Effects of Moderate Heat Stress on the Growth Performance of Goat Kids

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ABSTRACT

To study the effect of moderate heat stress on the growth performance of goat kids, 10 cross-bred Saanen kids were assigned into 2 groups: The control group and the stressed group. Both groups were exposed using a controlled climatic chamber to 3 consecutive periods of 15 days each: Period 1, the control and the stressed group, were subjected to thermoneutral conditions. In period 2, the control group remained under thermoneutral conditions while the stressed group was subjected to moderate heat stress. In period 3, both groups were again exposed to thermoneutral conditions. Dry matter intake, body weight gain, water consumption, respiration rate and rectal temperature were recorded during the 3 periods. The results showed a depression effect of heat stress on the growth performance of kids, with no apparent ability to compensate there-after. Temperature-humidity index of 77 was shown to have a limiting effect on the growth rate of kids. This was clearly indicated by significant reduction in total dry matter intake, body weight gain and elevation in water consumption, rectal temperature and respiration rate.

These findings suggest that growth performance of goat kids during early stages of life can be adversely affected by exposure to moderate heat stress. The effect could be more pronounced if kids were exposed to heat stress during their early active stage of growth (4-6 months). To avoid such growth alteration it is advisable to have kids pass their active stage of growth before the incidence of hot summer conditions.

INTRODUCTION

The growth performance of young farm animals is influenced by different environmental conditions. One of the most important factors being detrimental to animal growth is high environmental temperature. Goats have adopted various behavioral and physiological adjustments that enabled them to survive well under different environmental conditions. They can use sweating or panting or both as a mean of heat

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loss mechanism and thus have the privilege of withstanding high and low ambient temperature with equal efficacy (17). Several workers have studied the effects of heat stress on the physiological and compensatory responses of different animals (2, 3, 4, 6, 7, 9, 11, 16). However, informations on the growth performance of goat kids under heat stress and their ability to compensate thereafter are still limited.

The aim of this study was to investigate the growth performance of goat kids under heat stress using a controlled climatic chamber.

MATERIALS AND METHODS

Ten weaned cross-bred Saanen kids, 4 months of age were housed in the faculty of veterinary medicine and zootechny Bioclimatic laboratory, Botucatu, Brazil. Animals were assigned randomly into 2 groups according to birth weight, breed, sex and type of birth. The experimental procedure was to allow a period of 7 days for both groups to adjust to the daily routine management, after which they were exposed to 3 consecutive periods of 15 days each. Period 1, both groups were kept under thermoneutral conditions (TN) with an average ambient temperature (AT), relative humidity (RH), and Temperature-humidity Index (THI) of 25°C, 72% and 74 respectively. During period 2, the control group remained under TN conditions, while the stressed group was subjected to a moderate heat stress (HS) during the hours 0800 to 1600 (to simulate the daily natural temperature rythm), AT, RH and THI were: 34°C, 62% and 86 respectively. In period 3, both groups were again kept under TN conditions. All animals were maintained under similar management conditions throughout the experimental periods. Animals were provided with *ad libitum* water, green roughages and concentrate supplement. Table 1 contains the proximate analysis of the feed used in the experiment. The individual daily intake of green roughages, concentrates and water was recorded daily at 0800 and 1600 hrs. The refused portions were weighed and replaced by newly fresh weighed amounts of feed and water. Body weight was recorded every 3 days throughout the 3 periods. Rectal temperature and respiration rates were measured at 1500 hrs on Monday, Wednesday and Friday of each week. The daily measurement of environmental data in both rooms including dry bulb temperature, relative humidity and black-globe temperature. The temperature-humidity index was calculated using the formula of Kelly and Bond (10).

It was established that there were no significant differences due to age, sex and type of birth and therefore only the effect of temperature was considered in the analysis of the data. The data were analysed as a split-plot in time as described by Jill and Hafs (8) with treatments effect in the main plot and periods, periods within treatments in the sub-plots.

Table 1 — Proximate analysis of the diet

Item	Grain concentrate % Dry matter	Roughages % Dry matter
Protein	18.67	10.47
Ether Extract	3.65	2.70
Minerals	3.26	11.49
Fibers	8.4	32.79

RESULTS AND DISCUSSION

The effect of heat stress on dry matter and water intake, body gain, respiration rate and rectal temperature is summarized in Table 2 and illustrated in Figure 1. The dry matter intake, water consumption, respiration rate and rectal temperature were similar for both groups during period 1.These values were comparable to those reviewed early (16). The rate of body gain during this period was 87 and 77 gram/ day for both groups. During period 2 in which the temperature-humidity index exceeded 77 (figure 1), there appear to be a slight reduction in the concenrate intake and a slight elevation in the roughage intake. This was accompanied by a noticeable reduction in the rate of gain of both groups with the stressed group showing a negative rate of growth (-22g/ day) as compared to the control (50 g/day).

