DEPENDENCE OF VITAL SIGNS, MILK YIELD AND COMPOSITION ON TEMPERATURE HUMIDITY INDEX (THI) IN WHITE FULANI CATTLE

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Abstract

The interaction of vital signs, milk yield and composition on thermo-humidity index (THI) in white Fulani cattle is yet to be fully documented in Nigeria. This was the main focus of this research work. Parameters measured were done once a month from September to November. Ambient temperature and humidity; rectal temperature, pulse and respiratory rate of animals were recorded. Milk was harvested from the six white Fulani cattle used for this experiment and volume of each was determined. The milk samples were analysed in a reputable laboratory for lactose (%), calcium (mg/L), vitamin C (mg/L), vitamin E (mg/L), urea nitrogen (mg/day), α-lactalbumin (%), β-lactoglobulin (%), solid non-fat (%), percentage fat, crude protein (%), selenium (mg/dl). Mean values were subjected to linear regression using SAS (2003). Result showed that calcium (Y= 3997.60-84.73THI), vitamin E (Y= 1.29 - 0.04THI), vitamin C (Y= 0.16 - 0.01THI) and selenium (Y= -0.09 + 0.003THI) showed significant differences ($P<0.05$) while, rectal temperature, pulse rate, respiratory rate, volume of milk, fat, α-lactalbumin , β-lactoglobulin showed no significant difference ($P>0.05$). This study revealed that vitamin and mineral contents of milk is largely dependent on temperature and humidity which could be used to determine heat stress

Keywords: Vital signs, Cattle milk, Milk composition, Thermo-humidity index, White Fulani cattle

Introduction

There are an estimated 18.2 million heads of cattle in Nigeria. These animals are predominantly managed in large herds by semi-sedentary and transhumant pastoralists. Most animals are dual-purpose indigenous breeds, such as the Bunaji, Sokoto Gudali and Rahaji (Gaughan, *et al*., 2010). Large scale commercial farms raise imported exotic breeds and their crosses. Livestock production is a main source of income for the poor people which cater for their day-to-day social and economic needs. It provides employment for more than 1.3 billion people and contributes around 40% to the world's agricultural Gross Domestic Product (GDP) (Sejian, 2012). However, the demand for milk is in an increasing trend which is highly influenced by environmental factors and management practices. The changes in the environmental factors like ambient temperature, relative humidity, wind speed and solar radiation causes stress to lactating cattle. The heat stress adversely affects both the quantity and quality of milk during first 60 days of lactation and high yielding breeds are more susceptible than the low yielding breeds. The species wise changes in milk composition and milk yield due to heat stress are shown on table 1 below.

Table 1: Species wise changes in milk composition and milk yield due to heat stress

Species	Milk production level	Milk composition	References
Jersey	Milk yield decreased	Reduction in milk protein and fat	Bandaranayaka and holmes (1976)
Holstein-Friesian	Milk yield decreased	Reduction in protein concentration casein	Cowley *et al* (2015)
Zebu cattle	No significant yield	No significant change in milk	Hansen (2004)

(bos indicus)	reduction	composition	
Jersey	Increase in milk yield compared to Holstein	Reduction of fat and protein content	Smith et al (2013)
Tharparkar	No significant yield reduction	No significant change in fat	Alhussien *et al* (2016)

In Nigeria, cattle are very sensitive to extreme climate events; as temperature and rainfall determine the water availability, level of comfort, and consumption pattern of the cattle. During drought and intervening dry spell, cattle drink more water and less digestible feed need more water; this is because water is needed to maintain coarse feed in the cattle gut system (Hassan *et al.*, 2019; Ayanlade *et al.*, 2018b). This widens the disparity of water supply to water demand of cattle; as there is less water available with the occurrence of drought to meet increased demand for water caused by drought. Heat stress is of major concern among livestock owners in almost all parts of the tropics. Cattle that are affected by heat stress show reduction in feed intake which in turn affects yield. Heat stress also influence body metabolism and this could affect the quality of milk components. The objective of this study was to determine the dependence of vital signs, milk yield and composition on thermo-humidity index

Materials and Methods

This experiment was carried out at the ruminant animal section of the Teaching and Research Farm, Federal Polytechnic, Ilaro, Ogun State. It is located in the south - western part of Nigeria on latitude 6.899035° North and longitude 2.996836° East (Google earth). The temperature and relative humidity were 25.5°C and 89% respectively.

Six (6) healthy lactating cows were used for this experiment. The cattle were raised under extensive management system. The age of the animals ranged between 3 and 8 years while the age of their calves ranged between 1 and 9 months.

Parameters measured

Temperature Humidity Index (THI) was determined to measure the heat stress. Ambient temperature and relative humidity were recorded daily. Temperature and relative humidity were measured using thermometer and hygrometer respectively at 7am and 2pm. Only maximum values are being reported in the present study. With the help of thus two THI value can be calculated for the experiment period using the formula: THI= T (air) - (0.55 - [0.55x RH/100]) x (T(air) f-58.8) (Buffington *et al.*, 1997). (Where, THI=Temperature humidity index, T(air) = air temperature in Fahrenheit, RH = percent relative humidity).

Rectal Temperature was determined using a digital thermometer. Pulse rate was determined by counting the number passing through the jugular vein using the stop clock as a timer for 60sec. Respiratory rate was determined with the use of thread using the breath check and the stop clock as a timer for 60sec.

