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Justification of replacement of pasteurization equipment in dairy

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ABSTRACT

Purpose: The purpose of this paper is to study the influence of new equipment on the effect of pasteurization in the department for pasteurization. The total bacterial count (TBC) in receiving raw cow milk and after termical treatment - pasteurization has been measured.
Design/methodology/approach: The measurements were performed with old Alfa Laval Pasteur from year 1982 and after replacement with new Fischer pasteur 43 year 2006. The line between receiving tank to pasteur in dairy remain the same. The daily sampling and analyses of finale receiving tanks were made on department for receiving milk for October 2005 (93 analysis) and December 2006 (96 analysis).
Findings: The raw milk was in October 2005 on average for 10,6% worse quality (calculation of average value of TBC per ml), then in December 2006. The effect of pasteurization was after test, at working old equipment only 32,25%, at working new equipment was 100,00%.
Research limitations/implications: The new equipment for pasteurization allows the production of safe milk products in accordance with hazard analyses of critical control points (HACCP).
Practical implications: The effect of pasteurization with the new pasteur was perfect. At internal margin 95% this level overreach all 31/31 analysing samples. We get more stable production and reduce expense of steam, which serves for reaching of appropriate temperature of pasteurization.
Originality/value: to the use of new equipment allowing 20 second maintaining time of pasteurization the pasteurization temperature has been reduced from 78°C to 76°C and, thus, the profitability of the pasteurization process has been improved.
Keywords: Technological devices and equipment; Dairy, Energy saving; Effect of pasteurization.

1. Introduction

Every investment is an extensive project demanding preparation of investment documentation, of a project plan and plan for the realization of investment. Decision-making in every phase is of decisive importance for the success of the entire investment. To go through with the investment extensive human and material resources are needed, that is why decision on investment presents one of the biggest risks and at the same time a chance for securing successful performance of a company in the future. Risk accompanying investment decision can be diminished with acquiring extensive information, preparation of corresponding analyses and different simulations and optimisations [1, 2].

The new technological equipment in food procesing industry, replacing the depreciated one, will improve the competitivity and

efficiency of the companies' business activities and will promote fulfilment of the requirements of the district EU legislation. Financial support is intended for investments facilitating compliance with the veterinary and sanitary, technological, quality and environment protection requirements, establishment of systems of monitoring of production flawlessness, modernization of production and distribution capacities, reduction of production costs and more efficient horizontal and vertical associating inside the market chain [3].

The research was performed in a promising Slovenian dairy for which 245000 litres of raw cow milk per day was produced by 1404 farmers in year 2007. The raw milk is picked up by ten tank-trucks every second day. During one day those tank-trucks cover twelve different routes. When the raw milk is pumped into the tank-truck, it flows through the filtering system and the automatic sampling system. The additional automatic delicate equipment for the tank trucks had been made by the company Ebner, Austria. When receiving of the raw milk from the tank-truck starts, the technological path is as follows: tank-truck, line, aerator, pump (20000 litres/hour capacity), tubular filter (holes of 0.5mm diameter), refrigerator (ice water), counter, receiving tank. The receiving unit has three such lines for receiving raw milk. The chemical and microbiological analyses were performed in the in-house laboratory of the company, operating according to the Slovenian standard SIST EN ISO/IEC 17025: 2005 [4, 5].

Four receiving tanks of the total capacity of 280000 litres are located in the receiving unit. Each receiving tank has its technological number. After receiving raw milk each complete receiving tank represents one batch. The temperature of raw milk in the receiving tanks varies between 2 - 6°C.

