HEAT INTOLERANCE SYNDROME ASSOCIATED WITH FOOT AND MOUTH DISEASE IN CATTLE IN TANZANIA: OCCURRENCE AND ITS EFFECT ON ANIMAL BEHAVIOUR AND PHYSIOLOGICAL PARAMETERS

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SUMMARY

A heat intolerance (HI) syndrome in cattle has been suspected to occur in Tanzania and is associated with previous exposure to foot and mouth disease (FMD) virus. For the present study, a survey was used to explore livestock keeper knowledge of its occurrence and association with FMD in Morogoro, Mwanza and Shinyanga regions. In addition, a field experiment was conducted to evaluate changes in behavioural activities and physiological parameters of HI cattle during variation of ambient temperatures. Large percentage (45.3%) of informants from Morogoro region reported occurrence of HI and associated it with FMD. Livestock keepers' perceptions of association between HI and FMD were confirmed by using the detection of antibody to FMDV. From the field experiment it was shown that HI animals had significantly ($P<0.001$) higher rectal temperatures and respiration rates than health cows. Duration of grazing and rumination were significantly ($P<0.001$) lowered in the HI cows than in the health ones during sunny days. Also, shade seeking was significantly ($P<0.001$) higher in HI than in healthy animals. Furthermore, for HI animals grazing was higher during the morning and on cloudy days than in late evening and sunny days respectively. It was also evident that HI animals preferred wallowing in water. Based on the knowledge of livestock keepers, from the present study, it is concluded that livestock keepers in Tanzania recognize HI as a disease, which sets in as a sequel to FMD outbreak. Based on the results from the field experiment it is concluded that during sunny days HI animals exhibit behavioural changes which reduces their feeding time.

INTRODUCTION

In the late 1990s, a syndrome of heat intolerance (HI) and overgrowth of hair in cattle was reported to Sokoine University of Agriculture (SUA) veterinary clinic by Maasai pastoralists and one field veterinarian in Morogoro region, Tanzania (Makene, 1998). It was reported that affected cattle spent less time grazing than normal cattle, and more time resting in the shade of trees or wallowing in water. The coat developed a long and thick appearance and affected animals panted during the heat of the day. Cattle with HI lost body condition and milk production and fertility was reduced. Based on descriptions of foot and mouth disease (FMD) by Radostits *et al.*, (1994), it was suggested that HI was a sequel to FMD and was caused by damage to the endocrine system by FMD virus. Soon after the report on HI occurrence in Morogoro, workers in the Lake Zone of Tanzania reported that Sukuma farmers were complaining about a disease in cattle they called *luzwiga*, also characterised by heat intolerance and overgrowth of hair (Magoma *et al.*, 2000). The Sukuma word *luzwiga* was derived from *kuzwigila* meaning 'difficult breathing'. Using a participatory approach Catley *et al.*, 2004 also demonstrated the occurrence of a similar syndrome in Shinyanga region.

The first report of FMD in Tanzania referred to an outbreak in Kahama District, Arusha Region in 1927 attributed to type O (Anon, 1927). Since then the disease has been reported annually in almost every region of the country and is generally assumed to be endemic (Anon, 2001). Regarding virus strains, types O, A, SAT-1 and SAT-2 were noted in late 1960s (Rweyemamu, 1970), and SAT-3 was reported in 1996 in Arusha Region. Kivaria (2000) reported FMD in Tanzania due to type C virus. Tanzania has a substantial indigenous cattle population of approximately 17 million head (MAFS, 2002). Many of these animals are managed using agropastoral and pastoral systems, and the country has long, largely unregulated borders with Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo, Zambia, Mozambique and Malawi. Seasonal cattle movements across borders and a high wildlife population in Tanzania, including buffaloes, are among the factors likely to affect the epidemiology of FMD (Thomson *et al.*, 2003 and Morgan *et al.*, 2006).

