NUTRIENT CONTENT, SENSORY QUALITY AND CONSUMERS' ACCEPTABILITY OF FULL-FAT AND LOW-FAT FETA CHEESE MADE FROM BUFFALO'S MILK PACKED IN CANOLA OIL WITH OR WITHOUT BASIL

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ABSTRACT

The objective of the study was to evaluate the nutrient content, sensory quality, and consumers' acceptability of full–fat and low–fat feta cheese from buffalo's milk packed in canola oil with or without basil. Full–fat feta cheese were prepared from whole buffalo's milk whereas the low–fat feta cheese were from buffalo's milk standardized to 3% fat. The study used a 2 x 2 factorial arrangement in a completely randomized design. The cheese did not differ in protein content; however, the low-fat feta cheese had less (*P*<0.01) fat, calories, and greater (*P*<0.01) moisture and salt content than full-fat feta cheese. Full-fat feta cheese in canola oil with basil had the least (interaction, *P*=0.037) ash content compared with the other treatments. There was no interaction between the type of milk and packaging used on appearance and firmness ratings. Full-fat feta cheese had higher ratings for cohesiveness (*P*<0.001), flavor (*P*=0.02) and general acceptability (*P*<0.01) than low-fat feta cheese. Full-fat feta cheese in canola with basil had lower saltiness score (interaction, *P*<0.02) than the other treatments. There were no differences in aroma and after-taste among the treatments. Feta cheese in canola oil with basil was consistently preferred by consumer panelists. The yield of full-fat feta cheese was greater (*P*=0.01) than low-fat feta cheese. The cost of low-fat feta was higher than the full-fat cheese. In conclusion, product quality of low-fat feta cheese is lower than full-fat feta cheese but the advantage of the former is its greater nutritive value.

Keywords: Buffalo's milk, Canola oil with or without basil, Feta cheese, Nutrient content, Sensory quality, Consumer acceptability

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INTRODUCTION

There are numerous types of natural cheese that have been developed in different countries; however, most local processing plants and small-scale businesses in the Philippines are producing processed cheese products and the traditional “kesong puti”. Other types of cheese in the market are mostly imported from western countries. Therefore, ventures into high end cheese production will add increased variety to locally produced dairy products. Producing more value-added products may also provide opportunities for dairy entrepreneurs to increase their profitability. Since most of the dairy processors in the country are cooperative-based, cheese that will require minimal equipment and facilities for processing will be ideal.

One of the most popular cheeses nowadays is feta due to its flavor that goes well with salads and different healthy food preparations. Feta cheese is a white, soft, brine-ripened variety, usually made from either ewe’s or goat’s milk. It is usually formed into square cakes with a tangy, salty flavor that can range from mild to sharp. Its fat content can range from 30 to 60% but most feta has around 45% fat (Ehler, 2009). With the high fat content of buffalo’s milk, most of the products obtained from it are greater in fat than products coming from milk of other dairy species. And with increasing number of health conscious people, calories and fat of each and every food are being counted to maintain a healthy diet. In order to lower calories, fats from the cheese are being reduced, thus, the development of low-fat cheeses. Low-fat feta cheese is now being sold commercially and the fat content of the milk used is usually between 1.5 to 3% fat (Pitso, 1999).

The main objective of the current study was to develop a technology for the production of feta cheese that will have commercial applications in the Philippines. It specifically aimed 1) to compare the nutrient content and sensory quality of full-fat and low-fat feta cheese from buffalo’s milk packed in canola oil with and without basil; 2) to determine the effect of demographic parameters like age, sex, occupation, and type of cheese eaten on consumers’ acceptability of the cheese; and 3) to determine the product yield and production cost of feta cheese.

MATERIALS AND METHODS

Milk Collection, Sampling and Quality Determination

Buffalo’s milk was obtained from the Philippine Carabao Center (PCC) at the University of the Philippines Los Baños (UPLB) for the entire duration of the experiment. Milk samples were obtained and analyzed for protein, fat, and total solids content using an Ekomilk ULTRA milk analyzer (Bultech 2000 Ltd., Bulgaria). Analyzed composition of the raw milk was 4.02% protein, 8.39% fat, and 10.07% solids not fat (SNF).

