harmony with the finding of Rumsey *et al.* (1992) who reported that administration of thyroid hormones in beef steers did not affect body weight gain or protein deposition. It is a quite known that, in cold stress condition, growth gain is low (Scibilia *et al.*, 1987 and Andreoli *et al.*, 1988). In the present study it was clear that animals supplemented with thyroid extracts had slightly and insignificantly higher body gain than control, (871vs. 845g/d), respectively. Scibilia *et al.* (1987) reported that, calves which were exposed to cold stress (- 4° C for 3 weeks) required 32% more energy for maintenance. This may explain why thyroid supplementatoin did not affect significantly body gain and feed conversion. Since, the great part of energy goes to protect animals from cold stress.

Table 3. Effect of thyroid extract supplemenation on growth performance of Friesian calves (Mean ± SE)

Item	Thyroid supplementation (G_1)	Control (G_2)	± SEM	Significance of differences
No of Animals	5	5		
Initial wt. (Kg)	92.0	91.80	6.55	NS
Final wt. (Kg)	165.20	162.80	11.54	NS
Daily gain (g/d)	871.00	845.00	0.05	NS
Daily feed intake as Starch equalivent (Kg/h/day)	2.761	2.740	0.03	NS
Feed conversion (Kg SE/Kg gain)	3.169	3.243	1.42	NS

NS = Not significant (P>0.05)

B- Rectal temperature and respiration rate

Results in Table 4, indicates that, RT and RR responded positively (P>0.05) to TES. The corresponding values of RT were 38.43 ± 0.05 and 38.02 ± 0.05°C at 6:00 a.m. and 38.76 ± 0.05 and 38.28 ± 0.05 °C at 3:00 p.m. for G_1 and G_2 respectively .

In respect to RR, the concomitant values were 19.91±0.34 and 17.81±0.34 respiration/min. at 6:00 a.m. and 23.84±0.34 and 21.71 ± 0.34 respiration/min. at 3:00 p.m. of G_1 and G_2 respectively . Increased RR and RT associated with TES is in agreement with Marai *et al.* (1994) with differences due to animal breed, dose and season of the study. It seems likely that thermogenesis due to protein synthesis and energy metabolism affected by TES contributed to the increase of heat production in the cold stressd calves (Scott *et al.,* 1993) ; therefore, it may cause an increase in RT and RR. Also, it appears that TES led to supply enough readily energy substrate to support thermostability in cold stressed calves and increase the ability of glucose to maintain rectal temperature (Stanko *et al* ., 1992).

Table 4: Effect of thyroid extract supplementation on rectal temperature (°C) and respiration rate at 6:00 a.m. and 3:00 p.m. in Friesian calves

	RT (°C)		± SEM	Sign.	RR		± SEM	Sign.
	G_1	G_2			G_1	G_2		
6:00 a.m.	38.43	38.02	0.05	*	19.91	17.81	0.34	*
3:00 p.m.	38.76	38.28	0.05	*	23.84	21.71	0.34	*
± SE	0 .05	0.05			0.34	0.34		
Sign.	*	*			*	*		

* Significant at 5% level

Blood hematological characteristics:

Results in Table 5, revealed that TES to Friesian calved did not significantly change Hb concentration, PCV% or WBC .

These findings are parallel to the finding of Cole *et al (1994)* who reported that injection of T3 in cold stress lambs did not affect blood leukocyte count and any such hematological characteristics.

D- Blood constituents:

1- Total protein and its fractions

In ruminants and in growing animals in particular the values of plasma protein and its fractions can be used as an indicators to evaluate the ruminant nutritional status and physiological changes (Kumar *et al.*, 1980).

