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Evaluation of Some Hemato-Biochemical Parameters and Growth Performance of Friesian Calves During the Suckling Period Under Egyptian Conditions

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THE greatest challenges facing dairy farmers is heat stress. The summer season in Egypt is relatively long. This experiment aimed to study the effect of summer heat stress on some haemato-biochemical parameters and the growth performance of suckling Friesian calves. Eighteen Friesian calves with an average body weight of 30±1.5 kg were used and assigned into two groups (n= 9). The calves in the first group were reared inside an open pen without fans or sprinkling water. While the calves in the second group were reared in a well-ventilated fans pen as well as, the calves were sprinkled with water daily from 10 a.m. to 2 p.m. The results revealed that feed intake and body weight gain were significantly (P<0.05) decreased while water intake was increased by heat stress (HS). Also, parameters such as rectal or core body temperature (RT), respiratory rate (RR) and pulse rate (PR) are increased significantly. The levels of serum total protein and glucose decreased. Moreover, haemoglobin (HB) level, red blood cells (RBC), and total leukocytic (WBC) counts were significantly reduced in heat-stressed calves. It is concluded that keeping calves in a hot environment leads to a series of metabolic and physiological changes to reduce this stress.

Keywords: Blood parameters; Friesian calves; Heat stress; Physiological parameters; Sprinkling water.

Introduction

The Egyptian climate can lead to heat stress (HS), especially during the summer season, which characterized by high relative humidity (RH) and ambient temperatures, which has a negative impact on animal productivity [1]. There is a decrease in the animal's productivity arising from altering physiological metabolism [2], which is commonly related to HS. With high ambient temperatures, body reaction values increased linearly. This means that core body temperature (CT), skin temperature (ST), and breathing rate (BR) all have a strong connection with ambient temperatures [3]. When the animals are stressed outside their comfort zone, they try to maintain homeostasis [4]. Some researchers studied the changes in the level of blood metabolites when animals were exposed to different ambient temperatures [5]. In the cold, the main difference between normal and abnormal body temperatures is 15-25 ºC, and only around 3-6 ℃ in the heat [6]. This explains why HS represents more problems than colds. All researchers agreed that there was a lower daily weight gain under heat stress [7]. This may be explained by the lower feed intake of neonates in the hottest seasons [8,9].

High ambient temperatures affect the performance and well-being of calves in the pre-weaning phase [10]. Exposure to high ambient temperatures deteriorates the growth performance of calves [11]. However, scientific researchers have proved that there is an influence of HS on feed conversion ratio (FCR), physiological parameters, rumen development, and reproduction of heifers and calves [12]. These worst impacts play an important role in the future calves' productive life. However, environmental status, especially the thermal one inside the hutch used for keeping calves, wasn't evaluated enough by scientific researchers [13]. The calves kept under shade had a lower heart rate than calves exposed to solar radiation [14]. Evaporative heat loss can occur through increased respiratory frequency. The first sign of thermal discomfort is

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altered calves behaviour. In high ambient temperatures, calves change their posture, seek shade, reduce movement, and collect to make a shade for each calf [13]. Also, a low frequency of changing posture during the hottest climate is considered a sign of discomfort [15]. Some researchers advised to use Insulin-like growth factor 2 (IGF2) as a marker for the growth traits selection strategies in farm animals which plays an important role in muscle growth [16]. To date, the main challenge in the animal husbandry is HS, due to a little study on association of some haemato-biochemical parameters with growth performance of Friesian calves during suckling period has been reported. The main aim of this experiment was to explore the impacts of summer heat stress during the suckling period on Friesian calves' feed consumption, growth rate, and some blood biochemical and haematological responses.

Material and Methods

Ethical considerations: The ethical considerations of the protocol of this study have been approved and conducted in accordance with the recommendations of the Guide Lines of Animal Care and Use of Lab Animals in Research by the Animal Ethics Committee, Faculty of Veterinary Medicine, Kafrelsheikh University, Egypt.

Animals and experimental design: The current study was carried out at the Alomdah Draz Animal Farm, Mahallet Diay, Desouq, Kafrelsheikh Governorate, Egypt. During the experimental period (July, August, and September 2021), the ambient temperature and humidity index (THI) were calculated (Table 1) using the following equation [17]:

THI = (0.8XT) + H/100X (T-14.4) + 46.4),

Where H: is the relative humidity and T: is the ambient temperature.