Experimental Treatments and Design

The experimental treatments followed a 2 x 2 factorial arrangement using a completely randomized design. Factors were the type of milk (full-fat vs. low-fat) and the type of packaging used (packed with canola oil with or without basil). Three batches were prepared for each treatment.

Standardization of Buffalo's milk

Milk for processing were divided into two parts, one for the full–fat cheese and the other for the low–fat cheese. For the low–fat feta cheese, the buffalo's milk was standardized to 3% fat by adding computed amounts of 12% reconstituted skim milk (RSM). To obtain milk with 8.33% fat, 640 ml of 12% RSM was added to 360 ml of whole buffalo's milk to produce 1 L of cheese-milk. Pearson square was used for computations.

Processing of Feta cheese

The feta cheese was manufactured following the procedures of Barraquio (2011) with some modifications. Full–fat and low–fat milk were both pasteurized at 72°C for 15 sec and then cooled to 32°C. Once cooled, the full–fat milk were divided into 2 portions then packaged with canola oil with or without basil, and the same was done with the low–fat milk. A total of 5 L of milk were used for each treatment. Afterwards, 1.5% mesophilic starter cultures, *Flora Danica* that were previously prepared were added to each treatment and left undisturbed for 45 min. A 20 mL calcium chloride solution was added to all the treatments prior to the addition of rennet. Once rennet was added, 30 min was allotted for curd formation. The curd was then cut and left undisturbed for 20 min to allow whey separation. The whey was removed and collected in a plastic jar and the curd was put in perforated moulders lined with cheese cloth. The feta cheese and whey were kept for 24 h in a cold room at 5°C to allow proper draining to occur. Once drained, the cheese were weighed to determine the yield and brined with a 15% solution composed of water and pasteurized whey. Brining of the feta occurred for 17 h. Feta cheeses weighing 700 g were packed in 150 ml canola oil for all treatments and for treatments with basil, 20 g of fresh basil were added. Lastly, the packed feta cheese was stored at a cold room and was ripened for 5 d.

Data Gathered

Nutrient Content

Samples were analyzed for protein, fat, moisture, and ash in triplicates using AOAC procedures (2006). Gross energy (cal/g) was analyzed in triplicates using an isoperibol calorimeter (Parr 6200, Parr Instrument Co., Moline, IL). Salt concentration was measured in triplicates using the modified Volhard method.

Sensory Quality

Feta cheese was served in 10 g samples of each treatment group in random order and in different sample codes along with crackers. Experienced panelists assessed the quality attributes of feta cheese samples using a linear scale (Mabesa, 1986) in 3 separate sensory analysis sessions. The appearance, cohesiveness, firmness, aroma, flavor, after-taste, saltiness, and general acceptability of the feta cheese samples were rated. The score in the linear scale ranges from 0 to 100 with corresponding descriptions per attributes: For aroma, after-taste, and appearance: 0 is extremely undesirable and 100 is extremely desirable; for flavor: 0 is extremely undesirable and 100 is extremely rich and full; for cohesiveness: 0 is extremely crumbly and 100 is extremely cohesive; for firmness: 0 is extremely soft and 100 is extremely hard; for saltiness: 0 is for extremely not salty and 10 is extremely salty; and for general acceptability, 0 is extremely unacceptable and 100 is extremely acceptable.

Consumer Acceptability

Ranking method was used in determining the consumer's acceptability of the full-fat and low-fat feta cheese packed in canola oil with or without basil. Walk-in consumers in the PCC-UPLB Dairy Bar were the panelists in determining the consumer's acceptability of the feta cheeses. Feta cheese samples with different sample codes along with questionnaires and lettuce were served to each panelist. The samples were ranked based on their preferences between 1 to 4 with 1 being the most preferred and 4 being the least preferred cheese sample.

Product Yield

The weight of the feta cheese before and after draining was recorded and the product yield was computed.

Income over Production cost

Production cost of feta cheeses were calculated based on the amount of expenses for the materials and operational costs used. The operational cost was based on the computations used by PCC at UPLB. The income over production cost was determined by computing the projected sales and profit based on the amount of product obtained from each treatment. The price of the feta cheese used was based on the selling price of commercially available feta made from goat's and cow's milk.