Reference to the literature indicated that the HI syndrome and a possible association with FMD had been reported since at least the 1940s. In India affected cattle were known as 'panters' (Scott, personal communication; Anon, 1955a) and similarly in Pakistan the condition was called panting or *hanpa* (Minett, 1949). In Kenya, woolly coats, panting and reduced fertility were noted as complications of FMD (Anon, 1955b) and it was suggested that

the problem only occurred in high-grade cattle and not indigenous African types. More recently, there are reports of HI following FMD outbreaks in cattle in pastoralist areas of Africa. Working with Afar communities in Ethiopia, Blakeway *et al.*, (1996) described the disease *haleb* as a sequel to FMD. Similarly, the diseases *juol, jul* and *akumol* were noted in Nuer communities in southern Sudan (Blakeway *et al.*, 1996). Further north in Sudan the disease *ha'ish,* meaning 'ugly' (Kenyon, personal communication) was similar to HI reported in the areas. Veterinarians or associations between HI and FMD as described by livestock keepers base all these reports on ad hoc field observations. Worse, there were no published accounts of the incidence of HI in affected herds.

The study described in this paper aimed at using structured questionnaire and focus group discussion to investigate the occurrence and association between clinical FMD and the chronic HI syndrome, and estimate the incidence of FMD and HI. Further, we conducted a field-based experiment to establish change in physiological parameters among HI animals.

METHODOLOGY

Study locations

The study was conducted in Morogoro, Mwanza and Shinyanga regions in Tanzania. In Morogoro Region, research was conducted with Maasai communities in Wami-Dakawa, Melela, Matuli, Sokoine and Lumanda-Chalinze villages over a two-week period in May 2001. Maasai are pastoralists who inhabit large tracts of the Rift Valley in Kenya and Tanzania. In recent years they have expanded their range to Morogoro and Coast regions of Tanzania. In Mwanza and Shinyanga regions (Lake zone), research was conducted with Sukuma communities in Kibetilwa, Ng'wakilyambiti, Solwe, Sawida and Laini villages, in July, 2001. The Sukuma are sedentary agropastoralists who rely more heavily on crops than livestock as a source of livelihood. For field experiment, animals from Kingolwira prison farm in Morogoro region were used. Scattered acacia trees in the paddocks provided shade for the animals and presence of paddocks limited the animals from excessive movements within the farm. The selection of villages in each region was purposive. Livestock production systems and ecology in these villages were judged by local veterinary staff to be closely similar.

Survey

Diagnosis of HI

In total, 50 and 73 herds were visited, during which, one person was interviewed from each herd in Morogoro region and Lake zone, respectively. The identification of the HI animals was based on clinical signs indicative of heat intolerance. These included anaemia, hyperthermia, panting, salivation and overgrown hairs. Based on the presence or absence

of these clinical signs animals were classified as healthy or (HI) animals. Cases of HI diagnosed by livestock keepers were cross-examined by a veterinarian.

FMD serology

Blood samples were collected for FMD serology. In Morogoro, 249 blood samples (173 adults and 76 immature) were collected from 50 herds. In Lake zone, 241 (175 adults and 66 immature) samples were collected from 59 herds. Serum samples were tested at the Onderstepoort Veterinary Institute, South Africa. The liquid phase blocking enzyme linked immunosobent assay (ELISA) was used as described by Hamblin *et al.*, (1986) using reagents developed in-house to test for the six types of FMD serotypes (SAT-1, SAT-2, SAT-3, type O, type A and type C).

Field experiment

Twelve cows (6 HI and 6 healthy) were used in this study. The animals were adult, multiparous cows, crosses of Ayrshire or Friesian breeds with Tanzania shorthorn Zebu which belonged to Kingolwira prison farm in Morogoro region. The animals were ear tagged, grazed freely in paddocks and allowed access to watering points at 13:00 hours. Scattered acacia trees in the paddocks provided shade for the animals. Behavioural activities i.e. grazing, idling, ruminating and huddling in the shade were recorded once a week for six weeks. The behavioural activities for each individual animal were noted and recorded at an interval of 15 minutes in each of the four periods. Each recording day was divided into four periods, i.e. early morning (08:00-10:00), late morning (10:00-12:00), early afternoon (12:00-14:00) and late afternoon (14:00-16:00). Physiological parameters i.e. rectal temperature, respiration, pulse and heart rates were measured once in a week at 08:00, 10:00, 13:00 and 16:00 hours.

