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Short Communication

Effect of cold and hot seasons on fat, protein and lactose of Dhofari cow's milk

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ABSTRACT

This study was carried out to find the effect of both cold (December to March) and hot (April to July) seasons on the Dhofari cow's milk components (fat, protein and lactose). The study was done at Salalah livestock research station located in Salalah city, south of Sultanate of Oman. A total of 640 milk samples from the indigenous Dhofari cow's breed of 4 years old and 2 parities were taken by 20 samples per week for an average lactation period of 240 days. Cows were fed adlibitum Rhodesgrass hay (9% crude protein, Salalah livestock research station, Salalah, Oman) and a diet of a commercial concentrates (16% crude protein, Dhofar cattle feed company, Salalah, Oman) according to their weights and milk production. Water and mineral blocks were given adlibitum. Air temperatures and relative humidity during those seasons were acquired weekly to find the temperature humidity index (THI). Milk compositions of fat, protein and lactose percentages were analyzed. Statistical analysis of milk components and climate temperatures, relative humidity and THI during these seasons were done using SAS software version 6.12 using MIXED procedure showed significant effect ($P < 0.05$) of seasonal effect on fat and protein, while there was no significant effect ($P > 0.05$) on lactose. In conclusion, this change maybe due to the effect of heat stress of different seasons on the cows.

Keywords: Dhofari cows, heat stress, lactose, milk fat, milk protein, season.

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INTRODUCTION

The local indigenous Dhofari cow is a breed located in the south region of sultanate of Oman. It is a small sized breed with a small cervical-thoracic hump, short horns, a narrow body and a tendency towards dark skin colors (Mahgoub et al., 1995). It is an indigenous breed domesticated by Omanis for ages in that area of the world. Locals have used the breed for both meat and milk production. Dhofari cow breed average daily milk production per cow about 6.18 ± 0.30 L during a lactation period of 300 days. There is almost no research done on this animal or its ability of production or adaptation to the environment. Heat stress on animals is usually a result of the influence of both air temperature and relative humidity (Robert et al., 1992). Therefore, it is important to know the temperature humidity index (THI) which indicates the cow's heat stress. THI values below 72 show no stress imposed on the cows and they are in their optimum performance, whereas THI range of 72 to 89 is considered to be mild to medium stress, but THI values above 89 are suggested to be severe stress (John, 2005). In Salalah city (17°01' North, 54°16' East), the changes of seasons from cold (December to March) with low average temperature of 22 to 25°C and lower heat stress effect to hot season (April to June) with high average temperatures of 26 to 30°C (Omani ministry of climate and environmental affairs report, 2011) and great heat stress effect on the components of cow's milk is important for the production, consumption and nutritional values aspects. The objective of this study is to find out the effect of those seasons with their variant climatic uncontrolled effects on the change of milk fat, protein and lactose.

MATERIALS AND METHODS

A total of 640 milk samples were collected during cold (December to March) and hot (April to July) seasons and analyzed at Salalah livestock research station laboratory for fat, protein and lactose

percentages. Each season had 320 samples collected and analyzed. Cows were milked in the milking parlor and milk was pasteurized in the milk plant. Samples were collected from the bulk tank. Samples were tested for subclinical mastitis using somatic cell count method (DeLaval cell counter DCC, Sweden).

Diet content of cows feed

Cows were given *ad libitum* Rhodes grass hay of 12 UFL per day and PDI of 1320 g per day. Commercial concentrate feed was also given which contain 4 UFL per day, PDI of 440 g per day and crude fat of 4% minimum. Therefore, cows were given a total of 16 UFL and PDI of 1760 g per day during both seasons of the study.

Fat percentage determination

Samples were prepared as described under Rose-Gottlieb method for milk. Fat percentage determination was done using the Gerber's method (ISI, 1958) by the addition of 10 ml sulphuric acid to 11 ml of milk sample and 1 ml of amyl alcohol to butyrometer. The butyrometers were centrifuged for 4 min and fat percentage was determined.

Protein percentage determination

Milk samples were heated to 40°C, mixed gently and cooled to 20°C. Protein percentage determination was done using the Kjeldahl method (Kjeldahl 1030 Analyzer Tecator, Sweden) by adding 5 ml of milk sample to 1.0 g cupric sulphate and 15 ml concentrated sulphuric acid into a Kjeldahl flask. The mixture was boiled and digested till water evaporated, then 10 g potassium sulphate was added while boiling for 3 h. After that it was left to cool to room temperature and then transferred by graduated cylinder 250 ml tap water to Kjeldahl distillation flask with few grains of pumic stone added. 65ml of 33% sodium hydroxide solution was added to the Kjeldahl distillation flask and was heated till 125 ml was distilled in the conical flask. Finally, titration of the surplus of hydrochloric acid in conical flask with sodium hydroxide was conducted using the Kjeldahl indicator. Protein percentage was determined by formula.