Sample Collection

Milk samples were harvested once a month for 3 months (September, October and November), from the experimental animals through the udder. This was harvested from the experimental animals through the udder, by allowing the calf to suck for one minute and tie to the cow. Then the milk was collected by massaging the udder for milk until milking stopped after which it was poured into a measuring cylinder to estimate the yield in millilitre. 15 mL was poured into the container and immediately placed under ice pack until delivered to the lab.

Sample Analysis

Milk extracted were analysed in a reputable laboratory for selenium, lactose, crude protein, milk fat, vitamin C, Vitamin E, cholesterol, calcium, urea nitrogen, β-lactoglobulin, α-lactoalbumin and glucose using standard procedures.

Statistical Analysis

Values obtained were subjected to analysis using linear regression of SAS (2003). The regression equation used is $Y=a+b_1x_1$ **(**Where Y= parameter, a= intercept, b= index, x=THI value)

Results and Discussion

The dependence of vital signs, milk yield and composition in white Fulani cattle is shown on Table 2. The result showed that there were significant differences (P<0.05) between the interaction of calcium (Y= 3997.60 - 84.73THI), vitamin E (Y= 1.29 – 0.04THI), vitamin C (Y= 0.16 – 0.01THI) and serum glucose (Y= 0.09 – 0.003THI) with thermo-humidity index (THI). It was also observed that there were no significant (P>0.05) differences in Rectal temperature (Y= 39.15 – 0.005THI), pulse rate (Y= 209.62 – 5.04THI), respiratory rate (Y= 125.24 – 4.90THI), milk volume (Y= -1482.07 + 79.53THI), lactose (Y=5.18 – 0.02THI), urea nitrogen (Y= 32.79 – 0.62THI), crude protein (Y= 18.49 – 0.45THI), fat (Y= 2.75 – 0.05THI), β-lactoglobulin (Y= 48.74 + 0.34THI), α-lactoalbumin (Y=31.32 – 0.46THI) when regressed with THI.

Table 2: The interaction of THI and vital signs, milk yield and composition in white Fulani cattle.

Parameter	Model	Mean value	R square	Significance (P<0.05
Rectal temperature (◦C)	(Y= 39.15 – 0.005THI)	37.44	0.01	0.81
Pulse rate	Y = 209.62 -5.04THI	48.44	0.09	0.23
Respiratory rate	Y = 125.24+4.90THI	31.33	0.14	0.13
Volume of milk (mL)	Y= -1482.07+79.53THI	1059	0.01	0.74
Calcium (mg/L)	Y= 3997.60 - 84.73THI	1290	0.29	0.02
Lactose (%)	Y= 5.18 - 0.02THI	4.51	0.007	0.91
Vitamin E (mg/L)	Y= 1.29 - 0.04THI	0.17	0.38	0.01
Vitamin C (mg/L)	Y= 0.16 - 0.01THI	0.10	0.03	0.0003
Crude Protein (%)	Y= 18.49 - 0.45THI	4.10	0.14	0.13
Fat (%)	Y= 2.75 - 0.05THI	4.30	0.001	0.89
Solid Non Fat (%)	Y= 15.19 - 0.22THI	8.09	0.02	0.57
Total Solid	Y= 17.94 - 0.17THI	12.36	0.01	0.71
Urea Nitrogen (mg/dl)	Y= 32.79 - 0.62THI	12.99	0.04	0.43
α-lactoalbumin (%)	Y= 31.32 - 0.46THI	16.49	0.04	0.44
β-lactoglobulin (%)	Y= 48.74 + 0.34THI	59.53	0.03	0.51
Selenium (mg/dl)	Y= -0.09 + 0.003THI	0.02	0.05	0.0001

THI: Thermo-humidity Index

The dependence of vital signs, milk yield and composition in white Fulani cattle is shown on Table 1. It is generally accepted that heat stress exerts adverse effects when the THI exceeds 78 (Habeeb, 2018). The relationship between calcium and Thermo-humidity index (THI) could be due to animal under stressed in hot environmental conditions. The relationship of vitamin E and selenium as predicated on THI as observed in the equation model reported in this research could be due to heat stress. Both vitamin E and selenium have been reported to be involved in the antioxidant defense system, which plays important roles in the growth and health of humans and animals (McDowell, 2003; Surai, 2006). However, the concentrations of these micronutrients required to maintain the productivity and health of cattle exposed to high heat load are challenged because of reduced feed intake under such condition (Siegel, 1995). This suggests that supplementary Vitamin E and selenium in animal diet could help the animal mitigate heat stress. Selenium was also reported to play an important role in the regulation of various metabolic processes within the body (Zhou et al., 2013). The reduction in milk calcium content in hot environmental conditions may be an indication of excessive mineral metabolism predicated on stress. The relationship of Rectal temperature as predicated of THI as observed in this research contradicts the report of Omar et al. (1996) who observed that dairy cows under heat stress have increasing rectal temperature. In addition, panting, slowed heart rate and profuse sweating are observed (Blazquez et al., 1994) as well as reduced feed intake (NRC, 1989; Das, 2016).

Conclusion and Recommendation

This study reveals that vitamin and mineral contents of milk is largely dependent on temperature and humidity which could be used to determine heat stress. It is recommended that all measures which could cause heat stress should be considered good and quality milk production. This could be through the provision controlled housing system or dietary manipulation.

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