Issues in Biological Sciences and Pharmaceutical Research Vol.2(7),pp. 062-068, August 2014
Available online at http://www.journalissues.org/IBSPR/

ISSN 2350-1588

Original Research Article

The compositional quality of cows milk in Bhutan

3rd September, 2014

***Wangdi, J.,**
Dema, T.,
Karma, M.
and
Bhujel, P

RNR-RDC, Jakar, Bumthang, Bhutan.

*Corresponding Author
Email: jmewangdi@yahoo.com
Tel.:+975 77653485

The study was conducted to understand and document baseline information on the compositional quality of milk produced in Bhutan. Majority of milk are produced by the rural farmers rearing different dairy breeds and their crossbreds. The observed overall mean milk composition for the milk in Bhutan are 5.02 % fat, 8.68 % SNF, density of 1.029 Kg/L, freezing point of -.580 °C, 3.27 % protein, 5.48 % lactose and 0.68% other solids. The mean percent fat and protein recorded are 4.74 & 3.08; 4.99 & 3.23; 5.67 & 3.65; 5.15 & 3.02; 5.53 & 3.67; 5.08 & 3.15 and 5.07 and 2.98, for BSx, Jx, Mx, LC, PJ, Nublang and HFx, respectively. Added water in milk was encountered across the study locations with exception to Trongsa district. In overall, mean added water of 0.89 % was recorded in milk produced in Bhutan. Initially, Monggar district has the highest % added water of about 6.01 %; however, by the end of study period the % added water gradually decreased and reached to about 0.3 % by end of the study. There was significant differences ($p<0.05$) in the milk compositions among different study locations and among the different dairy breeds and their crossbreds. Likewise, a significant difference in milk composition was also observed between different seasons in this study. The protein to milk fat ratio (0.65) was found comparatively low, indicating milk protein depression in milk produced in Bhutan. It was also observed that most milk components with exception to lactose were found higher in improved cattle breeds reared in Bhutan than those reared in other countries.

Key words: mean daily milk yield, Nublang, protein to milk fat ratio

INTRODUCTION

Milk has been part of the human diet for millennia and is valued as a natural and traditional food. It is a nutrient dense food consumed across the globe by all age groups. Milk is generally composed of 87% water and 13% solids. The solid portions are composed of carbohydrate, fat, protein, minerals and vitamins, which has numerous functions. The fat, protein and lactose were routinely analysed as part of milk recording systems in many countries and those data were used for the breeding and genetic selection and to some extent for the feeding evaluation (Hamann, 1997). The solid content usually fat, protein and SNF determines the value of the milk for payment, and accordingly base prices for the raw milk were established between the buyer and seller in most countries. The milk components particularly protein and solid-not-fat (SNF) based milk pricing scheme are adopted for the payment to producers in most developed countries, placing a negative weighting on the carrier (volume) costs (Harding, 1995). Yet, milk is still marketed on volume basis with less emphasis on the milk components in Bhutan. Nevertheless, at one point of time it will also become inevitable to introduce quality milk payment based on compositions to ensure minimum fair milk payment to milk producers in Bhutan.

Butter and cottage cheese dominates the markets in Bhutan, and less emphasis in products diversification had led to poor understanding on the important roles of milk components in dairy industry. With the growing consciousness on adverse implication of fats on human health the dietary habits of the Bhutanese populace are changing and demand for more diversified low fat and protein based dairy products are increasing like any other countries.

This changing consumption trend will press on dairy industry to produce diverse milk products to suit the consumers' preferences and taste that can only be attained through milk standardization. However, prior to gearing into milk standardization it becomes imperative to have at least basic empirical information on the milk components of milk produced, which at this juncture is limited, nor attempts are made to explore and understand about it in Bhutan. Thus this augment a need for the study to understand and establish baseline information on the compositional quality of fresh raw cows' milk produced.