Statistical Analysis

Data for nutrient content and product yield were subjected to ANOVA for a 2 x 2 factorial arrangement of treatments. Sensory quality data were analyzed using ANOVA in a 2 x 2 factorial in a randomized complete block design with panelists as the blocking factor. Treatment means with significant interaction effects were compared using the Bonferroni (Dunn) T-

test. Consumer test data were analyzed using the Chi–square test. Data analysis were performed using SAS (ver. 9, SAS Inst. Inc., Cary, NC).

RESULTS AND DISCUSSION

Nutrient Content

There was no interaction between the type of milk and packaging used on nutrient composition (Table 1). The protein content of feta cheese packed in canola oil with or without basil did not differ significantly. This implies that the protein of 12% reconstituted skim milk was enough to replace the amount of protein lost during standardization of the milk. Basil reportedly has 11.9% protein (Board, 2010) but it did not influence the protein content of feta cheese. This is because the basil was only added to the canola oil. There were also no differences in fat, moisture, calories, and salt content of feta cheese packed in canola oil with or without basil.

Table 1. Nutrient composition of full–fat and low–fat feta cheese.

	Milk		*P*-value		
Item	Full-fat cheese	Low-fat cheese	Milk	Packaging	Milk × Packaging
Protein, %	9.9	10.4	0.50	0.12	0.76
Fat, %	18.6	11.1	<0.001	0.12	0.93
Moisture, %	54.7	64.6	<0.01	0.97	0.55
Calorie, cal/g	3,753	2,272	<0.01	0.25	0.69
Salt, %	2.6	3.6	<0.01	0.28	0.36
Ash, %	3.6	4.6	<0.001	0.04	0.04

As expected, fat content of the full–fat feta cheese was greater (P<0.001) than the low-fat feta cheese since the milk used for the latter was standardized to 3% fat. Similarly, calories of full–fat feta cheese were greater (P<0.01) than the low–fat feta cheese. This was primarily due to the difference in fat content of the cheeses. In contrast, moisture content in low–fat feta cheese was less (P<0.01) compared with full–fat feta cheese due to the large amount of water added during standardization with 12% reconstituted skim milk. The water was not able to drain properly during processing since it was trapped in the curd. On the other hand, the increased salt content of low-fat feta cheese can be attributed to the high moisture content of the cheese. During brining, more salt penetrated the low-fat feta since water content of the cheese was high. This lead to the binding of higher amount of sodium ions with water molecules trapped in the cheese. The current findings are in agreement with El-Abd *et al. (*2007) that salt content is greater in cheese curd with higher moisture content. The milk and packaging has an interaction (P=0.04) on the ash content of feta cheese.

Full-fat feta in canola with basil had less (P<0.05) ash content than the other treatments.

Therefore, on the basis of the fat and calorie content, the low-fat feta cheese is a healthier food option. Production of the product with good nutritive value is possible with the simple processing procedure for feta cheese.

Sensory Quality

There was no milk × packaging interaction for any of the sensory quality parameters measured; therefore, only main effects were discussed (Table 2). Aroma and after-taste of low–fat and full–fat feta cheese packed in canola oil with or without basil did not differ significantly. Each treatment had good aroma and after taste as commented by the sensory panelists.

Table 2. Sensory quality of full–fat and low–fat feta cheese packed in canola with or without basil[1].

	Milk		Packaging		*P*-value		
Item	Full-fat cheese	Low-fat cheese	Canola oil	Canola oil with basil	Milk	Packaging	Milk × Packaging
Aroma	69.64	68.97	67.18	71.43	0.80	0.11	0.96
After taste	65.42	60.88	62.19	64.10	0.22	0.61	0.88
Appearance	79.46	71.07	79.11	71.42	<0.01	<0.01	0.08
Flavor	74.19	68.65	72.14	70.71	0.02	0.55	0.86
Cohesiveness	77.68	64.60	73.15	69.13	<0.001	0.13	0.19
Firmness	73.07	59.68	70.39	62.38	<0.001	<0.01	0.53
General acceptability	73.65	65.43	69.46	69.62	<0.01	0.95	0.37
Saltiness	68.63	82.58	72.14	70.71	<0.001	0.19	0.02

[1]For aroma, after-taste and appearance: 0 is extremely undesirable and 100 is extremely desirable; For flavor: 0 is extremely undesirable and 100 is extremely rich and Full; For cohesiveness: 0 is extremely crumbly and 100 is extremely cohesive; For firmness: 0 is extremely soft and 100 is extremely hard; For general acceptability, 0 is extremely unacceptable and 100 is extremely acceptable; and for saltiness: 0 is for extremely not salty and 100 is extremely salty.

