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Original Article

Quality aspects of raw goat milk in Lower Southern Thailand

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Abstract

This study was conducted to determine the quality and safety of raw goat milk in Lower Southern Thailand during August to September 2008. Milk samples were collected from five farms in Songkhla, Yala, and Pattani Province of which the pH, acidity, specific gravity, milk fat, solid not fat, total solid, total plate count, *Coliform* count, and antibiotic residue were tested. The results did not show any significant difference ($p>0.05$) on pH and total plate count among samples from each farm. However, acidity, specific gravity, milk fat, solid not fat, and total solid varied between farms depending on feed supply and management. Means of total bacteria count and *Coliform* count of most samples were in TACF standard quality (log 3.720 cfu/ml and log 1.892 cfu/ml, respectively), except four samples had higher *Coliform* contamination. Additionally, a higher proportion (22.7 %) of samples with antibiotic residue was found.

Keywords: goat milk, platform test, bacterial contamination, antibiotic residue

1. Introduction

Goats have been raised in Thailand for their meat and milk. The number of goats raised from 130,904 heads in 1998 to 383,796 heads in 2009 and is still gradually increasing (Department of Livestock Development, 2009). Additionally, the large use of goat milk in cosmetics and a higher consumption of goat pasteurized milk have increased the popularity of dairy goat farming. In Thailand, goat farms belong to small holders who raise livestock in para rubber plantations. *Saanen* crossbred is the goat breed mostly used because of high milk yield and a longer period of lactation (Thongchumroon and Anothaisinthawee, 1996). However, many farms lack pastures and most of them do not pay much attention on management issues (Rujirawong *et al*., 2003). This explains the variation in milk quality and safety found in different farms.

In order to control the quality of raw goat milk, the National Bureau of Agricultural Commodity and Food Standards of Thailand (TACF) announced the first Thai agricultural commodity and food standard for raw goat milk in September, 2008 (TAFC, 2008). The standard classifies the normal condition of goat milk based on physico-chemical properties as well as level of bacterial contamination and antimicrobial residue. The quality of raw goat milk depends on the effect of breed, feeding, milking process, and storage as well as sanitation management. However, there are no previous published data about goat milk quality in the South of Thailand. This study was aimed to survey milk quality and contamination of goat milk samples from farms in Songkhla and nearby provinces for improvement of dairy goat farming and goat milk products.

2. Materials and Methods

Forty-four samples of ice cold fresh goat milk (not frozen) were provided from five farms in Songkhla (Farm A, C and D), Yala (Farm B), and Pattani (Farm E) Province. All samples were kept in plastic bags and were tested within six hours at the laboratory of the Department of Animal Science, Faculty of Natural Resources, Prince of Songkla University, Hat Yai. The quality of the samples were tested in certain

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categories of the TACF, such as platform test that is usually practiced on cow milk, as following: Organoleptic test (observing texture, color and smell), clot on boiling test (COB: boiling milk in test tube on water bath for five minutes), and alcohol test (mixing milk and 68% ethanol with ratio 1:1). Precipitation of protein in both COB and alcohol test methods indicate abnormal or sour (putrid) milk. Physical and chemical characteristics of milk such as specific gravity (using lactometer), pH, and acidity were quantified. Milk fat was measured by the Babcock method (Richardson, 1985). Total solid and solid not fat was calculated by

$$\%\text{Total solid} = (\text{Corrected Q°}/4) + (1.2 \times \%\ \text{Butter fat}) \quad (1)$$

$$\%\ \text{Solid not fat} = (\text{Corrected Q°}/4) + (0.2 \times \%\ \text{Butter fat}) \quad (2)$$

where the corrected Q° is the value measured by a lactometer at 20°C.

The total plate count and *Coliform* counts were determined by pour plate method with plate count agar (Difco™) and McConkey agar (Difco™), respectively. The plates were incubated at 37°C for 24 hours. The detection limit was at 1.0 x10° cfu/ml. Indirect methods, such as resazurin and methylene blue, were not conducted in this work.

Antibiotic residue was screened by Am-test® kit (Chulalongkorn University). The 0.1 ml of milk was dropped into the polypropylene tube containing non-pathogenic bacteria *Bacillus stearothermophilus* with purple color medium. The culture was incubated at 65°C for three hours. The change of color from purple to yellow indicated negative or non-contaminated result.

General data from each farm, except Farm E in Pattani, was used to evaluate the potential factors, which may affect the milk quality. Physical, chemical, and contamination data were analyzed and compared by analysis of variance (ANOVA) followed by Duncan's multiple range tests (Steel and Torrie, 1980).

3. Results

3.1 General information of farming system

All participants were male aged and more than 21 years old. The number of workers in each farm was 2-3 men per farm. The education of the workers was high school level or university undergraduate level. The goat farmers had more than one year experience. Their monthly income from selling goat milk consisted of circa 7,000 baht.