Although the values of plasma total protein, globulin and albumin : glabulin ratio were numerically higher in G_1 than G_2 (Table 5), however, the difference due to treatment was not significant. At the same time, results in Table (5) show that the treated animals (G_1) tended to have higher (P< 0.05) plasma albumin concentration than those in control (G_2). The positive increase in albumin concentration of treated animals is in agreement with the findings of Marai *et al.* (1994). This increase may be due to stimulation of protein synthesis and as a response to the increase in the regulators of GH-mRNA and GH synthesis (Wood *et al.*, 1987) which have a major role in the movement of amino acids and peptides transport and subsequently blood and body protein anabolism. Because albumin is affected more readily than globulin by nutritional factors (Hussein, 1986) and because of their different functions, metabolism and sites of origin, plasma albumin and globulin are subjected to different influences and their concentrations may therefore vary independently of one another. This may be explained in part by the positive response of albumin over globulin in the present study to TES .The part of the protein production contributed to the increase of heat production to protect the animal from the cold weather (Scott *et al* ., 1993) behind the varying response to TES between the two study groups.

Table 5. Effect of thyroid extract supplementation on some hematological characteristics and some blood constituents in Friesian calves (Mean±SE)

Item	G1	G2	±SEM	Significance of differences
Hematological characteristics				
Hemoglobin concentration, g/dl	9.05	8.8	0.11	NS
White blood cell, 10^3	8.0	7.9	1.40	NS
Packed cell volume (PCV%)	38.3	36.2	1.10	NS
Blood constituents				
Total protein (g/dl)	8.32	7.49	0.31	NS
Albumin (g/dl)	3.74	3.02	0.22	*
Globulin (g/dl)	4.84	4.42	0.24	NS
Albumin/ Globulin ratio	0.78	0.63	0.20	NS
Glucose (mg/dl)	67.7	64.8	2.89	*
Cholesterol (mg/dl)	70.42	71.97	3.31	NS
Total bilirubin (mg/dl)	0.689	0.779	0.07	NS
Na^+ (meq/L)	153.3	153.1	4.76	NS
K^+(meq/L)	5.827	4.801	0.23	*
GOT (μ/L)	47.82	48.31	0.36	NS
GPT (μ/L)	13.73	13.86	0.11	NS
T_3 (ng/ml)	0.824	0.701	0.02	*
T_4 (ng/ml)	81.30	61.56	3.23	**

*P<0.05 ** P < 0.01

2- Glucose and Cholesterol

Results in Table (5) revealed that treated animals tended to have higher (P<0.05) plasma glucose concentration than those in control . No significant differences were found in the values of plasma cholesterol concentrations between treated and control animals. These findings are in harmony with those reported by Cole *et al.* (1994) in lambs and Slebodzinki *et al.* (1995) in calves. The increase in plasma glucose in response to TES may be attributed to the increase of 0_2 consumption, carbohydrate metabolism and the increase in the rate of intestinal glucose absorption (Harper *et al* ., 1979). Moreover, it may be due to increased tissue response to the catecholamins and corticoid hormone (cortisol) and decreased insulin like growth factor that may consequently encourage gluconeogenesis and increase glucose availability for thermogensis in cold weather condition (Hadley , 1984 and El-Sasser *et al*, 1993).

3- GOT & GPT and Total bilirubin

Elevation in GOT, GPT and total bilirubin are considered to be good indicator of liver dysfunction (DeRities, 1956 and Sherlock, 1975).

Results in Table(5) indicate that the value of those parameters in plasma did not significantly differ due to treatment. It may indicate that there is no adverse effect of thyroid supplementation on liver function. Bull *et al* . (1991) found correlation between blood total protein, total bilirubin and cholesterol in cold stressed calves. In the present study, there is no significant effect of treatment on total protein or cholesterol, consequently total bilirubin did'not change .

