DETERMINING HYGIENIC PROTOCOLS FOR SWAMP BUFFALO MILKING AND FOOD SAFETY IN THAILAND

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ABSTRACT

This study focused on finding the critical controlling points in the swamp buffalo milking and storage processes in an intensive farm setting over a 12 months period (between June 2018 and July 2019). The raw milk and pasteurized milk samples were randomly collected once a month for laboratory testing by standard plate count (SPC) and total coliform count (TCC). The model for the investigation and implementation of this study was taken from the dairy cattle industry - which involves similar, though not identical, problems and issues. The first phase of this study was the problem finding phase. The collected raw milk samples showed that both the SPC and the TCC were higher than standard values and both contained environmental bacterial contamination. *Escherichia coli* contamination was found to be caused by improper hygienic conditions i.e. poor personal hygiene, inadequate techniques and procedures to clean and disinfect the milking equipment and milking area or from after milking issues such as high temperatures during milk storage and transportation. In the problem solving phase, protocols of good hygiene throughout the milking process were suggested and implemented. The collected raw milk and pasteurized milk samples for SPC and TCC decreased to the standard values after hygienic improvements were implemented. The hygiene of the milk workers (such as the hand washing), the lack of staff duty separation and the failure to properly regulate the temperature during, and duration of, the raw milk storage were found to be the critical controlling points of this study. In the follow up phase, the SPC and TCC of the raw and pasteurized milk tested in the standard value range throughout the monitoring period. Our finding suggested that client education and monitoring at least once a month might be necessary in swamp buffalo dairy farms in order to ensure good practices in the milking process. This study could provide guidelines for the development of a hygienic swamp buffalo milk production protocols for private and government farms - and as a prototype for future developments in this industry.

Keywords: *Bubalus bubalis*, buffaloes, swamp buffalo, milking, food safety, standard plate count, total coliform count

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INTRODUCTION

Swamp buffaloes have been primarily used in Thailand for agricultural labor, meat consumption and as a store of value, or agricultural asset. In a previous report on swamp vs Murrah buffaloes, lactation periods (127.5±104.6 vs 269.4±43.1 days), milk production per day (2.0±0.9 vs 6.0±0.54 kg./cow/day), milk production per lactation (255±209 vs 1,631.5±642.1 kg.) (Chaikhun *et al*., 2012; Pawar *et al.,* 2012; Sehgal *et al.,* 2018) and milk productivity in general were two to three times lower in swamp as opposed to river (Murrah) buffalo. From these reports, it would seem that swamp buffaloes are not good candidates for milk production. The high demand for, and difficulties involved in importing, both milk products and Murrah buffalo, however, have made swamp buffalo an affordable and practical option. In recent years swamp buffalo farmers have worked to set up intensive farming systems focused on breeding not just for parent and feedlot stock, but also high yield milk stock as well. This swamp buffalo production strategy can add extra profit to the female buffalo lifespan. Milk production can provide an extra dairy income (250 Baht or 8 USD/kg) to meat production (minimum 50,000 Baht or 1,660 USD at 2 years old with 500 kg bull), parent stock (minimum 100,000 Baht or 3,300 USD/heifer at one year old) and regular buffalo farming. Although many swamp buffalo farmers are interested in milking to supply consumer demand, few practical studies or reports have been done on swamp buffalo milking and dairy production. This pilot study on critical control points and hygienic protocols for swamp buffalo milking and food safety was based on dairy cow standard protocols. Hopefully, it can provide basic information to aid in the future growth and development of swamp buffalo dairy production in Thailand.

MATERIALS AND METHODS

This descriptive study was performed in an intensive breeder and dairy swamp buffalo farm in the east part of Thailand from June 2018 to July 2019 (12 months). There were 20 to 30 milking cows per day thru the study period. The study period was divided in 3 phases; Phase I, problem finding, Phase II, problem solving and Phase III, evaluation and follow up. Phase I: General farm information was recorded. The critical controlling points for food safety in the milking process and milk production were investigated by the research team. Phase II: Problems and causes were identified and solutions were determined. The farmer, the workers and the research team worked together. New protocols were reviewed, discussed and implemented in order to increase food safety in the milking and producing processes.

Phase III: The quality of raw and pasteurized milk was monitored. The milking and milk storage processes were subjected to monthly follow up evaluations for 3 consecutive months.

Milk sampling and laboratory tests

Raw milk was randomly collected (10 ml) from each raw milk tank then kept at 4°C until laboratory testing (within 24 h). The pasteurized milk samples were randomly collected from each raw milk tank. Samples were taken at the first visit (1 time), the problem solving phase (2 times), and the follow up phase (3 times) for laboratory testing by standard plate count (SPC), total coliform count (TCC) and *E. coli* culture (Tanchareon *et al*., 2003). The standard values of SPC and TCC in the Thai dairy cattle industry were used in this study

(Ministry of Public Health, 2003).