MATERIALS AND METHODS

Locations

The data were collected from migratory herders, members and non-members of dairy farmers' groups of Tang and Chumey geog in Bumthang; Tangsiji in Trongsa; Trong in Zhemgang; Pam in Tashigang; Themnangbi in Monggar; Gelephu and Sarpangtar in Sarpang; Deothang in Samdrup Jongkhar; and farmers of peri-urban dairy farms' in Thimphu. The data were also collected from the government owned cattle breeding farms i.e., Nublang farm in Tashiyangphu; National Brown Swiss Farm in Bumthang; National Jersey Breeding Farm in Samtse; Regional Mithun Breeding Farm in Aerong, Samdrup Jongkhar and community owned dairy farm in Tang, Bumthang.

Animals and milk samples collection

Milk samples were randomly collected from different dairy breeds and their crossbreds i.e. Mithun cross (Mx), Jersey cross (Jx), Pure Jersey (PJ), local cattle (LC), Nublang (siri), Brown Swiss cross (BSx), Pure Brown Swiss (BS) and Holstein Friesian cross (HFx). Milk samples were collected from 40 dairy cows of different breeds and their crossbreds once every month, for a period of one year from each study location (January 2013 to January 2014). Based on the convenience of the study locations, daily milk yield were measured for different animals using spring weighing balance with a 10 g precision.

After the complete milking, milk in the container was thoroughly mixed and milk samples of about 20 ml were collected from each cow in a plastic vial. The samples were stored and transported in a cool box to the place with electricity facilities for analysis. The samples were analyzed within 2 hours from the collection of samples using automatic ultrasonic milk analyzer (Master Eco, Indian made). This instrument automatically analyzes the following milk components – fat, SNF, protein, lactose, density, freezing point and added water. In total, 4849 milk samples were collected and analyzed by the extension staffs, technically backstopped by the staffs of Renewable Natural Resources – Research and Development Centre (RNR-RDC), the Regional Livestock Development Centre (RLDC) and the National Dairy Development Centre (NDDC).

The data were entered and organized in a excel spread sheet, then were exported and analyzed using GLM-multivariate ANOVA in SPSS (Version 21).

RESULTS AND DISCUSSIONS

Mean daily milk yield and composition of different study locations

Table 1 shows mean milk composition of milk by different locations of the study. There was a significant difference ($p<0.05$) in the milk composition for different study locations. This could be attributed to different environment conditions and adoption of different management practices – particularly the feeding and management systems (i.e. stall feeding, migratory and open grazing etc.). It could also be attributed to the rearing of different dairy breeds and their crossbreds of different % blood level, age, lactation number and stages. For instance, the government farm i.e. the National Jersey Breeding Centre (NJBC), Samtse, the Nublang Breeding Farm (NBF), Tashiyangphu and the National Brown Swiss Farm (NBF), Boepalathang reared PJ, pure Nublang and BS cattle, respectively. The overall management standards were also better at the government farms, in comparison to other study locations. The overall mean of 5.02 % fat, 8.68 % SNF, density of 1.029 Kg/L, freezing point (FP) of -0.580 °C, 3.27 % protein, 5.48 % lactose and 0.68% other solids were recorded for milk in Bhutan. An added water as high as 6.01 % in milk was encountered from the Monggar district in this study. However, % added water in milk decreased and attained to 0.3 % by the end of this study.

Mean daily milk yield and milk composition of different dairy breeds and their crossbred

Table 2 shows the mean milk yield and milk composition of different dairy breeds and their crossbred in Bhutan. A significant difference ($p<0.05$) in the mean daily milk yield and composition among the dairy breeds and their crossbred was observed. The overall mean daily milk yield recorded was 3.36 kg for the dairy breed in Bhutan. The highest mean daily milk yield of 6.39 kg was recorded for PJ