Appearance rating for low–fat feta cheese was lower (P<0.01) than the full–fat feta cheese. Low-fat feta cheese has reduced number of light scattering centers since there were less fat globules that dispersed the light thereby becoming less opaque. This becomes apparent especially when the fat level is reduced (Johnson *et al*., 2009). Flavor of the full–fat feta cheese had a higher (P=0.02) rating compared with the low–fat feta cheese. The full–fat feta cheese had higher fat content which is responsible for the full and creamy flavor (Hill, 2012). Cohesiveness of the cheese particles of the low-fat feta cheese was lower (P<0.001) than the full–fat feta cheese. This could be due to the higher moisture content and lower total solids content of the cheese. The low–fat feta cheese tends to break down into crumbles having lower rating compared to full – fat feta cheese that is more compact. The full–fat cheese was firmer (P<0.001) than the low–fat feta cheese due to

the lower moisture content and higher total solids. In the case of low-fat feta, standardization of milk with 12% RSM increased the water in the cheese milk resulting in more water being trapped in the curd. Additionally, the low–fat feta cheese had less fat in the cheese milk that allowed water instead of fat molecules to occupy the space in dense matrix of the curd which resulted in a softer cheese. There was an interaction (P=0.02) on the saltiness of feta. Full-fat feta cheese packed in canola oil with basil had lower (64.3%; P<0.05) saltiness ratings than when it is packed in pure canola oil (72.94%); however, this was not observed in the low-fat feta cheese. Low-fat feta cheese was perceived to be more salty than the full–fat feta cheese. This was due to the higher salt content of the low-fat feta cheese. The general acceptability rating of the low-feta cheese was lower (P<0.01) than the full-feta cheese due to saltiness and lower ratings in appearance, cohesiveness, flavor, and firmness.

There were no differences in the aroma, after-taste, flavor, cohesiveness, and general acceptability ratings of cheese packed in canola oil with or without basil. However, cheese packaged in canola oil with basil had lower (P<0.01) ratings for appearance and firmness than the cheese in pure canola oil. The basil in canola caused browning of the feta cheese which could have reduced the aesthetic value of the product.

The results indicate that the fat content of feta cheese have no influence on the aroma, and after-taste of the product. Additionally, the basil did not significantly improve the sensory quality of the feta cheese.

Consumer Acceptability

Overall, full-fat feta cheese packed in canola oil was the least preferred among the feta cheese tested (Table 3). Full–fat feta cheese packed in canola oil with basil and low-fat feta cheese packed in canola oil with or without basil had the same ranking of 1.

Across different demographic groups, full–fat feta cheese packed in canola oil with basil consistently ranked first among the samples from other treatments. The consumers' liked the pesto-like flavor imparted by the basil. In the 15 to 25 age group, the least preferred was the low–fat feta cheese packed in canola oil, while the most preferred was the full–fat feta cheese packed in canola oil with basil. The group liked the creaminess in full–fat feta and the basil flavor in the cheese. In the 26 to 50 age group, the least preferred was the full–fat feta cheese in canola oil and the most preferred was the full–fat feta cheese packed in canola oil with basil and low–fat feta cheese packed in canola oil. The group did not like the hardness of the full-fat feta cheese and preferred the cheese that was softer and had a basil flavor; however, it was commented that low–fat feta cheese packed in canola oil with basil were too salty to taste the basil flavor. For the 51 to 70 age

Table 3. Consumer ranking for full–fat and low–fat feta cheese packed in canola oil with or without basil.

