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THE ROLE OF PROBIOTICS IN AMELIORATING HEAT LOAD IN LACTATING FRIESIANS DURING SUMMER UNDER NORTH SINAI CONDITIONS

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SUMMARY

To study means of improving milk production of heat stressed Friesian cows during hot summer of Egypt, 14 lactating Friesians and 10 mature Friesian bulls were used. The effects of winter, heat stressful conditions of summer season and amelioration of these conditions by Bospro supplementation were studied. Daily milk yield and milk fat, protein, ash, lactose, total solids and solids not-fat decreased ($P<0.05$ and $P<0.01$) in summer compared to winter values. Similarly, plasma thyroxine and serum total protein, albumin, globulin, total lipids, urea-N and creatine decreased ($P<0.05$). On the other hand, rectal temperature, respiration rate, SGOT and SGPT increased ($P<0.05$) in summer than in winter.

Bospro treatment during hot summer resulted in significant ($P<0.05$) improvements in daily milk yield, milk fat and protein, and thyroid, liver and kidney functions as indicated by the significant increase in each of blood thyroxcine, total protein, albumin, globulin, total lipids, urea-N and creatine and the digestabilities of CP, CF and EE.

Keywords: Cattle, heat stress, milk, probiotics, physiological parameters

INTRODUCTION

Bospro as a pre-probiotic product is not a hormone, is non toxic, leaves no milk or carcass residues, has no deleterious effect on the organoleptic qualities of milk and does not require withdrawal prior to slaughter.

Bospro is a concentrated source of beneficial compounds and microbes having catalytic, probiotic and enzymatic properties. It contains natural and artificial flavors to improve feed palatability and to stimulate and stabilize appetite (Pet-Ag., 1993). With Bospro, rumen microbes multiply and symbiosis is established among intestinal microflora and consequently production of volatile fatty acids (VFA) in the rumen is stimulated (Pet-Ag., 1987). Some of these VFA are essential to the maintenance of healthy rumen epithelium (absorptive surface) and rumen motility. Further, up to 70

% of the energy required by the lactating cow is supplied by VFA. Consequently, an increase in the production of these acids can result in an increase in milk and milk fat produced. Proliferation of the rumen population is directly attributable to Bospro's complement of amino acids, trace elements (iron, manganese, zinc, copper, cobalt and iodine), B-complex vitamins, strepogenin and betaine (Pet-Ag., 1993).

Bospro including Aspergillus, helps the gut microflora to grow and alter the rumen microflora to favour the increase of VFA production (Akin and Borneman, 1989 and Pet-Ag., 1993). Much of the literature on Bospro product indicates that its catalytic and enzymatic properties improved rumen and intestinal function with beneficial effects on appetite, performance and health enabling cows to utilize low quality roughage more efficiently (Nisbest and Marten, 1989) under thermoneutral conditions.

On the other side, heat stress resulted in drastic changes in biological functions of the animal's body and, consequently, lower productivity (Abdel-Samee *et al.*, 1994 and Abdel-Samee 1995). Metabolism of carbohydrate, protein, fat, minerals and vitamins are disturbed under heat stress conditions due to depression in appetite and feed consumption. Hormonal profiles, especially anabolic hormones such as insulin, GH, cortisol, T3 and T4 are also disturbed (Abdel-Samee *et al.* 1989; Abdel-Samee, 1991 and 1992). The mechanisms by which animals face elevated environmental temperature vary greatly. These include the development of structural and functional modifications, mechanisms concerned with heat storage, evaporative cooling and behavioral responses. Alleviation of the heat load by providing suitable feeding, housing and management could help heat stressed animals to express their genetic potentialities (Abdel-Samee *et al.*, 1992 and 1994). The present experiments were carried out to study the effect of Bospro supplementation in alleviating heat load on lactating Friesian cows during the hot summer of El-Arish, North Sinai, Egypt.

MATERIALS AND METHODS

Two experiments were carried out in the present study. In experiment 1, seven lactating Friesian cows were maintained under El-Arish winter conditions (Mid-December to Mid-January) to study the effect of mild climate on milk production and some related biological functions (Group A). Another seven lactating Friesians, similar to the animals used in Group A in age, body weight and physiological status were maintained under summer climate (Mid-June to Mid-July, Group B) to study the effect of heat stress on milk production and some related biological functions. Group A was used as a control for group B. After the end of hot summer treatment, the same animals in Group B were subjected to Bospro supplementation under the same conditions to study the effect of Bospro in improving milk production during the hot summer season of Egypt. Each animal was used as a control for itself due to eliminate the possible interference of individual variations and managerial factors with the treatments. In experiment 2, ten mature male Friesian calves were divided into two equal groups (C & D) and were maintained under summer conditions. Group D was supplemented with Bospro and Group C was used as control to study the effect of Bospro on feed digestibilities. Experimental design, numbers of animals and periods of the study are presented in Table 1. The lactating cows were of similar ages (4-5 years), body weights and physiological status and were in their second lactation during 90 -120 days post-partum.