Statistics

Association between prevalence of antibodies to FMDV and HI was tested using Chi-square and relative risk (SPSS, 1999). Unpaired t-test was used to test whether there was significant difference in physiological parameters between HI and healthy animals.

RESULTS

Occurrence of HI and its Association with FMD

In Morogoro region 41 (82.0%) and 23 (45.3%) of respondents reported occurrence of FMD and HI in their herds respectively, in May, 2001. These figures were significantly higher than ones reported in Lake zone, where 40 (54.8%) respondents reported FMD in their herds ($\chi^2 = 9.77$; $p<0.01$) and 6 (7.8%) reported HI ($\chi^2 = 23.5$; $p<0.001$) respectively. Herds, which reported FMD, had outbreaks in the past 1-2 years. The percentage of cattle affected with HI syndrome in different herds ranged between 8.3% and 16.7% during the study period.

Foot-and-mouth disease seroprevalence is presented in Table 1. Antibodies to all 6-tested FMDV were detected in Morogoro region and Lake zone, and the most prevalent types were SAT-1 and SAT-2. No significant associations were observed between the presence of HI and cattle seropositive to FMD types SAT-1, SAT-2, SAT-3, type O, type A or type C in Morogoro and Mwanza or Shinyanga regions. In general, Morogoro region had higher percentage of seropositivity to FMDV (66.7%) than the Lake zone, (41.5%).

Table 1. FMDV seroprevalence in Morogoro region and Lake Zone by type

Type	Seroprevalence by region		Difference in seroprevalence between regions by Chi-square (significance)
	Morogoro region (%) (n=249)	Lake zone (%) (n=241)	
SAT-1	50.2	27.8	12.9 ($p<0.001$)
SAT-2	49.0	14.3	66.9 ($p<0.001$)
SAT-3	14.6	7.5	13.1($p<0.001$)
Type O	2.3	4.4	8.1 ($p<0.01$)
Type A	16.5	0.8	49.7 ($p<0.001$)
Type C	0.8	0.4	5.4 ($p<0.05$)
All tested types	66.7	41.5	31.3 ($p<0.001$)

Behavioural Activities

All the animals tended to spend more time grazing between 8:00-12:00 when ambient temperatures were around 25°C. Decrease in grazing activity was observed during the afternoon and evening (12:00-16:00) when ambient temperatures were around 28°C. For both HI and healthy animals, grazing times were observed to be significantly higher on cloudy days than sunny days. It was evident that HI cows showed lower grazing percentage time than the healthy cows between 10:00-14:00 ($P<0.01$).

As shown in Table 2, the percentage time spent idling and ruminating was lowest during the morning hours, then increased progressively throughout the day until it reached a peak at late afternoon hours. There was no significant difference ($P>0.05$) between HI cows and healthy cows in time spent on idling though HI cows spent longer time idling than healthy cows. However, healthy cows were spending significantly more time ($P<0.01$) ruminating than HI cows between 12:00 and 16:00 (Table 2).

Table 2. Mean ± SEM percentage times spent in grazing, idling, ruminating and shade seeking by healthy and heat intolerant (HI) cows during different periods of the day