Table 1. Milk composition of cows' milk for different study locations

Location	N	Milk yield (Kg)	% Fat	% SNF	Density (Kg/L)	FP (°C)	% Protein	% Lactose	% Other solids
Mongar	265	4.61^{f}	4.96 ± 0.05^{b}	8.09 ± 0.04^{a}	1.027^{bc}	-0.515 ± 0.00^{a}	2.96±0.01^{a}	5.47 ± 0.01^{a}	.60±0.01^{a}
Bumthang	523	2.42^{c}	4.98 ± 0.04^{bc}	8.85 ± 0.06^{d}	1.029^{cde}	-0.580 ± 0.00^{e}	3.21±0.01^{b}	5.50 ± 0.00^{a}	.69±0.00^{d}
Brown Swiss Farm	325	3.38	4.80 ± 0.04^{a}	8.52 ± 0.07^{bc}	1.028^{bcd}	-0.549 ± 0.00^{bc}	3.07±0.01^{a}	5.49 ± 0.01^{a}	.65±0.00^{bc}
NJBC	341	N/A	5.59 ± 0.04^{f}	9.15 ± 0.07^{e}	1.030^{ed}	-0.666 ± 0.01^{g}	3.72±0.04^{c}	5.47 ± 0.01^{a}	.78±0.01^{e}
Sarpang	1310	3.73^{de}	4.89 ± 0.02^{ab}	8.79 ± 0.03^{d}	1.029^{cde}	-0.607 ± 0.00^{ef}	3.41±0.01^{c}	5.48 ± 0.00^{a}	.71±0.00^{d}
Samdrup Jongkhar	270	4.36^{f}	5.20 ± 0.06^{e}	8.51 ± 0.04^{bc}	1.028^{bcd}	-0.558 ± 0.00^{bcd}	3.22±0.10^{b}	5.46 ± 0.01^{a}	.65±0.01^{bc}
Nublang BF	297	1.14^{a}	5.16 ± 0.05^{d}	8.96 ± 0.27^{d}	1.030^{ed}	-0.566 ± 0.00^{d}	3.14±0.01^{a}	5.44 ± 0.01^{a}	.67±0.00^{cd}
Tashigang	289	3.48^{de}	5.14 ± 0.06^{d}	8.33 ± 0.08^{b}	1.028a^{b}	-0.540 ± 0.00^{b}	3.03±0.02^{a}	5.49 ± 0.01^{a}	.62±0.01^{b}
Thimphu	122	6.39^{g}	4.99 ± 0.05^{bc}	8.33 ± 0.06^{b}	1.029^{cde}	-0.553 ± 0.01^{bc}	3.59±0.23^{c}	5.50 ± 0.00^{a}	.64±0.01^{bc}
Trongsa	28	N/A	5.36 ± 0.17^{e}	8.40 ± 0.14^{b}	1.026^{a}	-0.553 ± 0.01^{bc}	3.13±0.04^{a}	5.50 ± 0.00^{a}	.68±0.01^{d}
Wobthang	259	1.77^{b}	5.52 ± 0.06^{f}	8.79 ± 0.03^{d}	1.028^{bcd}	-0.581 ± 0.00^{e}	3.19±0.01^{ab}	5.50 ± 0.00^{a}	.68±0.00^{d}
Zhemgang	438	3.29^{d}	4.96 ± 0.04^{b}	8.46 ± 0.04^{bc}	1.028^{bcd}	-0.555 ± 0.01^{bcd}	3.18±0.02^{ab}	5.48 ± 0.01^{a}	.66±0.01^{cd}
Total	4467	3.36	5.02 ± 0 .01	8.68 ± 0.02	1.029	-0.580 ± 0.00	3.27±0.01	5.48 ± 0.00	.68±0.00

*the number with different superscripts are significantly different (p<0.05)

Table 2. Daily milk yield and milk composition of milk for the different dairy breeds and their crossbreds