2. Description of the approach, work methodology, materials for research, assumptions, experiments etc.

2.1. Sampling and pasteurization of milk

The milk pasteurization is the process of thermal treatment of milk at 65°C to 85°C for differently long times in order to destroy all pathogenic microorganisms and the majority of technologically harmful microorganisms. It was carried out with the old and then still with the new equipment [6]. During the test the daily sampling and analyses of complete receiving tanks were effected in the milk receiving unit for October 2005 (93 analyses) and December 2006 (96 analyses). Each full receiving tank is a complete batch. Every second day the complete receiving tank does not need to contain an equal quantity of raw milk from the same collecting stations due to the nature of work itself. When the receiving tank was not used, the result of analysis for the total bacterial count in the graph was indicated as the value zero (0). In those two months the comparison of the efect of pasteurization was made for October 2005 (31 analyses) and December 2006 (31 analyses). In October 2005 still the twenty years old equipment was used; after that month the investment in new equipment was made. New sampling and analyses were performed on the basis of operation of the new equipment.

The old equipment, Alfa Laval Pasteur 1982, has a capacity of 15000 litres/hour, serial number 30100 – 02230, technological number 31, pressure load of plates x < 4 Bars and plate thickness 0.6mm.

Technological work process: The raw milk was pasteurized at 78°C with the time of 15 seconds of maintaining at that temperature. The pasteur recorder recorded the temperature data on the thermographic sheet. Only the temperature created in the pasteur in the pasteurization unit was continuously recorded on that sheet. In that form the thermographic sheet is inadequate for the European veterinary inspectors judging the correctness of processes of thermal treatment of milk in the dairy [7, 8]. In addition, it was necessary to keep records manually in the forms; this is no more necessary with the new pasteur and new recorder.

The new equipment, Fischer pasteur, 2006 (figure 1), has a capacity of 25000 litres/hour, serial number 05180, technological number 43, pressure load of plates x < 6 Bars and thickness of plates 0.8mm.

The technological process of pasteurization with the new equipment has somewhat changed. The raw milk is pasteurized at 76°C with the time of 20 seconds of maintaining at that temparature. The pasteur recorder electronically records and saves the pasteurization data on the memory card. The data are subject to perusal any time and are in accordance with all rules.

Fig. 1. Fischer pasteur 43

In the computer record of pasteurization the following parameters are recorded continuously: state of machine (production or washing), pasteurization temperature, positive difference of pressures and output temperature of cooled pasteurized milk. In such form the computer record is adequate for the Slovenian and European veterinary inspectors judging the correctness of the process of thermal treatment of the milk in company [9, 10].

2.2. System of washing of machines and technological lines - CIP

Due to increased scope of production also the production of energy resources (steam, ice water, compressed air) was adapted. The energy saving system in the frame of CIP system represents an intervention reducing the energy consumption for heating and cooling of technological waters and influencing the cost of the

company's business activities as well as the reduction of environment burdening [11, 12].

The cleaning unit is an 8 line satellite system. The control of the decentral components is effected via the local control cabinets connected to central units through the Profibus networks. The control cabinets of all devices are located in the control room. In terms of logging and control of quality of cleaning the records are kept for the past period. The SPS control and the visualization are effected through RAS (Remote - Access) network. The visualization data are archived and the visualization is connected with PC network.

The component parts are tank for fresh water, tank for caustic solution, tank for acid, tank for flushing water and 6 decentral CIP modules.

The data on operation and/or defects during operation are as follows [1]:

If a defect occurs, the buzzer is activated (message about new value). The defects are recorded on a special sheet and are archived.

Operation of pump, valves, top levels, feedback signals of limit switches are monitored. In case of defect each stoppage is recorded. On the basis of this information any defect in the technological process can be localized on the screen.

Any possible defect on the device (valve, pump, mixer) appears on the screen as a red flashing light. If after the defect resetting the defect is not removed, flashing switches over to permanent glowing. The light goes out only after elimination of the defect on the spot.

3. Description of achieved results of own researches

3.1. Results of analyses of incoming raw milk

The induction of modern technology in producing and processing of milk, mainly in cooling milk on complete line from farm to consumer, has cause the changes in microflore. Mostly the microflore in raw milk has changed in which before induction of cooling the gram-positive and acid create bacteria's ruled. With cooling milk the gram-negative, psihrotrofical microflore and species *Pseudomonas* has become dominant, as hers most typical representative. In dairying we describe psihrotrofical bacteria's as bacteria's, which grow at temperature 7°C, although their optimal grow temperature is in most cases near mezofilial micro organisms [13, 8].

