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MICROWAVE MILK PASTEURIZATION WITHOUT FOOD SAFETY RISK

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ABSTRACT

According to nutrition science, milk and milk products are essential food for humans. The primary processing of milk includes its storage, separation, homogenization and the pasteurization process as well. The latter is a kind of heat treatment, which has been used to extend the storage life of food since the late 18th century. Although heat treatment of milk can be achieved through the use of microwave technology, the inhomogeneity of electromagnetic fields leads to an uneven distribution of temperature in the food products, therefore precluding their use in industry. The pasteurization operation is very often Critical Controll Point (CCP) according of food safety systems.

In recent years our research team has developed continuously operating heat treatment pilot-plant equipment, capable of measuring and contrasting the effects of different heat treatment methods, such as thermostat-controlled water baths and microwave energy, on liquid food products. We examined and compared protein, fat and bacterial content in samples of fresh cow milk with heat-treated cow milk samples. In addition, storage experiments were carried out under a microscope and recordings made of fat globules. Our results so far show that the microwave heat treatment is equivalent to the convection manner pasteurization technology, as we found no difference between the heat-treated products.

Keywords: primary processing; microwave; heat treatment; milk; Critical Controll Point (CCP)

INTRODUCTION

The basical material determines the quality of the food largely. This is especially true for food of animal origin where the quality of raw material function of the animal nutrition, health, human treatment and the technology. Therefore, the raw material quality and properties vary widely, which complicates subsequent food processing. The foregoing may be especially true in a dairy plant where the quality of milk after milking, or a few individuals may be affected. For this reason, it is understandable that the so-called primery processing role is increasing, resulting in a deterioration in the quality of raw materials largely determine.

The pasteurization is a possibilty for the primary processing of dairy technology, which means heat treatment under 100 °C. It aims to reduce the number of microorganisms to a level that does not cause a health risk and also to extend product shelf life. The microbial spoilage of milk by the greater heat-treated to destroy. The heat treatment operation can be carried out in various ways depending on applied temperature degrees and duration. In the pasteurization technology use difference temperature because the heat treatment has advantage – the germ of destruction – and disadvantage – such as denaturation of proteins – propertises for the milk. The heat treatment is considered two way as a larger proportion in milk total bacterial count want to destroy it, but we want to preserve nutritional value and the nature of milk. **(KvVM, 2005)**. This effort has a number of technical solutions for the mechanical device, the method has contributed to warming. Most often, indirectly, through heat conduction and convection of heat exchangers for heating. However the heat treatment of milk can be performed with a microwave method.

The inhomogeneous electromagnetic field caused by uneven temperature distribution in the product, which can be a food safety risk during the primery processing of dairy technology (Fig 1.).

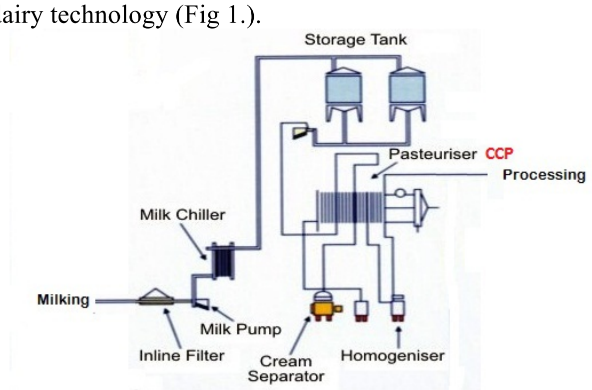

Fig. 1. Primary processing of milk

The research of the microwave heat treatments share the researchers for two part. It is clear, the speciality of the application of microwave energy to heating purposes is the fact that heat dissipates inside the food product therefore the heating process is faster. The advantage of faster heating is that the treatment causes less damage in the nutritive value of the product which results in higher quality. **Villamiel et al (1996)** found that both goat's milk and cow's milk, the microwave heat treatment is effective and suitable technology for the pasteurization of milk. **Sierra and Vidal-Valverde (2000, 2001)** research in milk B1, B2 and B6 vitamins studied continuously operating microwave and conventional (tube heat exchanger) heating methods. It was found that 3.4 % and 0.5 % fat milk at 90 °C with a heat treatment method did not cause vitamin loss.

Watanabe et al (1998) and **Sieber et al (1996)**, microwave treatment combinations used it was found that the A and B12 higher degree of degradation brought about, in other respects but they also demonstrate the microwave benefits of heat treatment to apply. The University of Kaposvár from the hungarian microwave research teams, continuous-mode microwave procedures have been developed and founded that the loss of vitamin C is greater degree **(Albert et al., 2008)**. The Mosonmagyaróvár research workplace make equal warming in the microwave cavity and they found difference enzymes activity and the size of milk fat ball compared a conventional pasteurisation technology **(Neményi, et al, 2006; Lakatos et al., 2010)**. The references examples are shows that the safe industrial application of the microwave heating in the food technology demand many investigation.