Dairy Cows	N	Milk yield (Kg)	% Fat	% SNF	Density (Kg/L)	FP(ºC)	% Protein	% Lactose	% Other solids
Brown Swiss cross	477	3.02 ± 0.08^{c}	4.74 ± 0.03^{a}	8.50 ± 0.05^{ab}	1.029^{b}	-0.549^{bc}	3.08 ± 0.01^{b}	5.49 ± 0.01^{a}	.65 ± 0.00^{b}
Jersey cross	2571	3.57 ± 0.04^{c}	4.99 ± 0.02^{ab}	8.52 ± 0.02^{ab}	1.028^{b}	-0.565^{c}	3.23 ± 0.01^{b}	5.48 ± 0.00^{a}	.66 ± 0.00^{b}
Mithun cross	43	1.83 ± 0.13^{b}	5.67 ± 0.10^{c}	9.79 ± 0.12^{c}	1.030^{c}	-0.689^{e}	3.65 ± 0.05^{a}	5.52 ± 0.04^{a}	.78 ± 0.01^{d}
Local Cattle	110	1.75 ± 0.11^{b}	5.15 ± 0.09^{ab}	9.02 ± 0.71^{b}	1.028^{a}	-0.538^{a}	3.02 ± 0.03^{b}	5.49 ± 0.01^{a}	.62 ± 0.01^{a}
Pure Jersey	127	6.39 ± 0.22^{e}	5.53 ± 0.03^{c}	8.92 ± 0.05^{b}	1.029^{c}	-0.633^{d}	3.67 ± 0.06^{a}	5.48 ± 0.01^{a}	.74 ± 0.01^{cd}
Nublang	214	1.14 ± 0.08^{a}	5.08 ± 0.05^{ab}	8.71 ± 0.03^{b}	1.030^{c}	-0.568^{c}	3.15 ± 0.01^{b}	5.41 ± 0.02^{a}	.67 ± 0.00^{bc}
Holstein Friesian cross	40	4.36 ± 0.57^{d}	5.07 ± 0.12^{ab}	8.27 ± 0.12^{a}	1.027^{a}	-0.512^{a}	2.98 ± 0.04^{b}	5.47 ± 0.04^{a}	.62 ± 0.02^{a}
Average	3582	3.36 ± 0.04	4.99 ± 0.01	8.59 ± 0.02	28.39 ± 0.04	-0.571	3.25 ± 0.01	5.48 ± 0.01	.67 ± 0.00

The different superscripts within the column indicate significant differences (p<0.05

cattle, followed by Jx, BSx, Mx, LC and Nublang. The lowest mean daily milk yield of 1.14 kg was recorded for Nublang. The difference in the mean daily milk yield might be accredited to genetic potential of the different dairy breeds in producing milk.

A significant difference ($p<0.05$) in the milk compositions was also observed with exception to lactose content, which was found similar across the dairy breeds and their crossbreds. The milk composition particularly lactose of the exotic breeds under Bhutanese conditions was observed higher, as compared to the findings of Harding (1995) (Table 3). This difference may have resulted from the application of different analytical methods to assess milk composition, and to some extent it could also be attributed to different environment and management aspects (feeding and nutrition,

Table 3: Milk composition of various cattle breeds

Breeds	% Fat	% Protein	Protein/fat	% Lactose	Ash	Total solids
Ayrshire	4.1	3.6	0.9	4.7	0.7	13.1
Brown Swiss	4.0	3.6	0.9	5.0	0.7	13.3
Guernsey	5.0	3.8	0.8	4.9	0.7	14.4
Holstein	3.6	3.1	0.9	4.9	0.7	12.2
Jersey	5.5	3.9	0.7	4.9	0.7	15.0
Zebu	4.9	3.9	0.8	5.1	0.8	14.7

Source: Adopted from Harding (1995)

housing, health, management system), % blood level of animals, genetics, and the productivity of animals.

The milk composition in general is reported to be affected by genetics, stage of lactation, level of milk production, age of cow, season, stage of lactation, environment, disease (for example, mastitis) and nutrition (Schroeder, 2012; Looper, 2014). Schroeder (2012) reported that heredity and environmental factors such as feeding management contribute to 55 % and 45 % of the variation in milk composition, respectively. Similarly, O'Mahony (1998) reported that the milk composition were affected by the genetics (among the breeds and individual animal), and environment factors i.e. interval between milking's, feeding regime, age, diseases, completeness of milking, lactation stage.