The water consumed by the stressed group was significantly ($p < 0.01$) higher than the control group during period 2 and also higher than values recorded for both groups during period 1. The amount of water consumed by group 2 during period 2 was about 45% more than those consumed by the control. A threefold increase in water consumption of bucks within 3 hrs of increasing ambient temperature was reported (9). Appleman and Delouch (1) observed an elevation in water consumption of goats by about 2.3 to 4 liters/ day/ goat when ambient temperature rose from 10 to 40°C. In addition Rao and Mallick (14) reported that an increase in air temperature resulted in an increase in the ratio of water to dry matter consumption by goats which reflects a chief homeostatic mechanism controlling the thermoregulatory responses of kids. In another study by Joshi *et al.*, (9) water consumption under heat stress was also elevated due to the increase in the evaporative mechanisms that were employed by the animals for thermoregulations.

The respiration rate and rectal temperature during period 2 rose significantly ($p < 0.01$) for the stressed group as compared to the control group. This elevation was about 4 folds in respiration rate and about 1°C in rectal temperature. These results were comparable to other studies on different animals where a positive relationship was always demonstrated between the high air temperature and rectal temperature and respiration rate (2, 3, 4, 6, 7). Exposure of goats to high environmental temperature caused 4 folds increase in the respiration rate from 26 to 261 breaths/ min (16).

The elevation in water consumption in conjunction with the increase in body temperature and respiration rate and the reduced dry matter intake give a direct indication to the ability of goat kids to ameliorate the adverse effects of heat load through thermoregulatory adjustments.

During period 3, both groups showed a normal respiration rate and body temperature. However, there still existed a depression effect on the growth performance of both groups (Table 2 and Figure 1) as they showed a negative growth rate. The noticeable reduction in the growth rate in both groups (treated and control) cannot be really related directly to high environmental temperature. Other factors concerning the growth behavior of kids during this critical age of life could influence directly the growth of both groups since it has been shown that the active stage of growth in goat kids lies around the age of 4 months (12, 13, 14, 16). It was clearly demonstrated in this study (Figure 1) that the active stage of growth is located between 4-6 months of age. Other investigations have shown that different animals were able not only to recover growth during exposure to heat stress but also were more efficient in converting feed into growth after they were relieved from heat stress (2, 3, 4, 5, 6, 7).

Table 2 — Main effects of heat stress upon daily dry matter and water intake, body gain Respiration rate and rectal temperature.

Treatments	Period 1		Period 2		Period 3	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
	TN	TN	TN	HS	TN	TN
Daily dy matter intake:-						
Roughages (kg)	5.376	5.653	4.723	3.877	3.936	2.869
Concentrates (kg)	0.465	0.659	0.548	0.669	0.699	0.757
Average daily gain (g/day)	87	77	50	−22	−11	−24
Daily water consumption (ℓ)	11.80[b]	12.13[b]	10.45[b]	17.64[a]	7.84[b]	7.98[b]
Respiration Rate (min)	41.00[b]	40.80[b]	39.78[b]	163.30[a]	36.00[b]	36.00[b]
Rectal Temperature (C°)	39.79[b]	39.68[b]	39.78[b]	40.84[a]	39.75[b]	39.76[b]

a, b = Unlike superscripts within same raw are significant ($P < 0.05$)
TN = Thermoneutral conditions
HS = Heat stress.