Period/Time	Health Animals	Heat Intolerant Animals	P-value	Remarks
Grazing				
08:00-10:00	92.2±3.2	88.4±3.2	0.2961	NS
10:00-12:00	80.2±2.4	64.8±2.4	0.0001	***
12:00-14:00	38.2±3.4	25.7±3.4	0.0094	**
14:00-16:00	27.9±3.4	22.2±3.4	0.2284	NS
Idling				
08:00-10:00	7.6±2.1	12.6±2.1	0.0871	NS
10:00-12:00	9.6±1.6	13.4±1.6	0.0944	NS
12:00-14:00	16.6±2.2	21.2±2.2	0.1493	NS
14:00-16:00	27.0±2.2	27.0±2.2	0.6650	NS
Ruminating				
08:00-10:00	0.25±2.2	0.2±2.2	0.9879	NS
10:00-12:00	4.29±1.726	2.61±1.7	0.4786	NS
12:00-14:00	26.23±2.3	15.85±2.3	0.0020	**
14:00-16:00	28.93±2.3	18.22±2.3	0.0014	**
Shade seeking				
08:00-10:00	0.23±2.7	0.23±2.7	0.9070	NS
10:00-12:00	4.28±2.0	16.62±2.0	0.0001	***
12:00-14:00	14.66±2.9	43.42±2.9	0.0001	***
14:00-16:00	12.85±2.9	30.57±2.9	0.0001	***

NS = not significantly different; ** = highly significant; *** = Very highly significant

The tendency of shade seeking was low during the morning hours but increased significantly during the afternoon before it dropped again in the evening hours. The average percentage time spent under the shade was significantly higher in HI cows (P<0.001) than in healthy cows (Table 2). For both HI and healthy groups the shed seeking behaviour was high during sunny days than during cloudy days.

Change in Physiological Parameters

The average rectal temperatures, respiration, pulse and heart rates were higher in both HI and healthy animals during sunny days than during cloudy days. The average rectal temperatures for HI cows were significantly higher (P<0.001) than healthy cows throughout the day even when animals were kept indoors (Table 3). The respiration rates for the HI cows were also significantly higher (P<0.001) than healthy cows at all times. The HI cows had significantly higher (P<0.05) heart rates and pulse rates between 08:00 and 14:00.

Table 3. Overall means ± (SEM) of rectal temperature, respiration, heart, and pulse rates for healthy and heat intolerant (HI) cows during different periods of the day

Period/Time	Health Animals	Heat Intolerant Animals	P-value	Remarks
Rectal Temperature				
08:00	38.48±0.07	38.97±0.07	0.0001	***
10:00	38.53±0.11	39.45±0.11	0.0001	***
12.00	8.9 ± 0.11	40.10±0.11	0.0001	***
14:00	38.79±0.11	39.86±0.11	0.0001	***
Respiration rate				
08:00	36.0±1.5	48.9±1.5	0.0001	***
10:00	39.6±2.3	72.3±2.3	0.0001	***
12:00	49.3±2.2	85.5±2.2	0.0001	***
14:00	50.8±2.3	89.3±2.3	0.0001	***
Heart rate				
08:00	63.4±0.64	66.4±0.64	0.0014	**
10:00	64.6±0.97	69.1±0.97	0.0052	**
12:00	65.1±0.94	68.8±0.94	0.0011	**
14:00	66.4±0.97	69.6±0.97	0.0218	*
Pulse rate				
08:00	63.6±0.58	64.4±0.58	0.2864	NS
10:00	62.4±0.89	66.8±0.89	0.0532	NS
12:00	63.0±0.85	65.5±0.85	0.0547	NS
14:00	64.38±0.86	66.3±0.86	0.1338	NS

NS=not significantly different from healthy cows;*= significant ** = highly significant; ***=Very highly significant

DISCUSSION

The present study has demonstrated the occurrence of HI syndrome in cattle in Tanzania. The results of the questionnaires and clinical examination in Morogoro, Mwanza and Shinyanga region revealed that livestock keepers are aware of the syndrome. Livestock keepers were even aware of the association of this syndrome with FMD outbreaks as observed elsewhere (Radostits *et al.*, 1994; Thomson, 1994). This awareness indicates that this syndrome may exist in many parts of the country and it deserves attention from the veterinary division.