Fat and Protein

In this study a significant difference ($p<.05$) was observed in % fat and protein content in milk of different cattle breeds and their crossbreds. The overall mean percent fat and protein content recorded in milk was 4.99 % and 3.25 %, respectively. The highest % fat content was observed in Mx (5.67) and PJ (5.53) followed by LC (5.15), Nublang (5.08), HFx (5.07), Jx (4.99) and the lowest was recorded in BSx (4.74) cattle. Similarly, the highest percent protein was observed in milk of PJ (3.67) and Mx (3.65), and the lowest was recorded in HFx (2.98%) in this study. Fat and protein concentration are affected by different factors, i.e. stage of lactation, disease, age, genetics, season and feed. A highest concentration of milk fat and protein was reported in early and late lactation and lowest during peak milk production through mid-lactation (Looper, 2014). Similarly, he also reported that the milk fat and protein percentages are highest during the fall and winter and lowest during the spring and summer resulted mainly due to changes in both the types of feed available and climatic conditions.

SNF and lactose content

Milk is standardized based on the SNF and fat content, and accordingly base milk prices were fixed in many countries. Most developed countries have adopted protein and SNF based milk pricing scheme for the payment to producers, owing to increasing demand for protein based food and ever growing consciousness on adverse implication of fats on human health and also to ensure fair milk payment to milk producers. The overall mean SNF content of 8.59 % was recorded in milk produced in Bhutan. The highest and lowest % SNF recorded was 9.79 % and 8.27% in Mx and HFx, respectively.

Lactose is the major carbohydrate fraction in milk. The overall mean lactose content recorded in this study was 5.48 %, ranging in between 4.5-5.8%. The findings was higher than the report of O'Mahony (1998), who reported to vary in between 4.7 - 4.9%.

Density and % added water

The specific gravity of whole cow milk (ratio of density of milk to density of water) varies among breeds and among cows within breed. The overall mean density of 1.028 Kg/L (range 1.023 to 1.032) was observed for the milk produced in Bhutan. The finding of the study was found lower than the specific gravity of individual breed, but it falls within the range reported by Hurley (2010). The mean specific gravity reported were 1.0330, (range 1.0268 to 1.0385) 1.0317 (range 1.0231 to 1.0357) and 1.0330 (range 1.0240 to 1.0369) for the Holstein, Ayrshire, and Jersey milk, respectively. Hurley (2010) also reported that the density of milk changes with temperature, primarily because water and fat expand as they are heated.

Freezing point of milk

The freezing point of milk is an important indicator of the milk quality. It is determined primarily to prove milk adulteration with water and to determine the amount of water in it (Zagorska and Cipovica, 2013). Similarly, Henno et al (2008) reported that the freezing point of milk is used as one of the quality criteria for insuring high quality milk. Ontario Agri-Business Association Nutrition Committee [OAANC] (2005) adopted freezing point estimates of >-0.530 °C and >-0.525 °C, respectively to warn and penalized the milk producers. In this study, the overall mean of base freezing point of - 0.570 °C and - 0.580 °C in cows' milk was

Table 4. Milk protein to fat ratio of different dairy breeds

Breeds	N	% Fat	% Protein	Protein Fat ratio
Brown Swiss cross	477	4.74	3.08	0.65
Jersey cross	2571	4.99	3.23	0.65
Mithun cross	43	5.67	3.65	0.64
Local cattle	110	5.15	3.02	0.59
Pure Jersey	127	5.53	3.67	0.66
Nublang	214	5.08	3.15	0.62
Holstein Friesian cross	40	5.07	2.98	0.59
Average		4.99	3.25	0.65

recorded by locations and dairy breeds, respectively in Bhutan. The findings in this study were found lower than the average milk freezing point reported by OAANC (2005) of -0.540 °C. OAANC (2005) reported that the freezing point of milk was affected by the freezing of milk during cooling, or addition of rinse water to the tank in most cases. The other possible causes reported are due to unbalanced ration, including factors such as low energy or lack of grain, and lack of salt or minerals.