Eighteen Friesian calves (their average body weight is 30 ±1.5 kg) were selected in this study and assigned into two groups (n= 9) each with three replicates. The calves in the first group (the control group) were reared inside an open pen without fans or sprinkling water. While, the second group of calves reared in a well-ventilated and containing fans pen, the calves were sprinkled with water three times daily every two hours from 10 a.m. to 2 p.m. to assess the harmful effect of heat stress on calves' performance and some haemo-biochemical parameters during the pre-weaning period. Firstly, all calves were fed whole milk two times /day at 7 and 19 hrs in plastic buckets. Secondly, mixed starter (20% wheat bran, 15% soya bean, 34% ground corn, 10% linseed, 2% limestone, 1% common salt, 15% rice bran, and 3% molasses) was provided *ad libitum* in a large known weight amount every day at 9 a.m. feed refusal from each individual calf was calculated; also, hay was offered once a day at eleven morning. Calves were weaned at 90 days of age.

Calves were fed their recommended requirements [18]. Water was accessed all day. In the morning before feeding, calf body weight was recorded monthly and body weight was recorded to the nearest kg. At the time of weaning, the pre-weaning body weight gain was calculated. Calf starter and water intakes and feed efficiency were also calculated.

Blood samples (10 ml from each calf) were taken weekly via the jugular vein into sterile and clean glass tubes, which were divided into two parts. In first part, the blood was collected in heparinized tubes for measuring haematological parameters. Whereas the second part of the blood was collected in unheparinized tubes then (and) left for an hour to clot at room temperature. Serum separation was done by centrifugation for 10 minutes at 3000 rpm. Then the aspirated serum was stored at –20 ℃ until analysis. Plasma total protein (albumin and globulin), creatinine and urea, glucose, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were measured using analytical kits from Diamond Diagnostics Drug Company, Egypt. Haematological parameter assessment was performed using the Procyte (IDEXX, SUA) blood cell counter [19]. Total leukocytic count (WBC), red blood cell count (RBC), and haemoglobin (HB) concentration. Rectal body temperature (RT) was taken using a modern regular digital thermometer ((Thomas Allbutt), and) the body temperature was recorded to the nearest 0.1 ℃. Respiratory rate (RR, cycle/minute) was measured by observing the movement of the left flank for a minute. Also, the pulsation rate (beats/min) was measured using a stethoscope for a minute. Data were collected at 9 and 15hrs.

Statistical analysis

For statistical analysis, an independent two-sample T test was performed using Minitab® 19 for Windows [20]. A statistical significance was checked for $P< 0.05$.

TABLE 1.Temperature-humidity index (THI) for experimental period.

Pen	Ambient temperature ^{o}C	Relative humidity%	Temperature-humidity (index (THI))
		Heat-stressed group	
July	33.4	75	65.97
August	34.2	79	68.37
September	29.3	80	62.30
		Treated group	
July	28.2	74	59.22
August	29	75	60.47
September	27.1	77	58.74

Results

The results of heat stress effects on ingestive behavior (food intake and water intake) and growth performance are presented in table 2. Data revealed that calves reared in the heat stressed group had lower FI (of) 1.585±0.14 kg and body weight gain of 658.70 ±3.11 g than those in the treated group of 1.889±0.22 kg and 707.73 ±2.53 g, respectively.

On the other side, the water intake among calves in the live heat-stressed group (3.77 0.31 L) was increased compared to 3.17±0.52L for treated group. The data in table 2 shows the impact of heat stress on physiological parameters. There was a negative effect of heat stress on rectal temperature (RT), respiration rate ((RR), and) pulse rate (PR). All physiological parameters, RT, RR, and PR, are showing a significant increase (38.9±0.23 ^{o}C, 24±0.86 cycle/min, and 66±0.43 beat/min, respectively) in calves living in the heat-stressed group compared to calves in the treated group (38.1±0.78 ^{o}C, 19±0.41 cycle/min and 59±0.52 beat/min, respectively).