Group	Treatment				X^2 computed	X^2 tab
	Full-fat feta cheese		Low-fat feta cheese			
	Canola oil	Canola oil with basil	Canola oil	Canola oil with basil		
Overall*	2	1	1	1	15.57	0.35
Age						
15 to 25*	2	1	3	2	13.17	0.35
26 to 50*	3	1	1	2	4.50	0.35
51 to 70*	1	1	2	3	1.90	0.35
Sex						
Male*	2	1	2	3	11.65	0.35
Female*	2	1	2	3	6.64	0.35
Occupation						
Working*	3	1	1	2	4.02	0.35
Non–working*	2	1	3	2	13.45	0.35
Cheese eater*	2	1	2	2	15.22	0.35
Non–cheese eater*	2	1	1	2	0.45	0.35
Type of cheeses eaten*						
Kesong Puti*	2	1	2	2	9.23	0.35
Processed cheeses*	2	1	2	2	12.80	0.35
Imported cheeses*	2	1	2	2	7.74	0.35
Tasted feta prior						
Have tasted feta*	2	1	3	2	14.97	0.35
Have not tasted feta*	2	1	3	3	6.38	0.35

[1]A sample of each treatment was ranked based on the panelist's preferences with 1 being the most preferred and 4 being the least preferred cheese sample.
*Means are significantly different (P<0.05).

group, the least preferred was the low-fat feta cheese packed in canola oil with basil and the most preferred was the full-fat feta cheese packed in canola oil with or without basil. They liked the creaminess of the full-fat feta cheeses and the basil had no effect on their preference. The low preference for low-fat feta was due to the higher level of saltiness of the cheese.

Female acceptability with feta cheese did not differ with males. Both mostly preferred the full-fat feta cheese packed in canola oil with basil and least preferred low-fat feta cheese packed in canola oil with basil. Both liked the taste of herb and creaminess of the cheese. In terms of occupation, the working group and non-working group composed of students and housewives preferred the full-fat feta cheese packed in canola oil with basil; however, the low-fat feta cheese packed in canola oil was also preferred by the working group. The least preferred of the working group was the full-fat feta cheese packed in canola oil due to its hardness and saltiness. The non-working group, on the other hand, least preferred the low-fat feta cheese packed in canola oil. They did not like a softer feta and preferred the harder one with basil flavor. Both groups loved the basil flavor that they mentioned it tasted like hotdog and pesto combined.

In the parameter of whether they are a cheese eater or not, both groups liked the full-fat feta cheese with canola oil and basil the most; however, the non-eaters also liked the low-fat feta cheese packed in canola

oil. The cheese eater group ranked the remaining treatments the same, as some of them liked the other treatments too. However they mostly preferred the creaminess, mild saltiness, soft and pesto-like flavor of cheese. The non-eater group preferred the low fat feta cheese in canola oil well due to its softness and milky taste as being mentioned. In the type of cheeses being eaten, Kesong Puti, processed cheeses, and imported cheeses, the groups preferred the full-fat feta cheese with canola oil and basil the most and the remaining treatments were all ranked the same. It can be observed that the type of cheese they have eaten does not affect their preference on the feta cheese. The group who were familiar with feta cheese and who were not significantly preferred the taste of full-fat feta cheese with canola oil and basil; however, the group who were familiar with feta cheese least preferred the low–fat packed with canola oil. The group familiar with feta cheese liked the creaminess of the full-fat feta cheese and the effect of the basil. The group who were not familiar with feta cheese did not appreciate the deformation of the cheeses cut in cubes, and the saltiness of the cheese.

In general, the full–fat feta cheese packed in canola oil and basil was the most preferred which coincides with the judgment of the experienced panelists. However, the least preferred cheese varied depending on the demographic parameters but it was also evident that the consumers often appreciated the low–fat feta cheese the least.

Product Yield

The product yield of the full-fat feta cheese was greater (P=0.01) than the low-fat feta cheese (Figure 1). Fat composition in the milk used in making the cheese caused the difference between the treatments. Standardization of the buffalo's milk to 3% fat with 12% reconstituted skimmilk resulted in higher moisture content. Increase in moisture and decrease in fat and total solids of the milk resulted in lower cheese yield. This is also similar to the report of Hill (2012) that fat is trapped in the casein protein matrix during cheese making; thus, it contributes to the cheese yield. Lower fat cheese often contains more water and less fat thus high yield loss.

