QUANTIFICATION OF BUTTER AND COTTAGE CHEESE FROM MILK OF DIFFERENT CATTLE BREEDS

ARPANA RAI[1], PEMA THINLEY[1] AND JAMBAY DORJEE[1]

[1]National Livestock Research Centre, Bumthang

*Author for correspondence: raiarpana108@gmail.com

ABSTRACT: *This study aimed to determine the quantity of butter and cheese produced from a liter of milk and to derive the relationship between fat and SNF in the production of butter and cottage cheese. A total of 69 samples each of raw milk, butter and cheese were collected. The mean fat and SNF content were recorded highest in Jatsham and lowest in Holstein Friesian. A significant difference ($p<0.05$) in the milk composition was observed with exception to water content between the breeds of cattle. The overall mean cottage cheese yield recorded from 5 ltr of milk is 506.01±97.71g, 454.01±88.08g, 403.5±13.39g, 414.3±70.40g and 519.84±78.83g for Jersey cross, Holstein Friesian, Nublang/Thrabum, Brown Swiss and Jatsham respectively. Similarly, the mean butter yield is 240.73±69.58g, 147.36±35.20g, 278.35±38.68g, 200.02±50.43g and 357.54±63.79g for Jersey cross, Holstein Friesian, Nublang/Thrabum, Brown Swiss and Jatsham respectively. A significance difference ($p<0.05$) was observed in cheese and butter production among the different breeds of cattle. A strong positive and significant correlation is observed between the fat percent and butter production among the different breeds of cattle. A weak positive correlation is observed between SNF and cottage cheese yield among the different breeds of cattle. Based on current study it is concluded that Jatsham produced the highest cottage cheese and butter followed by Nublang and Jersey cross. To further increase and enhance the quality of dairy products, it is recommended to improve the technical aspects of milk processing methods with improved technology.*

Keywords: Butter yield; Cattle breeds; Correlation; Cottage cheese yield; Fat percent; Milk composition; Solid not fat percent

1. BACKGROUND

Milk and milk products are nutrient dense food widely used around the globe. In most developing countries, milk is produced mostly by smallholder dairy farmers. Milk production contributes to household food and security and support livelihoods. It provides relatively quick returns for small-scale producers and is an important source of cash income (FAO 2022). Milk is highly perishable and requires careful handling and techniques to increase its shelf life. To ensure quality and increase shelf life, milk is processed into dairy products (Jorge 2016). The dairy products give small-scale dairy producers higher cash incomes than selling raw milk in absence of a market for raw milk. Easily transportable dairy products with long shelf life offer better opportunities to reach the local and urban markets (FAO 2022). Milk is generally composed of 87% water and 13% solids. The solid portions are composed of carbohydrate, fat, protein, minerals and vitamins (Wangdi et al. 2016). In milk compositions mainly fat and solid not fat (SNF) determines product yield (Khan & Pal 2011).

In Bhutan, milk production is widely practiced by farmers in a smallholder system for consumption and income generation. The majority of milk is

produced from cattle, followed by Yak and *Zom* (offspring of Yak and Goleng) in highland and few buffaloes in warm southern belts. As per the National Statistics Bureau[NSB] report 2023, milking animal population in the country stands at 66,309 heads, of which about 84.3% is cattle and 15.5% Yak and *Zom*, 0.03% Mithun and 0.14% buffalo respectively. In Bhutan, milk is both sold or processed into products primarily butter and cottage cheese called "*Datshi* (*a* soft unripened cheese) in almost all milk producing households (Wangdi et al. 2016). Butter and cottage cheese are the major products in dairy farmer's groups and cooperatives although various other products such as yoghurt, hard cheese, Gouda cheese and ice cream are also processed in small quantities (Choden et al. 2022). From the total of 43,828.51 MT milk produced in the country, 1727.46 MT butter, 2326.27 MT cottage cheese and 132 MT of *chugo* were processed (NSB, 2023).