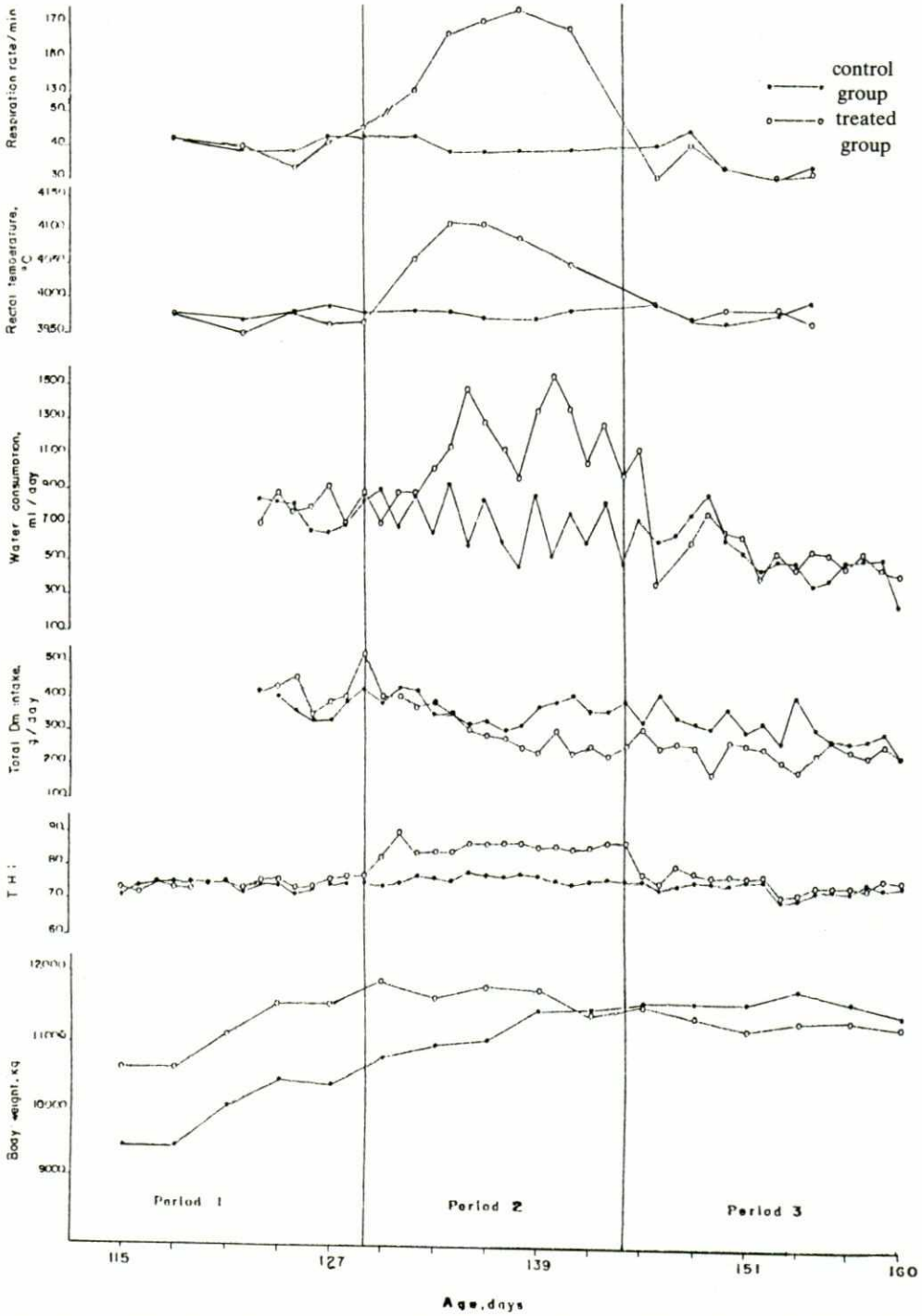

Figure 1: Effect of moderate heat stress on growth performance of saanen kids as related to: THI, Feed intake, water intake, rectal temperature and respiration rate.

Therefore, the negative depression of body gain of kids used in this study could be partly explained by the fact that these kids were introduced into confinement during their active stage of life thus influencing growth performance throughout the experimental periods with the inability to recover.

In conclusion, the results clearly demonstrated the adverse effect of heat stress on the thermoregulatory responses of goat kids with their inability to recover thereafter. The study also demonstrated that there exist a critical stage of growth located between 4-6 months after which growth comes to a slow down. Therefore, it is advisable to avoid exposing kids during the early stage of active growth to unfavourable conditions.

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أثر درجة الحرارة المرتفعة على نمو الجداء

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المستخلص

لدراسة أثر درجة الحرارة على معدل نمو الجداء استخدم عدد 10 من الجداء السانين المهجنة قسِّمت عشوائياً إلى مجموعتين: مجموعة التحكيم، ومجموعة المعاملة. تعرضت المجموعتان إلى ثلاثة فترات متتالية مدة كل منها 15 يوماً. الفترة الأولى: ـ تعرضت المجموعتان لدرجة حرارة بيئية معتدلة، الفترة الثانية: المجموعة الأولى بقيت تحت الحرارة نفسها في الفترة الأولى، بينما المجموعة الثانية تعرضت لدرجة حرارة مرتفعة. وفي الفترة الثالثة: كلا المجموعتان تعرضتا ثانية لحرارة معتدلة. خلال الفترات الثلاث تمّ تسجيل معدل الأكل ومعدل الوزن ومعدل استهلاك الماء ومعدل التنفس ودرجة حرارة الجسم. أوضحت النتائج أن الارتفاع في درجة حرارة البيئة أدى إلى انخفاض في معدل الأكل، انخفاض في الوزن وارتفاع في درجة حرارة الجسم وفي معدل استهلاك الماء ومعدل التنفس وانخفاض معنوي في معدل النمو مع عدم قدرة الجداء على تعويض النقص في الوزن خلال الفترة ما بعد الإجهاد. دلت نتائج هذه الدراسة بأن نمو الجداء يتأثر تأثيراً معنوياً بالارتفاع في درجة حرارة البيئة خاصة خلال الفترة ما بين 4-6 شهور، لذلك يجب تجنب تعرض الجداء للارتفاع في حرارة الجو خلال مراحل النمو المبكرة للجداء.