Blood serum biochemicals of suckling Friesian calves under HS are presented in Table 3. The levels of glucose and plasma total protein were significantly ($P<0.05$) lower in treated calves than those in the control group. While albumin concentration didn't show any differences. In addition, the levels of urea and creatinine were significantly ($P<0.05$) lower for treated calves than those in the control group. The levels of AST and ALT in serum were higher in control-grouped calves than those in the treated group. Data on haematological parameters are presented in table 3. Mean values of haemoglobin (HB) level (9.78±0.43 g/dl) and count of white blood cells (10.38±0.42 $\times10^{3}$/µl) and red blood cells (7.76±0.18 $\times10^{6}$/µl) were significantly decreased ($P<0.05$) in the heat-stressed group in comparison to the treated group (10.36±0.16 g/dl, 11.34±0.45 $\times10^{3}$/µl and 8.57±0.07 $\times10^{6}$/µl, respectively).

TABLE 2. Effect of heat stress on the performance and physiological parameters of suckling Friesian calves

Items	Heat-stressed	Treated	*P*-value
Number of calves	9	9	
Suckling period (day)	90.04 ±1.33	90.02 ±1.22	0.241
Birth weight (kg)	30.44±0.25	30.23±0.12	0.465
Weaning weight (kg)	86.75±1.15	93.94±1.41	0.003
Total weight gain (kg)	56.31±0.75	63.71±0.45	0.007
Daily feed intake (intake (Kg))	1.585±0.14	1.889±0.22	0.006
Water intake (intake liter)	3.77±0.31	3.17±0.52	0.012
Feed conversion ratio	2.41±0.13	2.67±0.46	0.013
Average daily gain (g)	658.70 ±3.11	707.73 ±2.53	0.001
Rectal body temperature (^{o}C)	38.9±0.23	38.1±0.78	0.014
Respiratory rate (cycle/min)	24±0.86	19±0.41	0.015
Pulse rate (beat/min)	66±0.43	59±0.52	0.017

TABLE 3. Means ±SE of haemo-biochemical parameters of suckling Friesian calves during heat stress

Items	Heat-stressed	Treated	*P*-value
Total protein (g/dl)	7.56±0.14	7.02±0.23	0.012
Albumin (g/dl)	3.56±0.42	3.52±057	0.210
Globulin (g/dl)	4.00±0.21	3.50±0.36	0.010
Glucose (mg/dl)	69.24±0.52	61.47±0.64	0.010
Urea (mg/dl)	28.59±0.47	25.88±0.66	0.0141
Creatinine (mg/dl)	1.64±0.47	1.02±0.85	0.013
AST (IU/L)	58.45±0.39	47.76±0.51	0.012
ALT (IU/L)	30.52±0.54	29.57±0.26	0.015
WBC's ($\times10^{3}$/µl)	10.38±0.42	11.34±0.45	0.017
RBC's ($\times10^{6}$/µl)	7.76±0.18	8.57±0.07	0.011
HB (g/dl)	9.78±0.43	10.36±0.16	0.013

*WBCs: White blood cells, RBCs: Red blood cells, PCV: packed cell volume, HB: Haemoglobin**,** AST: Aspartate aminotransferase, ALT: Alanine aminotransferase.

Discussion

In general, Egypt's summer is characterized by high ambient temperatures and relative humidity (RH) resulting in heat-stressed (HS) which everywhere affects the productive performance of livestock species. Calves reared in the heat stressed group had lower FI and body weight gain than those in the treated group. These results are in accordance with those recorded by Place *et al.* [21], who mentioned that calves reared in a hot environment tended to have a lower body weight gain than those reared in the winter season. This may be attributed to the low volume of milk and starter consumed daily by calves. Also, Rauba *et al*. [22] reported that calves born in the hot season had lower starter consumption than those born in the cold season. As well as Broucek *et al*. [23] observed that heat-stressed calves had a low starter intake in comparison with those raised under normal conditions. Similarly, Nonaka *et al*. [24] mentioned that Holstein heifers had lower feed intake and body weight gain under high thermal conditions (32.5 to 34 °C) in comparison with moderate environmental conditions (18 to 20 °C). On the other side, the water intake was higher in calves reared in heat stressed group than that recorded in those for treated group. These results run with those obtained by Nonaka *et al.* [24], who found that daily water intake was increased by 23% under HS due to high evaporative water loss via sweating. These results were explained by the high water requirement for calves in hot weather, as calves will lose more water *through* rapid respiration and more sweating [23]. There was a negative effect of heat stress on rectal temperature (RT), respiration rate (RR) and pulse rate (PR). The values of all physiological parameters; RT, RR and PR were showing a significant increase in calves raised in heat stressed group. Similar results were recorded by Kumar et al. [25], who noted that respiratory rate, pulse rate, and rectal body temperature were higher in calves during the summer. Such alterations in physiological parameters are considered an adaptive mechanism employed for homeostasis and are responsible for the low growth rate during HS. The values of glucose and plasma total protein were significantly ($P<0.05$) decreased in treating calves than those in the heat stressed group. In the same line, Dar *et al.* [26] detected that the levels of globulin and plasma total protein during the coldest season were significantly higher than those during the hottest one. This may be explained by the fact that under HS, there was low gluconeogenesis and glycogenolysis in cattle [27]. These results coincide with those of Vijayakumar *et al*. [28], who found that when buffalo heifers were treated with water sprinklers and fans during the summer season, there was a significantly higher blood glucose level. But, there were no differences in albumin concentration among treated groups. The serum levels of AST and ALT were higher in the heat stressed calves than those in treated ones. The explanation is that higher levels of serum AST and ALT in heat stress are grouped in order to compensate for the negative effects of thermal stress on physiological and biochemical homeostatic mechanisms. Similar results are mentioned by Brijesh [29], who recorded that during thermal stress, there was an increase in serum SGOT and SGPT activity. The higher serum creatinine level in treated calves may be attributed to excess muscular catabolism for energy as a result of low voluntary feed intake in these seasons [30].