Milk processing into butter and cottage cheese is nutritionally and economically important especially for the smallholders and saves the milk from spoilage and diversifies its use. Studies have shown a variation in volume of milk required and yields of butter and cheese (Tamang and Perkins 2005; Mahami et al. 2012; Derese et al. 2016; Salamończyk et al. 2017; Gemechu and Tola. 2017; Ogunlade et al. 2020). Genotype of animal, season and management influence milk composition, which further impact products yield (Wangdi et al 2016; Derese et al. 2016). Both local as well as exotic dairy breeds in Bhutan have different milk production levels with varying milk composition (Tamang and Perkins, 2005; Wangdi 2015; Wangdi et al. 2016). Although the Bhutanese farmers and milk processors have been processing milk into butter and cottage cheese, there is limited information available on the quantity of milk required for producing a kg of butter and cheese. Thus, this study was designed to document baseline information to quantify butter and cheese produced from a litre of milk from different dairy breeds and their crossbreeds in Bhutan. Besides, the research was also aimed to determine fat and SNF in milk from different cattle breeds and, estimate the relationship between fat and SNF for producing butter and cottage cheese.

2. MATERIALS AND METHODS

2.1 Study area

The study was carried out at Sampheling and Darla gewog under Chhukha, Geney Gewog under Thimphu, Chhoekhor and Ura gewog under Bumthang. In these study area, the cattle breeds comprised of Holstein Friesian, Nublang/Thrabum, Jersey cross, Brown Swiss and *Jatsham* respectively**.** The selection of gewog was based on purposive sampling**.** The study location was chosen based on the prevalence of a higher number of female animal populations of the respective breed.

2.2 Sample collection

A total of 69 samples of raw milk were collected and analyzed for fat, protein, SNF, pH, density, lactose and added water using ultrasonic milk analyzer. All parameters of milk composition were analyzed in triplicates for each processing and average value was recorded. For

processing of milk into butter and cottage cheese, minimum of 5 litres of milk was used per churn across all the breeds and study locations. The existing traditional method using curd percolator was used for processing the milk. The cottage cheese and butter were collected and measured using digital weighing balance. A total of 15 samples each of butter and cheese of each breed were collected expect for *Jatsham* (n=9).

2.3 Data analysis

The data was analyzed using the SPSS version 23. Volume of milk used and quantity of product (butter and cheese) obtained from different dairy breeds was included for the analysis. Prior to analysis, the data were cleaned and the outliers were removed. One-way ANOVA was deployed to determine if the means of volume of milk requirement and yields of butter and cheese differed significantly between different dairy breeds. Pearson correlation was applied to determine the relationships between fat and SNF and product (butter and cheese) yield.

3. RESULTS AND DISCUSSION

3.1 Milk composition of different breeds of cattle

The finding indicated that mean fat percentage stands at 4.73±0.96g, 4.00±0.58g, 5.70±0.51g, 4.70±0.55g, 6.87±1.06g for Jersey cross, Holstein Friesian, Nublang, Brown swiss and *Jatsham* respectively. The mean SNF percentage observed was 8.89±0.54g, 8.26±0.35g, 8.47±0.15g, 8.59 ±0.27g and 9.08±0.87g for Jersey cross, Holstein Friesian, Nublang, Brown Swiss and *Jatsham* respectively. The mean fat content was recorded highest in *Jatsham* when compared to other cattle breeds. Similarly, milk from *Jatsham* had the highest SNF content followed by other breeds of cattle. A significant difference ($p<0.05$) in the milk composition was observed with exception to water content among the breeds of cattle. Wangdi *et al*. 2016 reported higher fat percent and SNF percent content in *Jatsham* and lowest in Holstein Friesian which is similar to the current study. Tamang and Perkins, 2005 recorded higher mean fat percent of *Jatsham* and less fat percent in Siri compared to the current findings. However, Wangdi et al. 2016 reported lower fat percent of *Jatsham* but recorded similar SNF percent and also recorded the similar fat percent in Brown Swiss. Tamang and Perkins, 2005 have reported higher fat percentage of *Jatsham* and less fat percentage of Siri in comparison to current study. Norbu and Choki, 2021 has reported that the cows managed in peri-urban areas of Bhutan has 5.06% fat and 2.79% protein in milk sold at urban sales outlets in various district of Bhutan. Wangdi et al. 2016 have reported that the genotype of animal, feeding and management, season, calving season and lactation stage affect the composition of milk. Kalac and Samkova (2010) had also reported the similar factors such as animal species and genetics, environmental conditions, lactation stage, and animal nutritional status that affect the milk composition.

