Use of renewable energy sources as a way to reduce the cost of production of milk and cultured milk products

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Abstract. The subjects of the article are the problem of provision of people with healthy milk products and ways of solving this problem and development of milk processing in villages. A facility for primary milk processing and production of cultured milk products is suggested. There are the results of analysis of yoghurt samples of four different manufacturers including yoghurt produced with the use of the proposed production equipment. There are also conclusions based on the analysis results.

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Introduction

According to FAO/WHO (Food and Agriculture Organization/World Health Organization) experts [1], in connection with natural increase in population and gradually increasing hunger, the global demand for food worldwide will statistically increase by 3 times within the next 50 years. In view of that and the forthcoming accession to the WTO (World Trade Organization), Kazakhstan as a country with high agricultural potential will have to not only constantly increase the production of food for domestic consumption in the future but also export it.

One of the essential sources of nourishment in human diet are milk and cultured milk products because of their high nutritional and biological value and high content of vitamins and micro- and macronutrients required for normal existence of human body. «Milk is wonderful food cooked by nature itself», - academician I.P. Pavlov wrote. It is known that this product contains over a hundred valuable components [2]. From the standpoint of nutritive and biological value, cow's milk is considered to be the most acceptable milk of farm animals.

During lactogenesis, immune bodies and bactericidal substances hampering growth of bacteria in freshly drawn milk are passed from a cow's organism to the milk. Period of their activity is called bactericidal phase. Its duration depends on sanitary conditions of milk production and storage temperature [3].

Procured milk must correspond to certain physical, chemical, and microbiological sanitary safety indicators.

Currently available in Kazakhstan large milk factories are likely to not cope with ever-growing demand of the population for cultured milk products. A way out can be organization of milk processing directly in the milk farms.

Using common in-line production technologies [4] for cultured milk products under the conditions of Kazakhstani farms is unacceptable due to the impossibility of purchasing expensive high-tech equipment as well as placing it on small areas of farms. Difficulty in obtaining great benefit from production of cultured milk products in small farm enterprises is low brand awareness or mostly absence of a brand name. Authority of more well-known and advertized brands does not allow small farms to develop.

In view of the above, for cheapening production of cultured milk products it is necessary to adapt production technologies using renewable energy sources and to unify equipment to perform as many technological operations as possible.

Nowadays the world industry offers a great number of unified equipment for milk processing. But because of high cost and low payback purchase [5] of such equipment by small farms is unacceptable.

We propose improving and unifying vat pasteurizers of VDP type (milk processing by way of steam heating), consisting in the following:

- their adaptation for solar energy use - use of solar water heaters with the purpose of saving energy used to heat water for milk pasteurization and cultured milk products preparation;
- use of pasteurizing tanks for aging and bringing the product up to the required condition and processing milk into yoghurt and other cultured milk products;

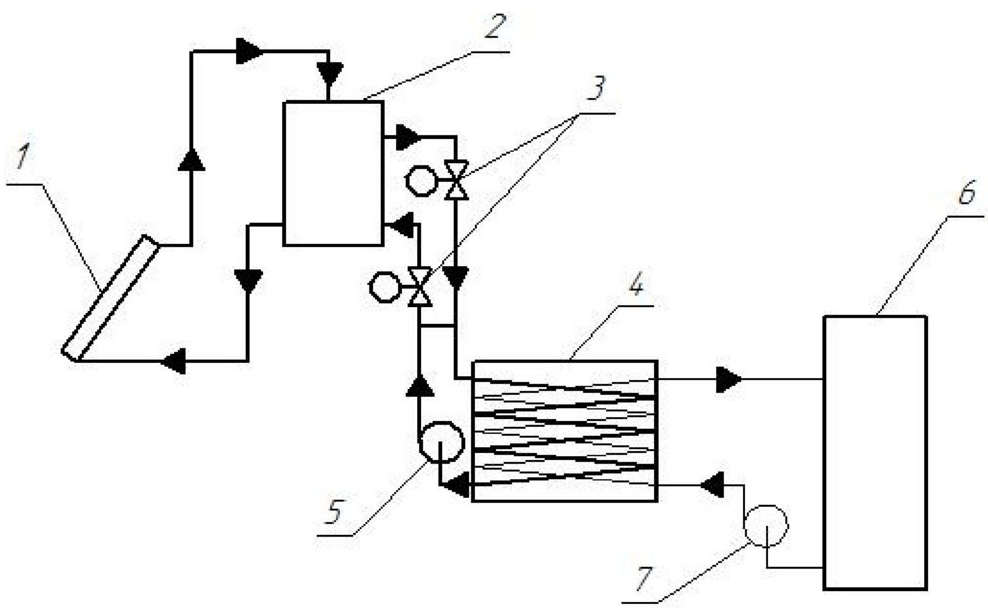
• use of natural sources of cold water as a refrigerant agent for cooling milk during primary processing and cooling the product after processing.

