Study on genetic character and milk composition in local crossbred dairy cattle for developing dairy industry and market in Cambodia

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Dairy farming and the dairy industry are needed parallel to develop. In Cambodia, there have been diversified cattle breeds, and they are regarded as the key to driving growth in the agriculture industry. Dairy cattle producing fresh milk and dairy products have been produced only a tiny amount in Cambodia. Almost dairy products are imported from neighboring countries to meet consumption. Currently, Cambodia has been experiencing a significant increase in the amount of imported fresh milk and dairy products rapidly in the last 10 years. Imported quantity in un-concentrated or non-sweetened milk was even though 3,469 tons in 2011, but 18,709 tons in 2014, and around 500% increase was recorded. In addition, this trend was found in other dairy products. The data shows a significant change in our Cambodian market, toward dairy consumption, observing similar trends in sweetened milk, buttermilk, yogurt, and other milk products. In addition, there are only a few limited data for predicting the potential need for Cambodian dairy products, such as preference, reputation, and culture. Thus, the Cambodian milk industry should tackle this lack of information first. The goal of this dissertation is to understand the potential local milk consumption widely, and how to develop and promote the local dairy farming industry in Cambodia. If the preference is found clearly, our strategy for developing the local milk production for local citizens will have great accomplishments and great potential benefits for farmers and the national economy.

In Cambodia, the government considers milk is one of the strategic nutritional protein resources, as the results of milk and dairy products play an important role in a healthy and balanced diet for maintaining health in many national and international health care programs. Milk is an excellent source of nutrients, such as vitamins and minerals, particularly calcium. It has an important role in bone health for stability and growth. Dairy products contribute to children a healthy diet, especially in primary schools. Dairy products are an important part of the diet because of providing carbohydrates, protein, and sometimes fat, they provide a wealth of vitamins and minerals, including calcium and vitamin D. Therefore, milk has the possibility of supplying nutritional satisfaction to Asian and African countries. Thus, I believe milk provides to our country Cambodia has great potential to improve our nation's nutrient sufficiency.

However, Cambodia has limited milk production for the nation’s consumption, especially fresh milk, because the production capacity of fresh milk is extremely low. There is a history of the dairy farm in Cambodia, in the 1960s, Cambodia is one of the developed countries in dairy farming in Southeast Asia and exported milk to neighboring countries. However, from 1970 to 1998, Cambodia had Civil War, and during this period, the dairy system collapsed once. After the Civil War, the dairy farming system has been on the way to being regenerated. In addition, to

enhance the dairy industry, we should understand the behavior and demand for drinking milk, and the preference of Cambodian people more deeply to resolve these issues in the dairy production system in Cambodia. The problem in Cambodia is that we do not have reports or information on the domestic milk market. In these situations, the General Directorate of Animal Health and Production (GDAHP) is on the way to establishing a dairy production system policy and guidelines for encouraging local dairy production, the general standard in local milk is important, respectively.

Moreover, in general, milk components are important for the evaluation of milk quality, and the decision of trade price. The payment system to farmers is related in milk quality, the milk price is related to protein content, fat content and/or somatic cell count, generally. However, in Cambodia dairy system, there are no definition related to raw milk in the nation low and the nation does not have any institute for evaluate raw milk qualities for drinking. Thus, milk of local dairy farmers face to lager difficulties compared with imported milk, which has international certificates. Thus, if we create the milk industry from raw milk produced in Cambodia, we have to evaluate its quality for drinking and processing products. If we hope to improve the milk industry, we have to evaluate the quality and have to accelerate milk production in Cambodia in several ways.