Mean values of HB, WBC and RBC counts were significantly declined in the heat stressed calves. This decline may be considered a response of the body's systems to heat-stress stimuli. Contrary to Aengwanich *et al.* [31], there were no significant changes in RBCs between hot and cold seasons in cattle. Another explanation is that animals consumed more water under HS, causing haemodilution and subsequent decreased RBC [32]. However, further confirmatory investigations on large scale are required.

Conclusion

From the obtained results of this study, it could be concluded that rearing suckling calves in a hot environment is likely to deteriorate their growth performance and cause undesirable biochemical and haematological changes in their blood. Sprinkling calves with water and applying fans in the pens may ameliorate heat stress effects.

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Conflicts of Interest The authors declare no conflict of interest.

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تقييم بعض المتغيرات الكيميائية الحيوية للدم وأداء النمو لعجول الفريزيان خلال فترة الرضاعة تحت الظروف المصرية

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أحد أكبر التحديات التي تواجه منتجى الألبان هو الإجهاد الحراري. حيث يعتبرموسم الصيف في مصر طويل نسبيًا. وتنتج أبقار الألبان كمية كبيرة من الحرارة الأيضية وتتراكم فى جسمها حرارة إضافية من الطاقة الشمسية مما يؤدي إلى الحمل الحراري وبالتالي تنخفض إنتاجية البقرة. وتستهدف هذه التجربة دراسة تأثير الإجهاد الحراري في فصل الصيف خلال فترة الرضاعة على بعض متغيرات الدم والكيمياء الحيوية وأداء نمو عجول الفريزيان. تم اختيار ثمانية عشر عجلا من الفريزيان (ن = ١٨) ، متوسط وزن جسمها ٣٠ ± ١,٥ كجم في هذه الدراسة وتم تقسيمها إلى مجموعتين (ن = ٩) مع ثلاث مكررات في كل مجموعة. تم تربية العجول في المجموعة الأولى (المجموعة الضابطة) داخل حظيرة مفتوحة بدون مراوح وبدون رش ماء. بينما تم تربية العجول في المجموعة الثانية في حظيرة جيدة التهوية وتحتوي على مراوح ، بالاضافة الى رش العجول بالماء يومياً من الساعة ١٠ صباحاً حتى ٢ ظهراً.

واظهرت الدراسة انخفاض تناول العلف ووزن الجسم المكتسب بينما زاد تناول الماء بسبب الإجهاد الحراري. سجلت زيادة فى درجة حرارة الجسم المقاسة من المستقيم ، ومعدل التنفس ومعدل النبض بشكل كبير. انخفضت مستويات البروتين الكلي والجلوكوز في الدم. علاوة على ذلك ، انخفض مستوى الهيموجلوبين وخلايا الدم الحمراء وإجمالي كرات الدم البيضاء بشكل كبير في العجول المجهدةحراريا.ونستخلص منها أن ايواء العجول في بيئة حارة يؤدي إلى سلسلة من التغيرات الأيضية والفسيولوجية للحد من هذا الإجهاد.

الكلمات المفتاحية: متغييرات الدم ، عجول الفريزيان ، الإجهاد الحراري ، العوامل الفسيولوجية ، رش الماء.