To date, price of electricity in Kazakhstan is in the range of 6.7 to 16.45 KZT for 1 kW depending on the region. In Almaty city it is 15.16 KZT/kWh [6].

Installation of solar water heaters will make it possible to exclude this figure from the self cost of cultured milk products while their price will remain the same.

Average duration of a light day in Almaty city is 9 hours in December to 15.5 hours in June [7]. This is a quite sufficient rate for heating water in a solar collector for pasteurization and aging during the process of production of cultured milk products.

Cooling milk and cultured milk products can be carried out with the use of water from mountain rivers (under the conditions of farms situated in the highlands) or artesian springs (for other regions) using an energy-saving facility [8].



Picture 1. Installation diagram

1 - solar collector; 2 - accumulator tank for hot water of enclosed-type with thermal insulation; 3 - solenoid valve; 4 - vat pasteurizer; 5 - centrifugal pump for milk heating system; 6 - accumulator tank for cold water with thermal insulation; 7 - centrifugal pump for milk cooling system.

The first embodiment consists in collection of cold water out of a river into a storage tank with thermal insulation. Even in the hottest summer days temperature of water in mountain streams is very low.

Installation diagram is illustrated in Picture 1. Principle of operation of the facility is as follows. Water is heated in the solar collector 1, from there hot water comes out into the accumulator tank 2 of enclosed-type. From the accumulator tank hot water gets by gravity into the vat pasteurizer 4 and flowing through the spiral heat exchanger heats the milk in the vat pasteurizer. From there water with the help of the centrifugal pump 5 flows back into the solar collector for heating, passing at that through the heat exchanger in the accumulator tank for hot water. Upon reaching the setpoint temperature of the milk a thermostat closes the solenoid valves 3 and hot water circulates in a small circle of the heating system to avoid overheating the milk during longtime pasteurization.

Cooling the milk is performed by way of running cold water through the spiral heat exchanger of the vat pasteurizer with the help of the centrifugal pump 7 for the cooling system. Cold water is kept in the accumulator tank 6 for cold water. At that the heating and cooling systems are insulated from each other and their flows are opposite in direction. Before cooling the heating system is emptied.

This facility can be easily used for production of such cultured milk products as yoghurt, soft cheese, and others. This will increase profit of small farms and encourage improvement of production of milk products in the country due to healthy competition.

Table 1. Results of the analysis of yoghurt acidity [9].

#	Manufacturer and the name of yoghurt	Actual acidity, T	Standard value according to GOST 51331-99, °T
1	«Company FoodMaster» JSC, «Natural» yoghurt	115	75 - 140
2	«ShISh & Co.» LLP, sour milk «Khan»	155	
3	«Ozalp sut» LLP, yoghurt «OZALP»	185	
4	«Mamed» farm, «Homemade» yoghurt *	136	

* yoghurt produced by our technology with the use of our equipment.

Experimentally we have made a comparative analysis of yoghurt produced according to our technology with the use of the proposed production equipment and three samples of yoghurts from trading network. Two of them are produced at small factories and one - at a large milk factory with a well-known brand. The analysis of yoghurts was made in «ExpertTest» LLP. Acidity of yoghurt was chosen as the parameter for comparison. As all yoghurts are made of natural products without preservatives (according to GOST (All Union State Standard) 51331-99), presence of preservatives was not analyzed. Analysis of nutritional value was also not carried out because all yoghurts had been produced by different technologies and with the use of different starter cultures. Test conditions were the following: temperature 22°C and humidity 70 %. All samples had been produced approximately at the same time. Table 1 summarizes the results of the analysis of the four samples of yoghurt.

Yoghurt of «Company FoodMaster» JSC [10] is made at a large factory according to an in-line production technology with the use of a specialized production line. Production of yoghurt is constant and fresh raw products and starter cultures are delivered constantly as well.

Yoghurts of «ShISh & Co.» LLP and «Ozalp sut» LLP are produced by a Turkish technology at small factories.

Yoghurt of «Mamed» farm is produced by our technology with the use of the proposed equipment only. «Mamed» farm is a cattle rearing business where produced milk is processed to benefit more from the products. Raw product is their own freshly drawn milk primarily processed.

Based on comparative analysis of the products made according to our technological scheme and samples of the products from trading network produced by other technologies on other farms, the following conclusions have been drawn:

1. «Homemade» yoghurt («Mamed» farm) meets the requirements of GOST 51331-99 in terms of acidity.

2. Yoghurts of «ShISh & Co.» LLP and «Ozalp sut» LLP are in demand among common buyers in spite of excessive acidity which means that yoghurt produced by our technology can provoke healthy competition with currently sold in the trading network yoghurts.

3. Quality yoghurt production is possible under the conditions of a farm.

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