The goat farms in this study were small to medium size (15-50 heads/farm). The type of goat was cross-breed between *Saanen* and *Toggenburg* or *Boer*. The ages of the goat were between 3 to 7 years and they had given birth 3 to7 times. Farm A, B, and C raised the goats in pasture during the day time and kept them indoors at night time; except farm D in which goats were kept indoors all day. Only farm B used corn silage as a feed supplement. Farm A, B, and D used the goat milk's concentrated feed, while farm C used cattle feed.

For the milking system, the goats were milked by hand once a day in the morning. The goat's milk let down was induced by massage using a cloth soaked with warm water or an antiseptic solution. Farm A, B, and C used one cloth for each goat, except farm D that used only two pieces of cloths for all goats. The teats of the goats were dipped by an antiseptic after finished milking (100 %). Farm A, B, and C used the CMT test to determine the mastitis. Antibiotics were used in every farm for both systemic and intra mammary infection. The withdrawal time of milk was more than five days after antibiotic treatment. The milking container was only a plastic jar or a glass bottle that was washed with water within one hour after use (100 %). The milk was collected in plastic bags on ice before sending it to manufactures in Songkhla Province, usually in a distance of 0.3 to 80 km.

3.2 Platform test

The samples were normal when tested by organoleptic test, such as white color, good natural smell, and no sediment contamination (normal 100 %). The results related to the COB method were detected as normal for 97.7 % of that milk. However, every sample showed precipitate or flake when tested by 68 % alcohol (abnormal 100 %) (see Table 1).

3.3 Chemical properties and composition result of goat milk

The pH, acidity, and specific gravity of most samples met normal TACF standard for 86.36%, 88.63% and 97.73%, respectively (Table 2). However, most samples showed low quantity on milk fat, solid not fat and total solid (47.72%, 56.81%, and 59.09%, respectively), which were significantly different ($p<0.05$) among farms (Table 2 and 3).

Table 1. Results of platform test of raw goat milk (abnormal sample/total sample) from five farms.

	Farm A	Farm B	Farm C	Farm D	Farm E
Organoleptic test	0/9	0/8	0/7	0/6	0/14
Clot on boiling test	0/9	0/8	0/7	1/6	0/14
Alcohol test	9/9	8/8	7/7	6/6	14/14

Table 2. Classification of goat milk samples by TACF standard.

	TACF standard	Result		
		Amount	Percent	Mean±SD
pH	<6.5	0	0.00	6.72±0.11
	6.5-6.8 (standard)	38	86.36	
	>6.8	6	13.63	
Acidity (%)	<0.10	1	2.27	0.14±0.03
	0.10-0.20 (standard)	39	88.63	
	>0.20	4	9.09	
Specific gravity	<1.028	1	2.27	1.030±0.001
	> 1.028 (standard)	43	97.73	
Milk fat (%)	<3.25	21	47.72	3.31±1.13
	3.25-3.5 (standard)	10	22.72	
	3.5-4.0 (good)	2	4.54	
	>4.0 (premium)	11	25.00	
Solid not fat (%)	<8.25	25	56.81	8.16±0.42
	≥8.25 (standard)	19	43.18	
Total solid (%)	<11.7	26	59.09	11.47±1.41
	11.7-12 (standard)	4	9.09	
	12-13 (good)	3	6.81	
	>13 (premium)	11	25.00	
Total plate count(log10 cfu/ml)	<4.699 (premium)	40	90.9	3.720±0.614
	4.699-5 (good)	4	9.1	
	5-5.301 (standard)	0	0.0	
	>5.301	0	0.0	
Coliform count (log10 cfu/ml)	<3 (standard)	40	90.9	1.892±0.973
	≥3	4	9.1	
Antibiotic residue	Positive	10	22.72	-
	Negative	34	77.27	

Table 3. Means of pH, acidity, milk fat, solid not fat, and total solid.

Farm	A	B	C	D	E
pH	6.72	6.75	6.66	6.81	6.71
Acidity (%)	0.12^{a}	0.12^{a}	0.17^{b}	0.11^{a}	0.17^{b}
Specific gravity	1.029^{a}	1.030^{ab}	1.030^{ab}	1.029^{a}	1.031^{b}
Milk fat (%)	3.72^{c}	4.83^{d}	3.07^{bc}	2.04^{a}	2.84^{b}
Solid not fat (%)	8.02^{ab}	8.49^{c}	8.11^{abc}	7.74^{a}	8.27^{bc}
Total solid (%)	11.73^{b}	13.32^{c}	11.18^{b}	9.78^{a}	11.12^{b}
Total plate count (log10 cfu/ml)	3.699	3.306	3.601	3.926	3.718
Coliform count (log10 cfu/ml)	2.146^{b}	0.537^{a}	1.88^{b}	2.36^{b}	2.316^{b}

(a, b, c) Means within row not follower by the same superscript differ ($p<0.05$)

3.4 Bacterial contamination

All of the samples were in the standard quality on low total bacterial contamination (less than 5 log cfu/ml), and most of them (90.9 %) were classified as good quality (less than 4.699 log cfu/ml). However, the *Coliform* counts of four samples had a high level of contamination (3.041, 3.176, 3.82, and 3.954 log cfu/ml, respectively) (see Table2).