The total count of microorganisms in raw milk, among which the bacteria are always predominant, can vary between < 1000/ml with minimum infection during milking and 106/ml with strong infection. The bacterial count is expressed as the number of the colony units (CU) in ml of milk, since the standard method of establishing the total bacterial count is based on the milk infection on the nutrient base - agar and on counting of the growing colonies. For many years the TBC has determined the bacteriological acceptability and/or the hygienic quality of the raw milk, since it is a good indicator of bacteriological infection of the milk produced. The low TBC in the raw milk is asign of good production practice which is most frequently marked with the GMDP card (good manufacture dairy practice). On the other hand, the TBC exceeding 100000 CU in ml of milk is a sign of bad hygiene in the milk production. Such milk which is, moreover, inadequately cooled and infected during storage and transport may contain several millions of microorganisms. In the countries with highly developed milk production the count of 100000 CU/ml of raw milk is considered to be the top limit of the hygienically acceptable milk [14, 15].

The raw milk was received in October 2005, namely 6688502 litres of the following quality:
- average value of raw milk 81139 MO/ml
- minimum value 19000 MO/ml
- maximum value 288000 MO/m.

On an average, the raw cow milk of 7249277 litres quantity, received in December 2006, was of better quality. The average value was 72541 MO/ml of raw milk, the minimum value was 21000 MO/ml and the maximum value was 227000 MO/ml.

3.2. Results of effect of pasteurization

To study the effect of pasteurization the TBC parameter in raw cow milk and, afterwards, the same parameter after thermal treatment - pasteurization were selected. The final result is evident as the effect of pasteurization (figure 2). The internal criterion for reaching the effect in the dairy is 95%. Consequently, assuming that the raw milk contains 100000 microorganisms in ml, 5000 microorganisms must be present in ml of pasteurized cow milk in case of 95% effect of pasteurization. The raw cow milk was sampled in a sterile manner on the sampling cock of the receiving tanks [1].

The average value of the effect of pasteurization was 92.32%, the minimum value was 86.3% and the maximum value was 96.1%. The pasteurized cow milk was sampled in a sterile manner at the exit from the pasteur. The analysis was made in the laboratory on the apparatus bactoscan 8000 made by Foss electric. The result of analysis was entered into a special table, where the TBC of the pasteurized milk of each batch was followed up every day. Then the calculation of the effect of pasteurization was made and the portion (%) was entered into the table.

The average value of the effect of pasteurization amounted to 97.9%, the minimum value was 97.1% and the maximum value was 99.1% which is an outstanding result.

4. Conclusions

On the basis of the technological results still the following conclusion can be summarized:

- On an average, the raw milk in October 2005 was of lower quality for 20.6% (calculation of average value of TBC/ml of raw milk) than in December 2006.
- After completion of the test the effect of pasteurization with the use of old equipment was only 32.25%. With the internal criterion of 95.0% only 10/31 samples exceeded this value.
- After completion of the test the effect of pasteurization with the use of new equipment was 100.00%. With the internal criterion of 95% all 31/31 samples exceeded this value.