The experiments were carried out in the Experimental farm of Animal Production Department, College of Environmental Agricultural Sciences, Suez Canal University, El-Arish. North Sinai. Laboratories of Animal Wealth Department, Institute of Efficient Productivity, Zagazig University and Animal Production Research Institute, Agriculture Research Center, Ministry of Agric., Egypt, were involved.

Table 1. Experimental design of the study.

Items	group	No. anim.	Initial B W	Season	Experimental period	Climate °C Max.	Min.
Experiment 1:							
Effect of mild climate on milk production and some related biological functions	A	7	447.5 ± 19.3	Winter (Mid-December to Mid-January)	30 days	12.7	5.1
Effect of hot climate on milk production and some related biological functions.	B	7	439.8 ± 22.6	Summer (Mid-June to Mid-July)	28 days	34.5	24.1
Amelioration of heat stress using Bospro to improve milk production.	B	7	440.5 ± 20.7	Summer (Mid-June to Mid-July)	28 days	34.5	24.1
Experiment 2:							
Effect of feeding Bospro on feed digestibilities of Friesian bulls	C, control	5	211.7 ± 2.9	Summer (Mid-June to Mid-July)	22 days	34.5	24.1
	D, treated	5	213.7 ± 4.1	Summer (Mid-June to Mid-July)	22 days	34.5	24.1

The meteorological data during the experimental period are shown in Figure 1. The temperature humidity index (THI) as indicator of adverse climatic conditions, was produced from a combination of wet and dry bulb air temperature for a particular day. The following equation was used: THI = db - (0.55 - 0.55 RH) (db - 58), where: db is the dry bulb temperature (° F) and RH is the relative humidity ÷ 100. See livestock and poultry heat stress indices suggested by Agricultural Engineering Technology Guide, Clemson University, Clemson, SC. 29634, USA. THI values of less than 72 are probably not stressful, of 72 to 78 are stressful and of over 78 extreme distress occurred and animals were unable to maintain thermoregulatory mechanisms or normal body temperature.

The animals were provided with a basal ration consisting of pelleted concentrates, rice straw and a free choice mineral salt mixture in dry lot to satisfy their nutritional requirements. The chemical composition of the concentrate feed and rice straw is

given in Table 2. The animals were watered freely *ad-libitum*. The drinking water (tap water of El-Arish) contained 3251, 231, 100, 31, 314, 31, 6, 6, 82, 592 and 600 ppm total dissolved solids, Ca, Mg, K, Na, Zn, Mn, Carbonate, Bicarbonate, Sulfate and Chloride, respectively and pH was 7.8.

The lactating cows were left loose in a yard measured 120x20 m and was surrounded by wire. The floor was of soil. One third of the surface area of the yard was covered at about 3.5 m high with an asbestos roof. Each group of animals was housed during day and night and the ventilation was by open air.

The animals were subjected to Bospro treatment at the rate of 30 g/head/day (Udomprasert *et al.*, 1992) and lasted for 28 days (which included a seven days adaptation period.