Table 4. Type, quantity, percentage, and cause of under standard milk.

	Farm					Total
	A	B	C	D	E	
Amount of samples	9	8	7	6	14	44
Standard milk	1	6	3	0	2	12
Under-standard milk	8	2	4	6	12	32
Percent of standard milk	11.1	75	42.8	0	14.2	27.27
Cause of under-standard milk (samples)*						
pH	1	0	1	3	1	6
Acidity	0	0	2	1	2	5
Specific gravity	1	0	0	0	0	1
Milk fat	2	0	3	6	10	21
Solid not fat	6	2	5	6	6	25
Total solid	5	0	4	6	11	26
Total plate count	0	0	0	0	0	0
Coliform count	0	0	1	0	3	4
Antibiotic residue	8	0	1	0	1	10

*Some samples showed more than 1 item under TACF standard

3.5 Antibiotic residue test

High percentage of samples contaminated with antibiotic was found (10/35 or 22.7%) and eight of the ten samples were collected from Farm A located in Songkhla Province. The other farms have less than 10% of antibiotic contamination (Table 2 and 4).

4. Discussion

The normal condition of cold fresh milk has been observed by organoleptic test. However, abnormal results were found in all samples when tested with 68 % alcohol, which was commonly practiced on cow milk (platform test). The results confirmed the previous study by Sripongpun *et al.* (2008) that all normal goat milk in Songkhla Province scored bad milk on common alcohol test. Horne and Parker (1982) indicated that the low ethanol stability of goat's milk was due to the different proportions of the individual caseins, in particular a lack of α_{s1}-casein homologue in cow's milk that might change micelle characteristic. Guo *et al.* (1998) studied ethanol stability of fresh goat milk samples and found that goat milk precipitated upon addition of an equal volume of 44 % ethanol, whereas fresh cow milk typically precipitated at 70 % of ethanol. They suggested that the low ethanol stability of goat milk may be related to the ratio of sodium to potassium. Their previous study showed the ratio of Na/K in goat milk was much lower than cow's milk (0.20-0.22 versus 0.31). It was found that adding sodium to the goat milk to increase the ratio of Na/K enhanced the alcohol stability of casein micelle (Lou and Gou, 1991). This means the standard alcohol test (70%) for cow milk is not suitable for goat milk since the low stability is not related to the freshness or microbiological quality of the milk.

The acidity of samples from Farm A, B and D were significantly different from Farm C and E ($p<0.05$). However, both acidity and pH were classed in the standard level of TACF. This implied that there was a little change in quality of cool milk during transport from farm to laboratory within six hours like stated in other reports (French, 1970; Dozet, 1973).

When the data was classified according to TACF standard, only 27% of raw goat milk samples met the standard level. Major causes of those were low total solid (59.1%), low solid not fat (56.8%), and low milk fat (47.7%), respectively. The results revealed insufficient feedstuff because most farms had not enough pasture or feed supplement, especially those from Farm D. Most samples had low quality for further milk processing. On the other hand, the quality of samples from Farm B was highest in all categories because of corn silage supplement for the milking goats.

Total plate count of all samples was in standard level. This showed that most farmers had good hygienic practices while milking. However, four samples showed higher levels of *Coliform* contamination. *Coliform* counts as thousands colony forming unit (cfu) per milliliter may indicate a problem of dirty goats being milked; an unclean udder, unsanitary milking practices, or milk contamination in the container. The number and types of microorganism present in milk depended on the microbial quality, the conditions under which the milk were produced and also on the temperature and duration of storage (Burgess *et al.*, 1994).

Milk samples from Farm D scored poor safety on bacterial contamination (Table 3). The problem of Farm D was the use of only two pieces of cloth for cleaning the udder of all goats before milking. The use of one cloth for each goat can reduce contamination between goats and should be

carefully practiced in milk goat farming.

The goat farms in this area collected raw milk from each goat in plastic bags kept on ice before sending it to the manufacturer within five hours. The temperature of milk has a significant effect on the rate of bacterial propagation and consequently on the spoilage of milk. It is generally understood that if milk is not cooled and does not reach the processor within five hours after milking, it will not be suitable for processing any more (Barabas, 1995).

The contamination of antibiotic residue was also found, especially in the samples from Farm A. However, there is no information about antibiotic use during milking in the goat farm in this survey.

This study did not include the manufacturer where some milk was frozen before processing. This can change the milk quality by a degeneration of proteins that decreases the alcohol stability. The study of milk quality at the manufacturing stage must be further investigated to improve the storage process and sanitation.

5. Conclusion

This study revealed the variation on general farm management and sanitation. Most farms were small farming systems that did not give adequate feeding and thus negatively affected the milk quality. Some farms encountered bacterial contamination because of unsuitable processes during milking. However, the collected data gave some understanding of how to improve the quality of goat milk and the management of goat farming.

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