Statistical analysis

The SPC, TCC and *E. coli* test results were compared before, during and after problem solving.

RESULTS AND DISCUSSION

Phase I

The farm information was divided into 3 parts; general farm management, milking procedure and storage protocol. A questionnaire was developed for interviewing, observing and recording farm information during farm visits. In terms of general farm management: two hundred swamp buffaloes were raised at the farm using an intensive farming system (individual cage, cut and carry fresh grass, concentrated feed twice a day, rice straw and water ad libitum). For the milking process, thirty cows were milked by portable milking machines. There was no division of labor so the same worker that brought the cow to the milking area also cleaned the milking machine and milked the animal. The workers were healthy but did no hand washing before starting the milking process. The strip test was done before milking, but no pre and post dip of antiseptic and dry wipe on the teat and no disinfection of the milking machine clusters between buffalo milking. Milk was kept in the tank at room temperature until the tank was fully filled (about 2 h) then carried to the creamery section where the raw milk was pasteurized within 2 h 30 minutes after collection at 80^{o}C for 1 minute. Then the milk was packaged in glass bottles and kept cold at 4^{o}C. The instruments for milking and the pasteurizing equipment were cleaned with dish wash detergent manually with hot water. The laboratory results are presented in Table 1. All raw milk showed too much to count (TMC) in both SPC and TCC more than standard values (SPC=500,000 cfu/ml and TCC=10,000 cfu/ml) with *E. coli* positive but not in any pasteurized milk.

Phase II

In the investigation phase, the main problem of this case was found to be environmental microorganism contamination in the raw milk from hygienic issues during the milking process; such as inadequate cleaning and storage of the milking equipment, poor milking staff hygiene, and a lack of staff duty separation. Temperature and duration conditions for raw milk storage were also, however, key critical controlling points of this study. To solve these problems, a more thorough cleaning process (with new and specialized brushes) and an enclosed and designated storage area for the milking equipment was established, along with pre- milking staff hygiene protocols. (Karakök, 2007). A policy of keeping the raw milk in a cold condition to reduce non-psychrotropic bacteria was also implemented (Suriyasathaporn, 2016). These procedures and policies were reviewed and discussed in a team setting during each visit and were adjusted, with staff input, to fit the practical conditions and issues at the site. The raw milk quality results after the three visits that comprised this phase had improved to standard values for food safety.

Phase III

In the follow up and monitoring phase, the milk quality was found to be in accordance with standard food safety values during each of the three monthly visits in this phase (Table 3). This result suggests that the farm can keep following

Table1. The milk testing results from the first visit (Phase I) June 2019.

Samples	Results		
	Standard plate count (cfu/ml)	**Total coliform count (cfu/ml)**	*E. coli*
Raw milk tank no.1	TMC	TMC	Positive
Raw milk tank no.2	TMC	TMC	Positive
Raw milk tank no.3	TMC	TMC	Positive
Raw milk tank no.4	TMC	TMC	Positive
Pasteurized milk no.1	0	0	Negative
Pasteurized milk no.2	0	0	Negative
Pasteurized milk no.3	0	0	Negative
Pasteurized milk no.4	0	0	Negative

Table 2. The milk testing results from phase II visits (July and August 2018).

Samples	Results				
	SPC (cfu/ml)		**TCC (cfu/ml)**		*E. coli*
	July	**August**	**July**	**August**	
Raw milk tank no.1	$2.5x10^5$	$>10^5$	$2x10^4$	$>10^5$	Negative
Raw milk tank no.2	$1.2x10^5$	$>10^5$	$3x10^4$	$>10^5$	Negative
Raw milk tank no.3	$2.1x10^5$	$>10^5$	$1.5x10^5$	$>10^5$	Negative
Raw milk tank no.4	$3x10^5$	$>10^5$	$1x10^4$	$>10^5$	Negative
Pasteurized milk no.1	0	0	0	0	Negative
Pasteurized milk no.2	0	0	0	0	Negative
Pasteurized milk no.3	0	0	0	0	Negative
Pasteurized milk no.4	0	0	0	0	Negative

Table 3. The milk testing results from from Phase III visits (March, April and May 2019).