Table 1: Mean ± SD milk composition of different breeds of cattle

Breed	Fat	SNF	Density	Protein	Lactose	Water	Freezing point	Ash
Jersey Cross	4.73±1.03^{a}	8.89±0.70^{ac}	26.69±2.63^{a}	3.24±0.24^{a}	4.91±0.36^{a}	0.56±1.48^{a}	15±0.58^{ad}	15±0.72^{a}
Holstein Friesian cross	4.00±0.58^{a}	8.26±0.35^{b}	27.78±1.52^{ab}	3.01±0.13^{b}	4.53±0.19^{b}	1.33±2.40^{a}	15±0.53^{bc}	15±0.67^{b}
Nublamg/Thrabum	5.70±0.51^{b}	8.47±0.15^{ab}	27.29±0.95^{b}	3.06±0.09^{ab}	4.68±0.12^{ab}	0.00±0.00^{a}	15±0.55^{ac}	15±0.68^{b}
Brownswiss	4.70±0.55^{a}	8.59±0.27^{abd}	28.39±0.82^{ab}	3.12±0.10^{ab}	4.72±0.15^{ab}	0.00±0.01^{a}	15±0.56^{ab}	15±0.70^{ab}
Jatsham	6.87±1.06^{c}	9.08±0.87^{cd}	28.39±2.75^{ab}	3.27±0.31^{a}	4.97±0.55^{a}	1.84±5.51^{a}	9.0±0.61^{d}	9.0±0.73^{a}
Mean±SD	5.06±1.17	8.62±0.56	28.30±1.96	3.13±0.20	4.75±0.31	0.65±2.38	69±0.56	69±0.70
P value	0.000	0.001	0.010	0.001	0.002	0.224	0.000	0.001

*Different superscript within the column significantly differs at 95% confidence interval

3.2 Cheese and butter production

The estimated butter and cottage cheese yield from 5 litre of milk of different breeds of cattle is indicated in Table 2.

The overall mean butter and cheese produced using 5ltrs of milk from different breeds stands at 235g and 454.29g respectively. The mean butter and cheese production recorded are 240.73g and 506.01g, 147.36g and 454.01g, 278.35g and 403.50g, 200.02g and 414.30g and 357.54g and 519.84g for Jersey cross, Holstein cross, Nublang, Brown Swiss and *Jatsham* respectively. A significance difference ($p<0.05$) was observed in cheese and butter production amongst different breeds of cattle (Table 2). The highest butter production was recorded from milk of *Jatsham* when compared to other breeds. Likewise, cottage cheese production was also recorded highest from milk of *Jatsham*. This finding could be attributed to high fat and SNF percent in the milk. In current study 1 ltr of milk of *Jatsham* and Thrabum yield approximately an average of 71.5gm and 55.6 gm butter and 103.96gm and 80.70 gm cottage cheese which is less compared to Tamang and Perkins, 2005 who recorded 83 gm and 56 gm butter and 186 gm and 121 gm cottage cheese. The production of cottage cheese in Brown Swiss cattle is notably lower than that of Holstein Friesian cattle. This difference may be attributed to several factors including the adequate coagulation of buttermilk to coagulum and following the addition of both hot and cold water which could result in reduced cottage cheese yield. Additionally, over churning of curd during the butter production may further contributed to less production. Variation in geographical location and environmental condition during the processing phase may also play a significant role in influencing the production.

The study revealed that approximately 22 ltrs of milk is required to produce a kg of butter and produces approximately 1.9 kg of cottage cheese. It aligns with the study conducted by Derese et al. 2016 who reported that 20.74 litres of milk is required to produce a kg of butter. Similarly, Gemechu and Tola. (2017) has also reported that between 20 to 25 litres of milk could yield approximately one kg of butter. In contrast, Woldearegay. (2016) has recorded that an average of 2.91 liters of milk yields 0.21 kg of butter or an estimated 13.85 litres is required to produce a kg of butter. Similarly, Tola et al. 2020 has reported that around 14.28 litres of milk produce a kg of butter. The yield may vary depending on factors such as the quality of the milk/whey or cream used, the butter production method, and the temperature and timing of the process (Aydemir and Altun, 2024). Additionally, Salamonczyk et al. (2017) has reported that Friesian milk of 100 kg yielded 20.10 kg of acid curd cheese under laboratory conditions.