But there are some examples from other areas of life as well for microwave treatments. **Kowalski et al. (2012)** studied the microwave impact for honey quality, **Kurják et al. (2012)**, and **Beke et al. (2012)** examined the apple, potato and onion samples possibilities of microwave drying, or **Beszédes et al. (2011, 2012)** said the possibility of the use of microwave energy in sugar beet processing and food industrial sewage sludge treatment.

MATERIAL AND METHODOLOGY

At the Faculty of Mechanical Engineering of Szent István University, a continuous operation microwave appliance was developed by the modification of a household microwave oven.

Fig. 2. *Microwave appliance with spiral insets*

The liquid foodstuffs (milk, beer, liquid egg, fruit juices) flown in the glass spiral in the microwave appliance (Fig. 2.) can be heated to the desired temperature depending on the length of the glass spiral and the volume flow rate of the feeding pump. The temperature can easily be checked both in front of and behind the microwave electromagnetic field, the process is well-controlled **(Géczi, Sembery 2010)**.

To ensure the comparability of the heat treatments, a method with equal duration and temperature was developed. The spiral installed in the microwave appliance was placed in a water bath thermostat. By the adjustment of the water bath's temperature, a treatment temperature identical to that of the microwave method was achieved with constant volume flow rate and thus in equal treatment time. The procedure enables the comparison of products treated under similar conditions but with different heating methods. The milk samples were obtained from the dairy farm in Egyházasdengeleg. Milk was cooled down to 4 °C right after milking without any additional treatments. During transportation, the temperature of milk did not increase above 8 °C. The test liquids were heated up to the same temperature in continuous operation with a water bath thermostat (TH) or a microwave appliance (MH). Liquid flown through the grass spirals without heating was used as a control (WH) (Fig. 3.).

For the statistical comparison 16-16 pieces of the liquids heated by the two different methods and from the untreated control the were analized. The heating temperature was 73.5 ± 0,2 °C. The raised temperature was not held, the samples cooled in a natural way to the storage temperature of 8-10 °C. The samples obtained this way were provided with a code and handed over to independent laboratories for examination. The milk samples were examined in the laboratory of Livestock Performance Testing Ltd. in Gödöllő. The samples were examined in blind tests where the person carrying out the examinations obtained coded and mixed samples. The person performing the preparation and heat treatments did not take part in the examinations.

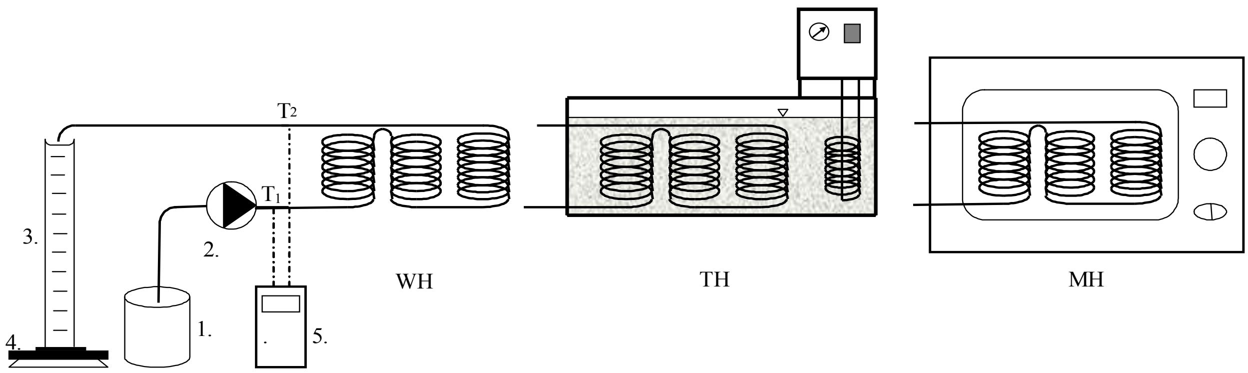

Fig. 3. *Methods of sample groups treating*

Legend for figures 2: 1-Test liquid container, 2-STENNER 85M5 feeding pump, 3-Sampler container, 4- Denver XP-3000 scales, 5-ALMEMO 2590-9 thermometer, MH (method) - Whirpool AT 314 microwave appliance with spiral insets, TH (method) - *T*-PHYWE water bath thermostat with spiral insets, WH (method) - glass spiral.

RESULT AND DISCUSSION

The samples of without heating is well-separated from the heat-treated samples, however, we found no significant difference between the heating methods by the total bacterial count. The Fig. 4. can be shown the diagram, where the difference observed in the untreated (WH) and heat-treated sample (MH, TH), but no visible difference between the heat-treatment methods.