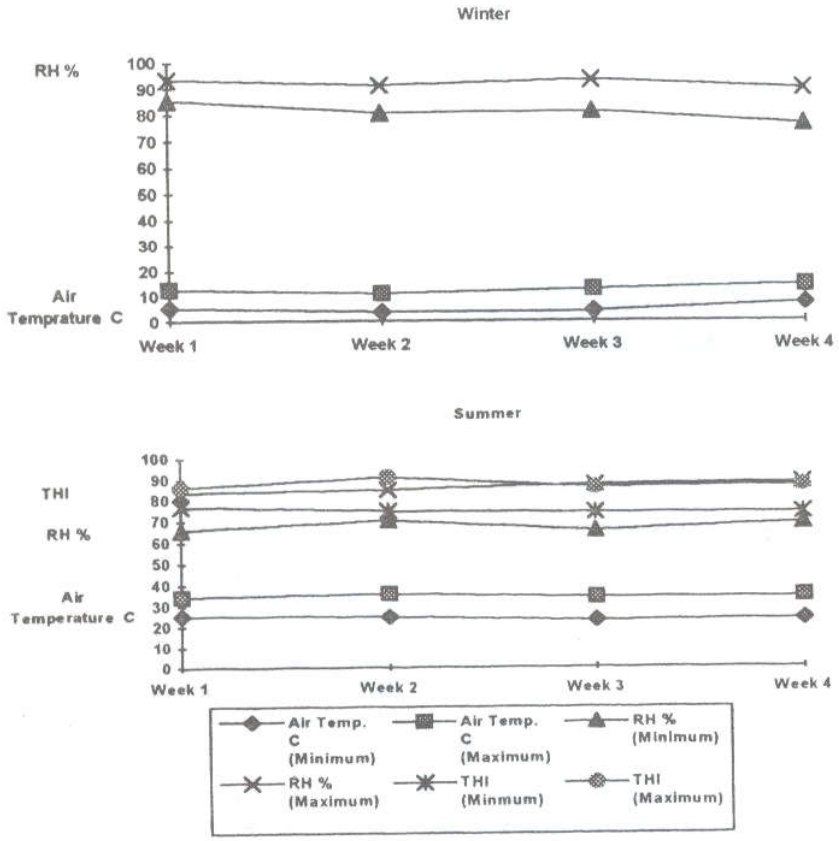

Figure 1. Air temperature°C, temperature humidity index (THI) and relative humidity (RH %) during the experimental period (winter and summer)

Cows were milked two times daily at 8:00 and 16:00 hr. and the yields were recorded. Milk samples from four consecutive milkings at the last two days of each treatment were composited and frozen until analyzed for total solids, total protein, bufferfat, lactose, ash and solids-not fat as described by Ling (1963). Rectal temperatures and respiratory activities were recorded twice weekly at 13:00 hrs.

On the last day of each treatment, blood samples were withdrawn before morning feeding from the mammary vein of each animal. The plasma and serum were separated within one hour by centrifugation and stored at -20 °C pending biochemical analysis. Plasma thyroxcine (T4) was assayed by kits purchased from Diagnostic Products Corporation, Los Angelos, California, USA. Serum total protein, total lipids and creatine were determined using reagent colorimetric methods. Serum glutamic oxaloacetic transaminase (SGOT), glutamic pyruvic transaminase (SGPT), urea-N and albumin were determined using commercial kits purchased from Bio-Merieux, laboratory Reagent and Products, France. The globulin values were obtained by subtracting albumin from total protein.

In Experiment 2, digestibility trials were conducted using two groups of Friesian bull calves to evaluate the addition of Bospro to the basal diet. Preliminary and collection period were 15 and 7 days, respectively. The concentrate mixture, rice straw and water were offered twice daily, Proximate analysis of concentrate mixture, rice straw and feces were carried out according to the official methods of A.O.A.C. (1980). Data were analyzed using the student's "t" test (Snedecor and Cochran, 1982).

Table 2. Chemical composition of pelleted concentrate feed, rice straw and Bospro.

Feeds	Proximate analysis (%)						
	DM	OM	CP	CF	EE	NFE	Ash
Concentrate mixture	91.5	85.4	17.9	13.3	3.8	50.4	14.6
Rice straw	92.1	80.2	3.2	33.7	1.4	41.9	19.8
Bospro	91.0	85.8	17.6	28.1	3.2	36.9	5.2

RESULTS AND DISCUSSION

Effect of high environmental temperature

High environmental temperature resulted in adverse effects on production traits of lactating Friesians (Table 3). These includes a significant ($P<0.05$) decrease than winter values in daily milk yield (21.3 %) and it's composition, total solids (17.1 %), fat (14.0%), protein (16.3 %), ash (13.3 %), lactose (19.5 %) and solids not fat (18.1 %). The present results are in agreement with Habeeb *et al.* (1989). This may be due to the disturbing of body thermregulation as indicated by increasing rectal temperature (4.6%) and respiration rate (247 %) as shown in Table 3. The reduction in thyroid, liver and kidney functions and blood metabolites studied as indicated in Table 3 my also lead to these pronounced decreases in productive traits of heat stressed Friesians. On the other side, the metabolism of carbohydrate, protein, fat, minerals and vitamins is disturbed under heat stress conditions due to depression in both appetite and consequently feed intake and also in anabolic hormones (Abdel-Samee *et al.*, 1989; Kamal *et al.*, 1989 and Abdel- Samee 1991 and 1992). This results in low levels of glucose, protein, fat, minerals and energy

the biosynthesis of milk, and consequently the milk yield decreases under hyperthermic conditions. The utilization of energy for milk production is reduced by 30 to 50 % under heat stress conditions (McDowell *et al.*, 1969). Another explanation of the decrease in milk production due to heat stress may be through the activity of the calorigenic hormones and enzymes. Their concentration decreased as a function of heat stress in an attempt by animals to diminish heat production to counteract the increased heat load due to heat stress. However, the increase in SGOT and SGPT (Table 3) may be due to the impaired function of the liver under heat sterss (Shaffer *et al.*, 1981).