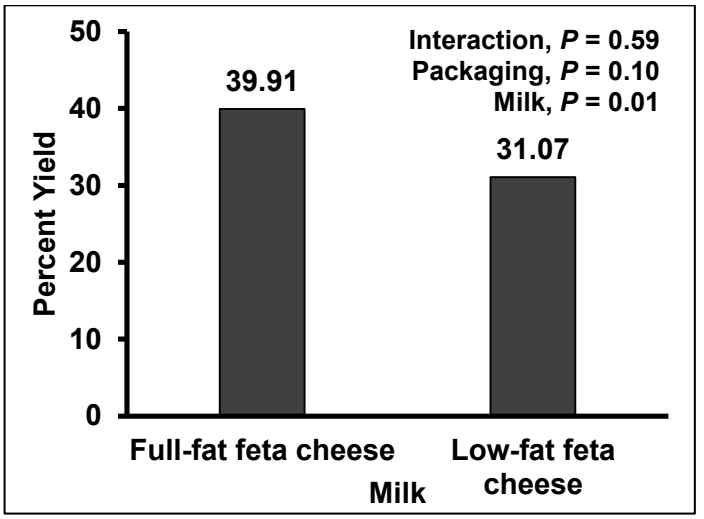

Figure 1. Percentage yield of full–fat feta cheese and low-fat feta cheese packed in canola oil and canola oil with basil.

Income over Production Cost

The cost of raw materials of low-fat feta cheese (Table 5) were less expensive than the full-fat cheese due to the addition of 12% reconstituted skimmilk during standardization that lowered the volume of whole buffalo's milk in the cheese-milk. The basil added during packaging resulted in a slight increase in cost. The normal price of feta cheese made from goat's milk sold in the market is ₱215 per 200g. On the processing procedure, in a 5 kg of buffalo's milk, full-fat feta cheese packed in canola oil, full-fat feta cheese packed in canola oil with basil, low-fat feta cheese packed in canola oil and low–fat feta cheese packed in canola oil with basil had product yields of 36.6%, 43.2%, 29.4% and 33.2%, respectively. If the cheese is to be divided into 200 g portions, the full-fat feta cheese packed in canola oil, full-fat feta cheese packed in canola oil with basil, low-fat feta cheese packed in canola oil, and low-fat feta cheese packed in canola oil with basil will produce 9, 10, 7 and 8 jars, respectively. Generally, a lower income over total cost was obtained in low-fat feta cheese. Both types of cheese, however, can be produced and sold at competitive prices thus could be a source of income.

Table 5. Income over production cost of full–fat and low–fat feta cheeses packed in canola oil with or without basil[1].

Item	Treatment			
	Full-fat feta cheese		Low-fat feta cheese	
	Canola oil	Canola oil with basil	Canola oil	Canola oil with basil
Ingredient cost				
Buffalo's milk	250.00	250.00	165.00	165.00
Starter	12.46	12.46	12.46	12.46
Rennet powder	5.52	5.52	5.52	5.52
Skim milk	-	-	235.00	235.00
Salt	8.00	8.00	8.00	8.00
Calcium chloride	24.00	24.00	24.00	24.00
Basil herbs	-	11.00	-	11.00
Canola oil	9.00	9.00	9.00	9.00
Operating cost[2]	308.69	332.49	275.04	298.84
Total cost	617.67	652.47	593.02	627.82
Actual cost of product based on yield (P/kg)	337.52	302.07	403.42	378.20
Actual cost of product per pack in 220g	37.50	30.21	57.63	47.28
Income from sales (P215/200g pack)	1,935.00	2,150.00	1.505.00	1,720.00
Income over total cost	1,317.33	1,497.53	911.98	1,092.18

[1]Cost were based on a 5 kg of buffalo's milk
[2]Operating cost was based on the computations by PCC at UPLB

CONCLUSIONS

The low-fat feta cheese from buffalo's milk had a higher nutritive value based on the lower fat and calorie contents than the full-fat feta cheese. Lower sensory ratings were obtained in low-fat feta cheese than the full-fat cheese. However, ratings for the low-fat cheese in different sensory attributes of 60% and higher indicate that the product is highly acceptable. Basil in canola oil did not improve the quality of the cheese. Full–fat feta cheese in canola oil with basil was the most preferred by consumers. Consumer preference for the low-fat feta cheese was influenced by age, sex, occupation, type of cheese eaten and familiarity with feta cheese. Product yield and income over production cost was higher in full-fat feta cheese. Sales of both types of feta cheese could be a good source of income. The results indicate that the processing technology for feta cheese made from buffalo's milk is profitable and can be easily adapted by local dairy processors.

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