Samples	**Results**		
	standard plate count (cfu/ml)	**Total coliform count(cfu/ml)**	*E. coli*
Raw milk tank no.1 March 2019	$4.5x10^3$	$1.6x10^3$	Negative
Raw milk tank no.1 April 2019	$19.5x10^3$	$5x10^3$	Negative
Raw milk tank no.1 May 2019	$22.6x10^3$	$0.4x10^3$	Negative
Raw milk tank no.2 May 2019	$25.7x10^3$	$0.1x10^3$	Negative
Pasteurized milk no.1 March 2019	2x10	0	Negative
Pasteurized milk no.1 April 2019	24x10	0	Negative

the recommended procedures from Phase II continuously and regularly. Hygienic practices, especially personal hygiene in the milking process, seems to have reduced the microorganism contamination to a statistically significant degree (Duangpan and Suriyaphan, 2009; Pandey *et al*., 2014). A key factor in this success, however - beyond these hygienic and procedural changes themselves - was the positive attitude of the farmer and his milking staff, and their concern for consumer food safety. The governmental and private sectors which are responsible in this regard, should prepare practical information, materials and food safety training for the dairy buffalo farming industry in Thailand.

CONCLUSION

In the present day, buffalo dairy products such as milk, yogurt, cheese and ice cream are in high demand by consumers as nutritious and delicious foods. Since early 2018, a swamp buffalo breeder in Prachinburi, - using an intensive farm system - has been milking his swamp buffalo for extra income. The critical controlling points were analyzed for this farm's swamp buffalo milking process as well as its, raw and pasteurized milk production during a 12 month period. The raw milk samples were collected for laboratory microorganism detection by standard plate count and coliform count. The investigation and implementation of this case was divided in 3 phases; the first phase focused on observing and identifying problems, the second phase involved determining and implementing solutions, and the third phase entailed monitoring and evaluation of the new protocols. The first visit showed SPC and TCC results were higher than standard (Thailand Dairy Cattle Standard) but in the second and third visits (during Phase II) only coliform counts were still higher than standard for food safety. The main problem of this case was environmental microorganism contamination of the raw milk due to hygienic problems during the milking process. For example, inadequate cleaning of the milking equipment, poor milking staff hygiene in general and a failure to separate milking staff duties from general farm work (no division of labor). Temperature and duration conditions for raw milk storage were also key critical controlling points of this study. In the follow up phase, the milk quality was up to food safety standards. Client education and monitoring of swamp buffalo farms should be continuously implemented to establish best practices in the milking process and maintain for food safety.

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REFERENCES

Chaikhun, T., R. Hengtrakunsin, F.D. Rensis, M. Techakumphu and S. Suadsong. 2012. Reproductive and dairy performances of Thai swamp buffaloes under Intensive farm management. *Thai J. Vet. Med*., **42**(1): 81-85. Available on: https://www.vet.chula.ac.th/dept/tjvm/full_text/v42/421/TJVM421%20PDF/SC01-TJVM42-1.pdf

Duangpan, W. and O. Suriyaphan. 2009.

Preliminary assessment of microbiological quality of raw buffalo milk commercially produced in Thailand. *Asian Journal of Food and Agro-Industry*, (Special Issue): S368-S373. Available on: http://www.thaiscience.info/Journals/Article/AFAI/10850246.pdf

National Bureau of Agricultural Commodity and Food Standards. 2010. *Raw Cow Milk*. Available on: http://www.acfs.go.th/standard/download/raw_cow_milk.pdf

Pandey, N., A. Kumari, A.K. Varma, S. Sahu and M.A. Akbar. 2014. Impact of applying hygienic practices at farm on bacteriological quality of raw milk. *Vet. World*., **7**(9): 754-758.

Pawar, H.N., R. Kumar and R. Narang. 2012. Effect of year, season and parity on milk production traits in Murrah buffaloes. *Journal of Buffalo Science*, **1**(1): 122-125. DOI: 10.6000/1927-520X.2012.01.01.22

Sehgal, J.P., A. Dey and S. Kant. 2018. Developing feeding module for increasing milk production in Murrah buffaloes (*Bubalus bubalis*). *Buffalo Bull*., **37**(1): 45-50. Available on: http://kuojs.lib.ku.ac.th/index.php/BufBu/article/view/80

Suriyasathaporn, W. 2016. *Herd Health in Dairy Cow and Good Quality of Milk Production*, 1st ed. Chulalongkorn University Printing House, Bangkok, Thailand. p. 393-379, 400-401, 406-407, 411-412. (in Thai)

Tanchareon, S., J. Wongsanit, S. Phandee, S. Pannium, K. Jeenachareon, K. In-Eium, Y. Sophi, A. Dungsongnern, E. Soinam and K. Thamjong. 2003. *Milk Quality Test Handbook*. Kasetsart University Printing House, Bangkok, Thailand. (in Thai)