Added water in milk was encountered across the country with exception to Trongsa district. In overall mean added water of 0.89 % in milk produced in Bhutan was recorded. The management practices, particularly the remains of the rinse water of the milk container prior to milking and addition of the rinse water to the tank after the milking might have contributed to the presence of added water in milk. Initially, Monggar district has the highest % added water of about 6.01 %, however; the % added water in milk gradually reduced to about 0.3 % in milk by the later stage of the study. A continuous data collection and assessment of milk composition for the study, and simultaneous awareness on the importance of keeping milk free of added water and its repercussion to the milk producers and processors might have attributed to lowering of % added water in milk under Monggar district.

Milk protein to fat ratio

Table 4 shows the mean protein to milk fat ration of milk produced in Bhutan. In general, if the milk protein-to-milk fat ratio is less than 0.80, there is a problem of milk protein depression (low milk protein test) and when this ratio is greater than 1, the herd suffers from milk fat depression (low milk fat test) (Schroeder, 2012). The overall mean protein to milk fat ratio of 0.65 was recorded, which in comparison (Harding, 1995) was found comparatively low indicating milk protein depression of cow's milk in Bhutan. This might have resulted due to feeding of animals with low protein content feed. Thus, there is a greater scope in enhancing milk protein content in Bhutan through incorporation or feeding animals with a high protein diet.

Mean milk composition for the different milking times

Table 5 shows mean milk composition for the different milking times. Animals are usually milked twice in a day, i.e. once in between 8-10 hrs. in the morning, and 3.30-4.30 hrs. in the evening. A significant difference ($p<0.05$) in the mean milk composition in milk was observed for the different milking times. However, there was no difference in the lactose content of milk for different milking times. The % fat content in the evening milk was observed higher than the morning milk. In contrast, the % added water was observed higher in morning (1.05%) milk in comparison to evening milk (0.16%). The fat content of milk was reported to vary considerably between the morning and evening milking because there is usually a much shorter interval between the morning and evening milking than between the evening and morning milking (O'Mahony, 1998)

Seasonal variation of milk components

Table 6 shows the seasonal variations of daily milk yield and milk compositions. A significant difference ($p<0.05$) in the daily milk yield and milk composition with exception to protein and lactose content was observed. A higher variation in % fat content was observed in comparison to other milk components. The % fat content was observed highest during the autumn months followed by winter, summer and spring months (Table 6). The differences may be attributed to different calving seasons – where majority of calves were found to be calved during the winter months in this study, and by the autumn months the animals have attained last stage of lactation. Fat content was reported to be high, immediately after the calving but soon begins to fall, and continues to do so for 10 to 12 weeks, after which it tends to rise again until the end of the lactation (O'Mahony, 1998).

CONCLUSION AND RECOMMENDATIONS

Baseline information on the compositional quality of fresh raw milk produced and consumed in Bhutan was

Table 5. Daily milk yield (Kg) and % Milk composition of cow's milk for different milking times

Milking Time	N	Milk yield	Fat	SNF	Density (Kg/L)	FP(ºC)	Protein	Lactose	Other solids	Added water
Evening (E)	700	2.58[a]	5.10± 0.03[b]	8.49± 0.04[a]	1.029[a]	-0.550[a]	3.10± 0.01[a]	5.49 ± 0.00[a]	0.65± 0.00[b]	0.16 ± 0.04[a]
Morning (M)	2647	3.35[b]	4.98± 0.01[a]	8.63 ± 0.03[a]	1.029[a]	-0.577[a]	3.27 ± 0.01[a]	5.47 ± 0.00[a]	0.63 ± 0.00[a]	1.05± 0.09[b]
M + E	132		4.82±0.05[a]	8.36 ± 0.06[a]	1.029[a]	-0.541[a]	3.42 ± 0.21[b]	5.49 ± 0.01[a]	0.63 ± 0.01[a]	1.14 ± 0.40[b]
Average			5.00 ± 0.01	8.59 ± 0.02	1.029	-0.571	3.25 ± 0.01	5.48 ± 0.00	0.64 ± 0.00	0.89 ± 0.07

The different superscripts within the same column indicate significant differences ($p<0.05$)