Table 2: Butter and cottage cheese yield from different breeds of cattle

		Mean±SD	
Sl. No	**Breed**	**Butter(g)**	**Cheese (g)**
1	Jersey Cross	240.73 ± 69.58^{a}	506.01 ± 97.71^{a}
2	Holstein Friesian	147.36 ± 35.20^{b}	454.01 ± 88.08^{ac}
3	Nublang/Thrabum	278.35 ± 38.68^{a}	403.5 ± 13.39^{bc}
4	Brown Swiss	200.02 ± 50.43^{ab}	414.3 ± 70.40^{bc}
5	Jatsham	357.54 ± 63.79^{c}	519.84 ± 78.83^{a}
	Overall mean	*235±83.28*	*454.29±86.21*

*Different superscript within the column significantly differs at 95% confidence interval

3.3 Correlation between Fat and Butter

The table above shows the correlation between breed, fat percent and butter yield. There is a strong positive correlation between the fat percent and the butter production among the milk of different breeds of cattle. There is a highly significance correlation found between fat percent and butter production among the different breeds of cattle ($p<0.05$). The strong positive correlation is observed between fat percent and butter production of Jersey cross milk ($r= 0.735$, $p<0.05$) and Nublang/Thrabum ($r= 0.714$, $p<0.05$). In contrast, a weak positive correlation is recorded in fat percent and butter production in milk of Brown Swiss ($r= 0.207$). Derese et al. (2016) has reported that butter output is linked to fat content of the milk, higher the fat yields more butter. Jorge, (2016) has further proved that not only fat content but volume of milk churned at a time, churning mechanism, length of churning time and churning temperature which affects fat percentage and subsequently butter yield from a given milk.

3.4 Correlation between SNF and cheese yield

The table above represents the correlation between different breeds of cattle, SNF percent and cottage cheese yield. Overall, there is a weak positive correlation between SNF and cottage cheese yield ($r= 0.127$) which is statistically not significant ($p>0.05$). When examining different breeds, the study found out that weak positive correlation in milk of Jersey cross ($r=0.291$), Nublang ($r=0.393$) and *Jatsham* ($r=0.191$) between SNF content and cottage cheese yield. Salamończyk (2017) have reported that cheese output is directly related to the amount of milk solids in the milk, especially protein. This is because cheese product is formed mainly by the coagulation of proteins in milk, thus greater the protein content higher the yield of cheese. Metz et al. (2001) has also reported that protein and fat content predominately influence cheese yield. The cheese yield is positively correlated with the casein and fat contents of milk.

Table 3: Correlation between fat and butter production amongst cattle breeds

		Breed	Fat	Butter
Breed	Pearson Correlation	1	.493	.369
	Sig. (2-tailed)		0	0.002
	N	69	69	69
Fat	Pearson Correlation	.493	1	.733
	Sig. (2-tailed)	0		0
	N	69	69	69
Butter	Pearson Correlation	.369	.733	1
	Sig. (2-tailed)	0.002	0	
	N	69	69	69

Table 4: Correlation between breeds, SNF and cheese production

		Breed	**SNF**	**Cheese**
Breed	Pearson Correlation	1	0.102	-0.122
	Sig. (2-tailed)		0.406	0.317
	N	69	69	69
SNF	Pearson Correlation	0.102	1	0.127
	Sig. (2-tailed)	0.406		0.3
	N	69	69	69
Cheese	Pearson Correlation	-0.122	0.127	1
	Sig. (2-tailed)	0.317	0.3	
	N	69	69	69

The yield is also influenced by the processing conditions that determine the amount of whey retained in cheese, such as the rennet dose, pH of vat milk, temperature of coagulation, curd cutting and cooking, pressing, etc (Summer et al, 2014).

4. CONCLUSION

It is evident from the findings that *Jatsham* produced highest cheese and butter followed by Nublang and Jersey cross. The study has established a baseline data regarding the volume of milk required to produce a kilogram of butter and a cottage cheese. These results will provide valuable information to Bhutanese milk processor and also the dairy farmers to forecast and strategize their business operation to maximize profit and satisfy customer needs. The correlation indicates that the fat content in the milk is a critical quality indicator for butter production. The weak correlation was observed between SNF content and cottage cheese production even though SNF is the primary determinant of cheese production so it suggests that other factors such as milk quality, specific characteristics of milk from different breeds and processing methods may have influence the production as well the quality of product. Therefore, it is recommended to improve the processing techniques/methods and also take into consideration other milk components for better production of butter and cottage cheese. Moreover, further research to include seasonal variations is recommended to explore the relationship between SNF and cottage cheese production. The future study should identify and include other variables that might affect the quantity of cheese and butter to determine the actual quantity and relationship between the studied variables with larger sample size.

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