Since the 2000s, various breed of semen has been introduced to Cambodian cattle farmers with the spread of the artificial insemination technique. Therefore, Cambodia has large diversity in cattle genetic backgrounds. Unfortunately, all cattle breeding in Cambodia has been conducted without any integrated strategy. On the other hand, no study has been conducted what cattle are adequate for dairy production in Cambodia, from their genetic characteristics. In my dissertation, I aimed to understand milk composition and genetic characters in local crossbred dairy cattle for the developing dairy industry and market in Cambodia. Previous reports indicate that many genetic characteristics support milk yield and milk quality, therefore many dairy sectors consider improving their dairy strain based on this genetic information in tropical areas. In Cambodia, almost dairy cattle are not purebred and without pedigree certificates. Therefore, understanding the genetic character of local crossbred dairy cattle is important for improving the efficiency of future cattle breeding and dairy market

The study on cattle productivity and breeding system are limited in Cambodia since the civil war completely destroyed the animal husbandry in this country. The overall objective of this study is to understand milk composition and genetic characters in local crossbred dairy cattle for the developing dairy industry and market in Cambodia. In the dissertation, I aimed to introduce

the potential demands for dairy products in Cambodia, aimed to understand on milk components of local crossbreed dairy cattle in Cambodia, and aimed to reveal the genetic variation and the milk production in Cambodian dairy crossbred cattle.

In Chapter 2, I aimed to introduce the potential demands for dairy products in Cambodia. In this study, I tried to understand the potential demand and behavior of consumers, and what factors influenced consumers' behavior. Through this study, I indicated that consumers drank fresh milk daily at 18.2%, weekly at 35.0%, 2-3 weeks per month at around 31.9%, and monthly at 15.0%. Around 56 % of consumers buy fresh milk and milk products from supermarkets, 10.7% buy directly from local farmers in their hometown, and 33.7% buy from the general markets. In fresh milk consumption in the household, more than 60% of Cambodians drank fresh milk of fewer than 10 liters monthly, 29.8% of households consumed less than 2 liters, and 35.6% consumed less than 10 liters. The factor components were analyzed using multiple linear regression. The analysis indicated that family size and income of household affected fresh milk consumption, and almost consumers agreed with the current price of fresh milk in the market and grocery store. Therefore, the potential demand for fresh milk could be high if household income increases sustainably like the current. In the present situation, the market for fresh milk and dairy products could be enlarged more.

In Chapter 3, I aimed to understand the milk components of local crossbreed dairy cattle in Cambodia. The milk samples were supplied from one local dairy farm (Farm S), one local private farm (Farm M), and one private intensive farm (Farm L), and each farm raised different breed cows. This study is the first to observe the changes in milk compositions in local Cambodian crossbred dairy cattle. The milk composition in local crossbred dairy cattle had been changed in the dry season, and fat and protein contents were decreased from bulk data analysis. On the other hand, in the early lactation period, fat content was maintained in local crossbred dairy cows, higher than in other crossbred dairy cattle in Cambodia. Therefore, for improving dairy products, local crossbreds could be useful with their concentrated milk compositions. Although further experiments are needed, the present study provides useful information for Cambodian cattle breeding stakeholders.

In Chapter 4, to encourage the recovery of the Cambodian dairy sector, I aimed to reveal the genetic variation and the milk production in Cambodian crossbred dairy cattle. Initially, I conducted interviews to understand the breeding background and milk production of two local farms (Farm R and Farm M) in Cambodia. The percentage (%) of milk fat content in Farm R was higher than that in Farm M. A genome-wide analysis of the genetic characterization for 75 cows

in the two dairy farms implies that some cows in Farm R are genetically far from other crossbred cattle and retain a higher proportion of genetic background derived from Cambodian-native cattle. The present study indicated genetic characteristics and milk composition in Cambodian crossbred cattle. Genetic character in Cambodian local crossbred cattle could contribute to milk production in the Cambodian dairy system. Thus, our basic genetic study could provide a new breeding strategy by using local Cambodian crossbred dairy cattle to establish an adequate dairy strain.

In conclusion, I indicated the consumers' preferences and behavior related to purchasing dairy products in Cambodia, the milk compositions in local crossbred dairy cattle, and the genetic character of local crossbred dairy cattle. Through these studies, I concluded dairy sector in Cambodia has a large potential to be developed to follow market demand, provides adequate nutritional content to the nation through drinking local milk, and develop local dairy cattle focusing on useful genetic characteristics.