Effect of heat-stress on some physiological and biochemical parameters in buffaloes

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ABSTRACT: The experiment has been carried out with 10 lactating buffaloes (Bulgarian Murrah breed) in an interval of two successive days. They were kept in shade(first day) and exposed to direct solar radiation (second day) with ambient temperature not less than 30⁰C for 12 h. Rectal temperature (RT) and respiratory rate (RR) were measured at 8 a.m., 11 a.m., 3 p.m. and 8 p.m. Both RT and RR increased significantly at temperature – humidity index (THI)- 77.83, showing that the lactating buffaloes are sensitive to heat stress and are not able to maintain their core temperature within the thermoneutral zone. The same THI had no significant effect on rectal temperature elevation when the buffaloes were kept in the barn. These data demonstrate that lactating buffaloes need protection against direct solar radiation. Plasma cholesterol and total protein levels tended to be lower during the exposure to direct solar radiation compared to the morning levels. Plasma urea level increased and plasma indol level remained unchanged when the buffaloes were exposed to sun. It is suggested that the level of the first three parameters is closely related with the dynamic of cortisol and blood volume fluctuation in animals under heat.

Kay words: Lactating buffaloes, Stress, Cortisol, Indol.

INTRODUCTION - The effect of heat stress on physiologic status of lactating buffaloes is relatively less studied in comparison with that in lactating cows. Rectal temperature (RT) and skin temperature have been reported to fluctuate much more in buffaloes than in tropical cattle under increased ambient temperature (Koga et al., 2004). Consequently the aim of the present study was to evaluate the effect of direct solar radiation on buffalo heat-tolerance under the typical for Bulgaria summer temperatures.

MATERIAL AND METHODS - The experiment has been carried out with 10 lactating buffaloes (Bulgarian Murrah breed) in an interval of two successive days. They were kept in shade(first day) and exposed to direct solar radiation (second day) with ambient temperature not less than 30⁰C. During the experimental period the buffaloes were fed once daily at 4 a.m., before the morning milking. Rectal temperature (RT) and respiratory rate (RR) were measured at 8 a.m., 11 a.m., 3 p.m. and 8 p.m. Temperature humidity index (THI) was calculated by Tom (1959) and the intensity of the heat load
- by the formula of Benezra (1954). The average values of RT and RR measured at 8 a.m. were used as thermoneutral values. Blood samples were collected at 8 a.m. and 3 p.m. by jugular vein puncture and the immediately separated plasma was stored at -10 °C. The following methods were used: cholesterol (Watson, 1960), urea (Rerat et al., 1976), total protein (Kinsley, 1939) and indol (Chilov (1959). The results are expressed as mean±SEM and were analyzed by Student’s T test.

**RESULTS AND CONCLUSIONS** - Rectal temperature values and respiratory rate were significantly higher (P<0.01) at 3 p.m. during the exposure to direct solar radiation compared to the RT and RR values measured in the barn (Figure 1 and Figure 2), despite of the similar values of THI in the open air and in the barn (Figure 3). Furthermore the greater increase of RT in the buffaloes kept in sun occurred on the background of 2.5 times higher air velocity (Figure 4), and it is known that external wind breaks up the layer of air retained by the fur and increases convective heat transfer. Rectal temperature values of the buffaloes kept in the barn were not significantly higher at 3 p.m. compared to those at 8 a.m. and 11 a.m. (Figure 1). However RR increased significantly at 11 a.m. and 3 p.m. compared to RR at 8 a.m. (Figure 2).

![Figure 1. Diurnal dynamics of rectal temperature (t0C) exposed to sun or kept in a barn lactating buffalos during hot summer days.](image1)

![Figure 2. Diurnal dynamics of respiratory rate (resp/min) exposed to sun or kept in a barn lactating buffalos during hot summer days.](image2)

![Figure 3. Daily dynamics of temperature-humidity index in open air and in a barn.](image3)

![Figure 4. Daily dynamics of air velocity (m/sec) in open air and in a barn.](image4)
Therefore when kept in the barn the buffaloes maintained their RT within the thermoneutral zone at the expense of higher RR. The exposure to direct solar radiation resulted in significant enhancement of both RT (P<0.05) and RR (P<0.001) at 3 p.m. (Figure 1 and Figure 2), showing that the animals were not able to maintain RT within thermoneutral zone in spite of the increased RR and air velocity (Figure 4) at that time.

The greater sensitivity of the buffaloes to hot conditions especially when exposed to direct solar radiation could be due to the dark body, lesser density of sweat glands and the thick epidermis which reduce the capacity of cutaneous evaporation. Our data indicate that lactating buffaloes raised in Bulgaria should be protected against direct solar radiation during hot summer months, when ambient temperature is above 30°C (THI – 77.8). Plasma cholesterol levels at 3 p.m. (THI – 77.83) tended to be lower compared to those at 8 a.m. (Figure 5). The observed trend of cholesterol decline in buffaloes under heat could be related with the decreased feed intake in hot environment. Consequently the decreased feed intake is related with reduced intake of dietary cholesterol. Plasma urea level tended to be higher (P>0.05) at 3 p.m. when the heat load was highest (Figure 6).

The enhanced urea level could be due the negative effect of the elevated core temperature on rumen microflora activity. Plasma total protein level tended to be lower (P>0.05) during the maximum heat load (Figure 7). It is well known that heat exposure causes initial hemoconcentration followed by hemodilution. Therefore the observed decline of plasma total protein indicates that the animals were in the stage of hemodilution. Similar results have been reported in cows (El –Nouty et al., 1980). Plasma indol level (Fig. 8) tended to be higher at 3 p.m. and indicate a possible negative effect of the elevated core temperature on the ratio between “friendly and unfriendly” intestinal bacteria.

It was concluded that the exposure of lactating buffaloes to direct solar radiation (THI – 77.83) caused heat stress indicated by the enhanced levels of RR. The same value of THI did not induce significant changes in RT when the buffaloes were kept in the barn.
However the maintenance of RT within the thermoneutral zone in the animals kept in barn was achieved at the expense of higher RR as compared to RR values at 8 a.m.. Heat exposure did not cause significant changes in plasma levels of cholesterol, urea, total protein and indol.

![Figure 7. Plasma total protein level (g%) in buffalos exposed to direct solar radiation.](image)

![Figure 8. Plasma indol level (mg/ml) in buffalos exposed to direct solar radiation.](image)

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