4- Sodium and Potassium

Results in Table (5) indicate that TES treated animals tended to have higher ($P<0.05$) plasma K^+ concentration. However, there was no significant effect due to treatment on Na^+ concentration in plasma. The increase of plasma K^+ in treated animals without concomitant change in Na^+ concentration may be attributed to the role of thyroid hormone in controlling thermoregulation responses to cold weather. There is strong evidence that thyroid hormones stimulate mitochondria oxygen consumption and production of ATP and also increase the number of active plasmalemmal sodium pumps (Edelman, 1974). Inhibition of Na^+, K^+, ATPase activity by sodium pump antagonists markedly reduces the action of thyroid hormones on heat production and oxygen consumption. In winter conditions, increase in oxygen demand results in a concomitant stimulation of the Na^+ pump, and it is speculated that the evolution of nonshivering (metabolic) thermogenesis involved a bypassing of behavioral thermogenesis to a direct stimulation of the Na^+ pump by thyroid hormones to produce heat .(Stevens, 1973). The previous explanation may answer why there was no difference in Na^+ concentration between G1, and G2. Thyroid hormones decrease plasma aldosterone and that could be the reason for the observed increase in plasma K^+ (Quinn and Williams, 1988) during winter.

5- Thyroid hormones

Results in Table (5) showed that TES resulted in an increase in thyroxine (T_4, P<0.01) and triiodothyronine (T_3, P<0.05) hormone concentrations in plasma of G1 in comparison with G2 (control) . These findings are in agreement with Marai *et al.* (1994) in rabbit and Hibbitt and Baird (1967) in dairy cows and Kamar *et al.* (1979) in chickens. It may be a result of elevated circulating thyroid hormone levels .

In conclusion thyroid extract supplementation to growing calves under cold winter conditions increases circulating levels of thyroid hormones which stimulate metabolic rate. Such increase in metabolic rate was associated with increased heat increment, as reflected by increased RT and RR , without adverse effect on liver function . However, the increase in metabolic rate was sot realized insignificant improvement in growth performance of calves under the prevailing conditions of this study. Extensive studies was demand to clarifiy the effect of different doses of thyroid extract with different levels of energy and protein supplemented of growing calves under cold winter conditions.

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الإستجابات الفسيولوجية لعجول الفريزيان المعطاه مستخلص الغده الدرقية خلال ظروف الشتاء البارد

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أستخدمت عشرة عجول فريزيان متوسط أوزانها ٩٠ كجم وعمرها ٦ شهور في مجموعتين متساويتين أعطيت المجموعة الأولى جرعه واحدة من مستخلص الغده الدرقية (٦٠ ملليجرام/رأس/ أسبوع) ولمدة ١٢ أسبوع و أستخدمت المجموعة الثانية كمجموعة مقارنة. تم إسكان الحيوانات حره خلال فصل الشتاء البارد وأظهرت النتائج أنه لم يكن هناك تأثير معنوى للمعاملة بمستخلص الغدة الدرقية على كل من الزيادة اليومية وكفاءة تحويل الغذاء. أظهرت المعاملة بمستخلص الغدة الدرقية تغيرات في التمثيل الغذائى والتى أنعكست بدورها على زيادة معنوية بإحتمال ٥٪ في تركيز كلا من الألبيومين ، الجلوكوز ، البوتاسيوم . الترا.ايودوثيرونين والثيروكسين في بلازما الدم علاوه على زيادة معنوية بإحتمال ٥٪ في درجة حرارة المستقيم ومعدل التنفس ، ولم يلاحظ أى إختلافات معنوية في تركيزات كل من البروتين الكلى ، الجلوبيولين ونسبة الألبيومين: الجلوبيولين، الكولستيرول، البليوروبين، أنزيمات الكبد -(GPT GOT)، الصوديوم وعدد كرات الدم البيضاء، والحجم النسبى للمكونات الخلوية وتركيز الهيموجلوبين فى الدم .

نخلص من هذه الدراسة بأن إمداد العجول النامية غذائياً بمستخلص الغدة الدرقية تحت ظروف البرد القارصه يشجع زيادة إفراز هرمونات الغدة الدرقية (الترا ايودوثيرونين والثيروكسين) والتى بدورها تزيد من معدل التمثيل الغذائى وإنطلاق الجلوكوز وينعكس ذلك على زيادة درجة حرارة المستقيم ومعدل التنفس بدون حدوث أى تأثيرات عكسية على وظائف الكبد بينما لم ينعكس ذلك على زيادة معنوية في معدل نمو العجول .