Table 3. Milk production and some related physiological and biochemical changes in Friesians as affected by Bospro supplimentation during heat stress.

Item	Winter (W)	Summer (S)			
		Control (C)	Change % @	Treated (T)	Change % @@
Milk yield (Kg/day)	15.3±1.0	12.0±0.8	-21.3**	13.8±1.0	+14.4**
Milk composition (%)					
Total solids	15.7±0.6	13.1±0.6	-17.1**	14.0±0.6	+ 7.28
Fat	3.8 ±0.1	3.3 ±0.1	-13.95*	3.6 ±0.1	+10.4**
Protein	3.9 ±0.2	3.3 ±0.2	-16.3**	3.8 ±0.2	+15.6**
Ash	0.8 ±0.1	0.7 ±0.1	-13.3**	0.7 ±0.0	+ 7.69
Lactose	7.3 ±0.8	5.9 ±0.4	-19.53*	5.9 ±0.7	+ 0.85
Solid not-fat	11.9±0.6	9.8 ±0.6	-18.1**	10.4±0.6	+ 6.24
Thermoregulation:					
Rectal temperature,°C	38.6±0.1	40.3±0.1	+ 4.6 **	40.2±0.2	- 0.01
Respiration rate (rpm)	25.8±5.4	89.5±10	+247**	92.5±16	+ 0.03
Thyroid function:					
Plasma thyroxcine (mg/ml)	51.3±4.2	40.1±5.1	-21.9**	46.3±4.2	+15.5**
Liver functions:					
Serum total prot.(g/dl)	8.2 ±0.2	6.9± 0.2	-16.1**	7.5±0.2	+ 9.6*
Serum albumin (g/dl)	3.8 ±0.1	3.6± 0.1	- 6.8*	3.8±0.1	+ 7.0 *
Serum globulin (g/dl)	4.4 ±0.1	3.3± 0.1	-24.3	3.7±0.1	+12.4 *
A/G ratio	0.9 ±0.1	1.1± 0.1	-22.7	1.0± 0.1	- 4.63
Serum total lipids (g/dl)	396 ±40	312±26	-21.3**	357±32	+14.4 **
Kidney functions					
Serum GOT (unit/dl)	72.8±3.1	83.1±0.9	+14.1**	79.9±3.1	- 3.8
Serum GPT (unit/dl)	17.1±1.9	23.7±0.3	+38.3**	24.6±1.8	+ 3.9
Serum urea-N (mg/dl)	20.1±0.9	15.7±0.5	- 22.1	17.6±0.9	+12.3*
Serum creatine(mg/dl)	0.8 ±0.1	0.59±0.5	- 27.2	0.7±0.1	+10 **

@ Change %: [(C-W) / W] x 100, @@ Change %: [(T-C) / C] x100,
* $P < 0.05$ and ** $P < 0.01$.

Effect of Bospro treatment in alleviation heat stress

Supplementation of the heat stressed lactating Friesians with Bospro (Table3) significantly ($P<0.05$) increased daily milk yield and milk fat and protein content by

14.4, 10.4 and 15.6 %, respectively. This may be due to ,the significant increase in plasma thyroxcine (15.5 %) and serum total protein (9.6%), albumin (7.0 %), globulin (12.4%), total lipids (14.4 %), Urea-N (12.3 %) and creatine (10.2 %) as indicated in Table3. The present improvements in milk production and blood components of heat stressed Friesian supplemented with Bospro may be due to the significant increase in the digestibilities of CP, CF and EE of the ration supplemented with Bospro (Table 4). Moreover, Bospro supplementation may increase the volatile fatty acids by altering the rumen microflora. Additionally, cobalt and both natural and artificial flavors are included to stimulate and stabilize appetite. Bospro's complement of amino acids, trace elements, B-complex, vitamins, strepogenin, betaine, cellulases, amylases and squalene in the rumen may help in alleviating heat sterss (Pet-Ag., 1987). Similar results were reported by Udomprasert *et al.* (1992) who found that feeding Bospro at the rate of 30 grams/cow/day increased daily milk yield under thermoneutral conditions.