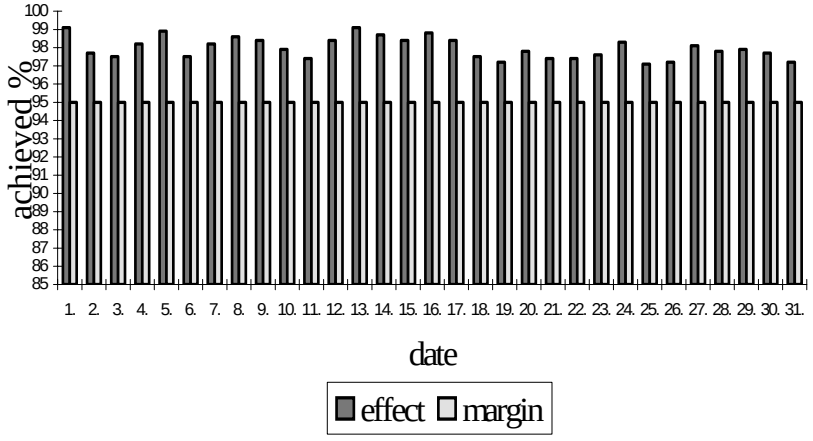

Fig. 2. Effect of pasteurization in December 2006, with pasteur 43 (new equipment)

- Thanks to the new equipment having 20 second maintaining time of pasteurization (the old equipment had 15 second maintaining time) such good results were reached that the reduction of the pasteurization temperature from 78°C (old equipment) to 76°C (new equipment) was possible. The production is more stable and the consumption of steam as the energy resource for reaching the desired pasteurization temperature has been cut.
- After comparison of data and quality of half products the investing in new equipment gives us very positive effects. The sense of investment in company was confirm.

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References

[1] A. Maher, The influence of new equipment on microbiological count of milk in dairy Celeia, Graduation thesis, Maribor (2007) 40-52.
[2] M. Janzekovic, C. Rozman, The Milk quality and feasibility analysis of loose housing dairy cows - a case study. Mljekarstvo 56 (2006) 59-66.
[3] P. Walstra, T.J. Geurts, A. Nooman, A. Jellema, B. MAJS: Principles of milk properties and processes, Dairy Technology (1999) 727-767.
[4] M. Janzekovic, B. Mursec, I. Janzekovic, F. Cus, P. Vindis, Applicability of polar sport tester for cattle heart rate measurements, Proceedings of the 12th International Scientific Conference CAM3S'2006, Gliwice-Zakopane, 2006, 5-8, (CD-ROM).
[5] J. Cleveland, TJ. Montville, IF. Nes, ML. Chikindas, Safe natural antimicrobials for food preservation, International Journal of Food Microbiology 71 (2001) 1-20.
[6] R. Bibek, Fundamental Food Microbiology, 2nd ed. CRC Press Boca Raton, London, New York, (2001) 29-412.
[7] P. Vindis, B. Mursec, M. Janzekovic, F. Cus, Processing of soybean meal into concentrates and testing for Genetically Modified Organism (GMO), Journal of Achievements in Materials and Manufacturing Engineering 20 (2007) 507-510.
[8] J. Garbutt, Essentials of food microbiology, London, Sydney, Auckland, Arnold (1997) 251-296.
[9] J.L. Bergere, J. Lenoir, Cheese manufactoring accidents and cheese defects, Cheesemaking from science to quality assurance (2000) 477-508.
[10] J.V. Chambers, The microbiology of raw milk, Dairy Microbiology Handbook: The microbiology of milk and milk products (2002) 39-90.
[11] M. Janzekovic, B. Mursec, F. Cus, A. Ploj, I. Janzekovic, U. Zuperl, Use of machines for liquid manure aerating and mixing, Journal of Materials Processing Technology 162-163 (2005) 744-750.
[12] B. Mursec, M. Janzekovic, F. Cus, U. Zuperl, Comparison of rollers after sowing of buckwheat, Journal of Achievements in Materials and Manufacturing Engineering 17 (2006) 269-272.
[13] CP. Champagne, RR. Laing, D. Roy, AA. Mafu, MW. Griffiths, Psyhrotrophs in dairy products: their effects and their control, Critical Reviews in Food Science and Nutrition 34 (1994) 1-30.
[14] H. Singh, O.J. McCarthy, J.A. Lucey, Physico-chemical properties of milk, Advances Dairy Chemistry 3 (1997) 469-518.
[15] B. Mursec, F. Cus, Integral model of selection of optimal cutting conditions from different databases of tool makers, Journal of Materials Processing Technology 133 (2003) 158-165.