Table 6. Daily milk yield (Kg) and the milk composition for different seasons

Seasons	N	Milk yield	Fat	SNF	Density (Kg/L)	FP (C)	P	Lactose	Other solids
Winter (Dec-Feb)	1442	2.95[a]	5.00[b]	8.40[a]	1.028[b]	- 0.543	3.13[a]	5.48[a]	0.64[b]
Spring (Mar-May)	470	3.71[b]	5.11[c]	8.25[b]	1.027[a]	-0.524	3.14[a]	5.49[a]	0.65[c]
Summer(Jun-Aug)	737	4.13[c]	4.88[a]	8.35[a]	1.028[b]	-0.540	3.05[a]	5.49[a]	0.62[a]
Autumn(Sept-Nov)	939	3.13[a]	4.80[a]	8.61[a]	1.028[b]	-0.550	3.14[a]	5.48[a]	0.63[b]
Average	4847	3.48	4.95	8.40	1.028	-0.540	3.12	5.48	0.64

The different superscripts within the same column indicate significant differences ($p<0.05$)

established. A significant difference in the milk composition was observed among different locations and dairy cattle breeds and their crossbreds in the country. There was also a significant difference in milk composition for different seasons. The above differences among different breed and crossbreds may be attributed to the non-uniformity in sample size, different breeds of different age, lactation number and stages managed under different management systems (migratory, stall feeding and open grazing or day out night in system. With this baseline information generated on the milk compositions in the country, the livestock sector could now gradually gear towards standardization of milk and milk products, which is imperative to assure uniformity in products to consumers across the country. In addition, the sector could also embark into introduction of milk pricing scheme particularly for the payment to producers to ensure fair minimum milk price. However, it is recommended to validate the findings of the study to that of standard milk components analytical methods.

The value estimated in this study for the protein to milk fat ratio (0.65) was found comparatively low indicating protein depression in milk produced in the country. Thus, a study may be undertaken to address the problem of protein depression in milk by feeding animals with a diet high in protein content.

ACKNOWLEDGEMENT

- All respondents and extension agents of the study sites for their time and supports
- All DLOs for their supports
- PDs of RLDCs and the National Commodity Centres for their kind supports
- The staffs and the management of RNR-RDC, Jakar for their kind supports

REFERENCES

Hamann VK (1997). Livestock Production Science

Production Science (48), pp. 201-208
Harding F (1995). Milk quality. Chapman and Hall, 2-6 Boundary Row, London, UK
Henno M, Ots M, Jõudu I, Kaart T, Kärt O (2008). Factors affecting the freezing point stability of milk from individual cows, Int. Dairy J, 18(2):210–215.
Hurley WL (2010). Lactation biology. Animal Sciences, Department of Animal Sciences, University of Illinois, Urbana, IL http://ansci.illinois.edu/static/ansc438/Milkcompsynth/milkcomp_density.html retrieved June 12, 2014
Looper M (2014). Factors Affecting Milk Composition of Lactating Cows. Agriculture and Natural Resources, Department of Agriculture Research and Extension, University of Arkansas System. http://www.uaex.edu/publications/pdf/fsa-4014.pdf retrieved on 1/9/2014
O'Mahony F (1998).Experiences in Ethiopia. ILCA Manual No. 4, International Livestock Centre for Africa, Addis Ababa, Ethiopia. http://www.ilri.org/InfoServ/Webpub/fulldocs/ilca_manual4/Factors.htm#P36_1410 retrieved 16/6/14
OAANC (2005). Significance of Nutritional Effects on the Freezing Point of Milk.Ontario Agri-Business Association Nutrition Committeehttp://www.milk.org/corporate/pdf/Farmers-FreezingPoint.pdf retrieved 12 June, 2014
Schroeder JW (2012). Dairy Cow Nutrition Affects Milk Composition http://www.ag.ndsu.edu/pubs/ansci/dairy/as1118.pdf retrieved June 12, 2014
Zagorska J, Ciprovica I (2013).Evaluation of Factors Affecting Freezing Point of Milk World Academy of Science, Engineering and Technology 7:02-22 http://waset.org/publications/15910/evaluation-of-factors-affecting-freezing-point-of-milk retrieved 12 June,