Table 4. Feed intake and apparent digestibility of Friesian bull calves fed a ration with or without Bospro.

Item	Control (C)	Treatment (T)	Change% @
Average body weight (kg)	211.7 ±2.85	213.7 ±4.09	-
Feed intake:			
DM kg/100 kg B.W.	2.53 ±0.002	2.5 ±0.003	-
Digestibility (%):			
DM	67.0 ±0.231	67.6 ±0.552	+ 0.91
OM	71.1 ±0.077	71.4 ±0.519	+ 0.04
CP	71.7 ±0.145	79.0 ±0.332	+ 10.4 *
CF	66.0 ±0.168	78.9 ±0.513	+ 19.6 *
EE	70.5 ±0.897	80.2 ±0.439	+ 13.8 *
NFE	72.9 ±0.235	71.2 ±0.618	- 2.36

@ Change %: [(T-C) / C] x 100
** P < 0.05.*

Data presented in Table 4 shows the effects of Bospro supplementation on feed intake and digestibility of heat stressed Friesian bull calves. The digestibilities of CP, CF and EE increased ($P<0.05$) due to Bospro supplimentation. This may be attributed to that Bospro comprised primarily of an aspergillus source of fungal fiber which allows the complete digestion of the feed in the rumen (Pet Age, 1987). However, the digestibilities of DM and OM did not change significantly as a function of Bospro supplementation. Turnbull (1989) and Udomprasert *et al.* (1992) found that Bospro feeding increased DM digestibility of both high and low quality ration.

Conclusively, it seems that the Bospro supplementation treatment is a simple, safe, economical and practical method for decreasing the heat stress effects on animals and consequently improving milk production under hot climate.

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دور البادئـــات الحيـــوية فى تخفيف العبىء الحـــرارى فـى الأبقـار الفريزيـان الحلابـــة أثناء الصيـف تحت ظروف شمال سيناء

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إستخـدم فى هذه الدراسـة ١٤ بقرة فريزيان و عشرة عجول ناضجة للتعرف على تأثير الجـو الحـار على إنتاج اللبن و مكوناته و بعض الخصائص الفسيولوجية و البيولوجية المصاحبة، و أيضا لدراسة إمكانية استخدام البوسبرو لتخفيف العبىء الحرارى عن الأبقار الحلابة، و كانت النتائج كما يلى:

أولا: تعرض الأبقار لدرجات الحـرارة العالية صيفا أدى الى إنخفاض انتاج اللبن (٢١ ٪) و مكوناته من الجوامد الكلية (١٧ ٪) و الدهن (١٤ ٪) و السبروتين (١٦ ٪) و الرمـاد (١٣ ٪) و اللاكتـوز (٢٠ ٪) و الجوامد اللادهنية (١٨٪). و قد يرجع هذا إلى إختلال الأتزان الحرارى، حيث لوحظ إرتفاع معنوى فى درجة حرارة المستقيم و معدل التنفس (٢٤٧ ٪). كذلك إنخفض نشاط الغدة الدرقية حيث نقص تركيز الثيروكسين معنويا فى الدم (٢٢ ٪). أيضا إنخفض نشاط الكبد، حيث لوحظ إنخفاض معنوى فى تركيز الدم من كل من البروتـين الكلى (١٦ ٪)، و الألبيومين (١٧ ٪) و الجلوبيولين (٢٤ ٪) و الليبدات الكليه (٢١ ٪)، و فى نفس الوقت حدث خلل فى نشاط الكلية، حيث لوحظ إنخفاض معنوى فى تركيز اليوريـا (٢٢ ٪) و الكرياتين (٢٧٪) فى الدم. بينما حدثت زيادة معنوية فى تركيز الانزيمات الناقلة لمجموعة الأمين فى الدم.

ثانيا: إمداد الأبقار المعرضة للاجهاد الحرارى بالبوسبرو ساعد على تخفيف العبىء الحرارى، و أدى إلى تحسين معنوى فى انتاج اللبن (١٤ ٪) و الدهن (١٠ ٪) و قد يرجع هذا إلى إصلاح الخلل فى معظم المقاييس الفسيولوجية و البيولوجية المدروسة مثل نشاط الغدة الدرقية و الكبد و الكلية. أيضا إمداد العجول الناضجة بالبوسبرو أدى إلى تحسن معاملات الهضم لكل من البروتـين و الألياف و الدهن الخام معنويا.