Animal owners interviewed in this study reported that most of the animals developed the HI syndrome 5-6 months post FMD outbreak, as opposed to Thomson (1994) who reported 5-6 weeks post infection. This discrepancy can be attributed to failure of farmers to diagnose FMD in its early stages. The finding that low percentage of HI cases was reported by the Sukuma informants (7.8%) may be related to low prevalence of FMD in the Lake zone. In fact, during herds

visit a veterinarian diagnosed far fewer HI cases during clinical examination in Lake Zone herds as compared to Morogoro herds. Table 1, demonstrates significant higher exposure to FMD virus in Maasai herds compared with Sukuma herds as reflected by the high percentage of positive samples to different FMDV. This might be a clear reason for having a higher percentage of HI animals. The reasons for this difference are not clear, however, the location of a trunk road in Morogoro region (Dar es Salaam to Dodoma and Iringa) through which large herds of cattle are either transported or tracked to Dar es Salaam livestock market, this, may have exposed the animals in Morogoro region to frequent FMDV than herds in Lake zone. In addition, compared to Sukuma herders, Maasais tend to move along with their animals long distances searching for water and pasture for most part of the year, thus, exposing their animals to FMDV.

Changes in behaviour of animals exposed to varying ambient temperatures included a decrease in time for grazing and ruminating and an increase in time for shade seeking and idling. These changes were more apparent in the HI than in clinically healthy animals when they were subjected to the same environmental conditions. These changes were more apparent during sunny than cloudy days. The decrease in time spent for grazing during high ambient temperatures has also been reported by other workers (Morrison, 1983; Bennett *et al.*, 1985; O'connell, *et al.*, 1989; Kabuga, and Agyemang, 1992).

The tendency for shade seeking and idling set in earlier during the day in HI cows than in clinically health ones. This tendency was more apparent in the afternoon and during sunny days. Similar observations have also been reported in non-adapted cattle to the hot climate of the tropics (Winter *et al.*, 1980). This indicates that HI animals are more prone to high environmental temperatures. Idling behaviour is a physiological response aimed at reducing heat production through decreased muscular activity. Resting under the shade is an effective way of reducing radiant heat load and increasing heat loss (Lewis, 1978).

The time spent by HI cows ruminating was shorter compared to clinically health animals. This difference may partly be attributed to the difference in the amount of feed eaten as the frequency of rumination varies directly with the amount of feed in the rumen (Colvin *et al.*, 1978; Wei-Guo *et al.*, 1999). Because of high rate of shade seeking and idling, HI animals have less time for grazing. In addition, in heat stressed animals, ruminal contraction rate has been observed to be low (Martz *et al.*, 1994). This finding can explain the persistent low weight of HI cattle, which was observed during the field survey. It might be also true that, the poor fertility, and low calve viability

reported in HI animals are also due to inadequate feeding.

As reported by Amakiri and Funsho (1979) and Kabuga and Agyemang (1992) an apparent increase in body temperature with increase in ambient temperature was also observed in this study. The reason for higher rectal temperatures in HI animals than in healthy animals is not very clear. However, it can be due to increased penetration of radiant energy into their skin due to altered histology of the skin (Makene, 1999).

Although no attempt was made to establish the pathophysiology of the HI syndrome, its development probably depends on the severity and dissemination of the FMD viruses. The severity of FMD in cattle is determined by the strain of the virus involved and the degree of trauma on tissues (Brown *et al.*, 1991). Furthermore, it is likely that HI animals harbour FMD virus longer than non-HI animals and act as a source of infection for subsequent FMD outbreaks. In our experience, pastoralists in East Africa rank FMD among the most important cattle diseases. Consequences of FMD include calf deaths (due to cardiac disease and starvation), large reduction in milk production, losses due to starvation (affected cattle cannot move to grazing areas) and secondary infections, in addition to problem caused by HI. Also, the endemic nature of FMD in pastoral herds and periodic re-infection with different virus strains means that these losses are experienced repeatedly. We propose that further studies on the economic and social impact of FMD and the role of HI in the epidemiology of FMD in herds are warranted. Based on these results we highly suggest that HI syndrome is associated with FMD in cattle and it does exist in Tanzania, and more work should be done to elucidate on the pathophysiology of the syndrome.

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