In the Table 1. are presented the statistical results where the initial total bacterial count was 126.500 ± 6,500 CFU/cm^3 and the warming temperature was 73.5 ± 0.2 °C. The heat treatment decreased the total bacterial count 76.4 % in average, for the milk protein and fat content the heating was not affected. The effects of various heating methods was statistically verified by Student's t-test. Null hypothesis, we assume that the sample group averaging 95 % confidence level by selecting the same. A two-sample t-test for the applicability of the conditional approval of variances by F-test were checked. Based on the results of the Table 1. the microwave heating equal as the water bath thermostat heating for the decreasing of total bacterial count. A two-sample t-test shows no significant difference between the two sample groups by p = 0.05 significance level.

Our results so far show that the microwave heat treatment and the convection manner equivalent for pasteurization. Accordingly, the microwave heat treatment method suitable for primary processing of freshly milked milk.

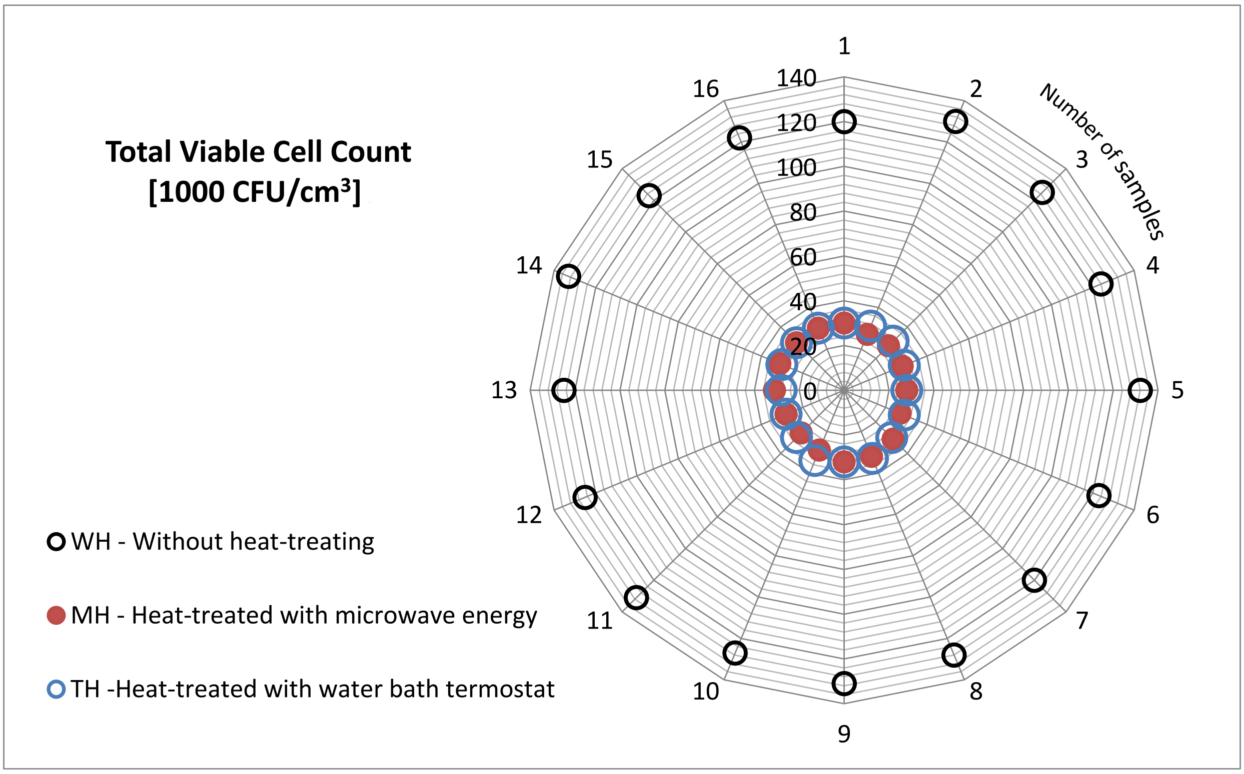

Fig. 4. *Total viable cell count of milk samples as a function of treating methods*

Table 1. *Statistical analysis of changes in total viable cell count*

WH 126.500 ±6.500 CFU/cm^3 *Statistical sample of 16 pieces*	***Total viable cell count*** [CFU/cm^3]	
Heat-treating methods *T = 73.5 ±0.2°C*	**TH**	**MH**
Number of samples	16	16
Expected value	30.187	29.312
Variance	2.962	3.162
t_{sz} value	1.4142	
t_p value	2.0422	
Result (p=0,05)	$\|t_{sz}\| < t_p$	

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