Lactose percentage determination

Lactose percentage determination was done using the photo-electric colorimeter (spectrophotometer UV2000). First 1 ml of milk sample was added to 1 L volumetric flask to make a standard solution. 2 ml of milk sample of the prepared standard solution from the volumetric flask was added to 5 ml concentrated sulphuric acid and 0.15 ml phenol 80% was added. The mixture was put in the spectrophotometer set to wavelength of 490 milimicrone to determine the lactose concentration. Lactose percentage in milk was determined using formula.

Temperature humidity index (THI)

Data of weekly average temperature and humidity acquired from Omani ministry of climate and environmental affairs report, 2011 were used to calculate the temperature humidity index using the THI table of Frank Wiersma (Andrew and Karl, 2010).

Statistical analysis

Chemical analysis of milk samples of fat, protein and lactose and climatic data acquired were statistically analyzed using SAS software (1999) version 6.12 with MIXED procedure. Means were compared with t-test for significance at $P < 0.05$. Seasonal (hot and cold) effects as independent factors on the changes of milk compositions of fat, protein and lactose as dependant factors were examined.

RESULTS AND DISCUSSION

Fat and protein percentages of milk samples were significantly ($P < 0.05$) lower during the hot season compared to the cold season. Whereas lactose was significantly ($P < 0.05$) affected (Table 1). During the hot season, average air temperature and relative humidity increased (22.90 and 76.61% respectively) above those averages of the cold season ($P < 0.05$). As a result, the temperature-humidity index showed significant difference ($P < 0.05$) between the two seasons which indicated an increase of heat stress during the hot season (Table 2). These climatic-physiological changes on the cows increased water intake, decreased milk production and feed intake as it was recorded by other research (Umberto et al., 2002) during the hot season. The decreased feed intake of cows during the hot season reduced the UFL and PDI required which in turn reduced milk daily yield. In addition, although the shift in season from winter to summer had significant ($P < 0.05$) elevated rectal temperature as recorded by other researchers (Abdoun et al., 2012); it did not affect the quality of milk produced as the somatic cell count of samples was below 200000 cells. Water intake was reduced during the cold season and fat concentration increased which was recorded by other researchers (Sharma et al., 2002). This might let them use up their body reserves of fat and protein which negatively affected the percentages of these ingredients in the milk. However, the lactose percentage was not significantly ($P > 0.05$) affected by the season because the chemical breakdown of body fat reserve during the hot season that maintain the glucose normal range in the animal's blood and maintenance energy (McDonald et al., 1988) which in turn maintain milk carbohydrate supply. The non-significance effect of hot season on milk lactose percentage need extensive research to find out the critical heat stress effect that will lead to a significant alteration of its percentage and the exact explanation of the reasons of that alteration is recommended by this paper. The low temperature during the cold season elevated the milk production and protein percentage of milk as expected and recorded by other researchers (Broucek et al., 2006).

Conclusion

This study shows that the local Dhofari cow's milk ingredients of fat and protein were affected by season. However, the lactose percentage will not be affected. This effect could be due to the climatic changes and heat

Table 1. Effect of cold and hot seasons on fat, protein and lactose percentages of milk (Mean ± SE).

Milk ingredients	Seasons*	
	Cold	Hot
Fat (%)	4.89 ± 0.05[a]	3.56 ± 0.23[b]
Protein (%)	3.71 ± 0.02[a]	3.43 ± 0.08[b]
Lactose (%)	3.79 ± 0.04[a]	3.60 ± 0.12[b]

a – b: Mean values within rows with different superscripts differ significantly ($P < 0.05$).
*Seasons: cold (December to March) = 22 to 25 ºC; hot (April to July) = 26 to 30ºC.

Table 2. Mean values ± SE of climate parameters analyzed during both cold and hot seasons.

Season	Temperature (°C)	Relative humidity (%)	THI
Cold	23.19 ± 0.37[a]	40.31 ± 4.25[a]	70.69 ± 0.18[a]
Hot	28.50 ± 0.48[b]	71.19 ± 3.07[b]	78.88 ± 1.13[b]

THI = Temperature humidity index. a - b: Mean values within columns with different superscripts differ significantly ($P < 0.05$).

stress during these seasons. Therefore, as a recommendation, care and proper management should be taken into consideration accordingly.

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