JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2012, *18* (3), 191-194

Journal of Agroalimentary Processes and Technologies

Study concerning the influence of microwave treatment on raw milk freezing point

Anca Dumuţa[1], Zorica Voşgan[1], Lucia Mihălescu[1], Oana Roşca[1], Florin Boltea[2*]

[1]*Technical University of Cluj-Napoca, North University Center of Baia Mare, Victoriei Street 76, 430122 Baia Mare, Romania*
[2]*National Sanitary Veterinary and Food Safety Authority, Vasile Alecsandri Street 66, Baia Mare, Romania*

Received: 10 M 2012; Accepted: 15 June 2012

Abstract

This study aims to investigate how the raw milk freezing point varies while the milk samples are exposed to the microwave action for different periods of time. The analyses indicated that the freezing point increases with the augmentation of the microwave exposure. This variation is characterized by a critical point equal to -0.53 °C obtained after 31.06 s of treatment, which shows the moment when the freezing point values suffer the first significant change denoting the first important alteration of the milk macro components.

Keywords: freezing point, milk, microwave treatment, critical point

1. Introduction

Freezing point or freezing temperature shows the temperature at which milk freezes and depends on the osmotic pressure of milk especially on the concentration of molecules and ions, particularly being influenced by lactose and chlorides [1].

The freezing point takes values between -0.532 and -0.580 °C, with an average of -0.550 °C [2]. In the case of colostral milk, of tampering with inorganic salts and of mastitis the freezing point value lowers and in case of tampering with water its value increases to 0 °C [3].

Microwave heating of food is generated by the microwave energy conversion into heat due to water molecules friction caused by the fluctuation of the electromagnetic field [4]. The difference between microwave heating and other conventional heating methods is the fact that microwaves generate the volumetric heating of the material [5].

Although the microwave technique is widely used in the food field, however there are not many studies on how it affects various characteristics of food [6]. Thus, the purpose of this study was to see how the microwave heating of milk influences its freezing point value.

2. Materials and Method

The raw cow milk used for the analyses was obtained from a local farm. Then, 10 samples of 250 ml milk were exposed in unclosed vessels to the microwaves action for each of the following 6 different periods of time: t0 – milk samples not treated with microwaves, t15 – milk samples treated for 15 seconds with microwaves, t30 – milk samples treated for 30 seconds with microwaves, t45 – milk samples treated for 45 seconds with microwaves, t60 – milk samples treated for 60 seconds with microwaves and t120 – milk samples treated for 120 seconds with microwaves. Microwave heating was carried out using a Hansa AMM 21 E80GH (Hansa, Germany) microwave oven at electrical power of 800 W.

* Corresponding author: *e-mail:* boltea_florin@yahoo.com

Then the samples were analyzed with the CryoStar device (Funke Gerber, Germany) in order to determine their freezing point values.

The results were then statistically processed in Microsoft Office Excel using the indicators: average (Xm), standard deviation (*s*), coefficient of variation (*V* %) and correlation coefficient (*r*) and the Student's *t*-test.

3. Results and Discussion

After the determination of the freezing point values for each of the 6 different periods of microwave exposure their standard deviation (*s*) and coefficient of variation (*V* %) were calculated. These indicators provided a high degree of representativity for the obtained values allowing them to be used for the statistical evaluation.

The averages obtained for the freezing point values are shown in table 1. These averages registered an upward trend from t0 to t120, as one can see in figure 1.

Table 1. The freezing point averages corresponding to the different microwave exposure

Time exposure, s	Xm Freezing point values, °C
0	-0.5623
15	-0.5426
30	-0.5353
45	-0.5322
60	-0.5302
120	-0.528

The variation of the freezing point averages was not constant during the different periods of the microwave exposure, being similar for the first 3 periods and resembling for the rest of them. On purpose to evaluate the variation of the freezing point dynamic, we applied the linear regression and so we modeled the variation corresponding to the first 3 intervals by the equation: $y = a1 + b1x$ and the variation for the next 3 intervals by the equation: $y = a2 + b2x$, were y is the studied parameter and x is the corresponding time interval.

The intensity of the coherence between x and y was assayed by determining the corresponding correlation coefficients which were tested using the Student's *t*-test. This test showed that the correlation coefficients are statistically eloquent establishing that between x and y there is a significant connection.

At the intersection of the 2 lines characterized by the above 2 equations we obtained a critical point as one can see in figure 2. This point is tagged by critical y equal to -0.53 °C and critical x corresponding to 31.06 s. This critical point indicates the moment in which the increasing dynamic of the freezing point values changes.

The freezing point values increased under the microwave action for the 6 time intervals indicating that the dry substance of the milk declined. This decreasing in the milk solids content is due to the fact that the mane components of the milk were affected by the microwave action.

The milk lipids may suffer processes like auto oxidation and formation of trans fatty acids during the microwave action, facts that lead to the reduction of their concentration [6,7].

The proteins are as well affected by the microwave action, especially the sulfhydryl groups which are exposed to the surface due to the heating process [8]. Protein content and lactose concentration of the microwaved milk decreased also because of their engagement in the Maillard reaction [9].

The dry substance of milk depressed due to the reduction of the vitamin content too, the most affected being vitamins C, E and A [10].

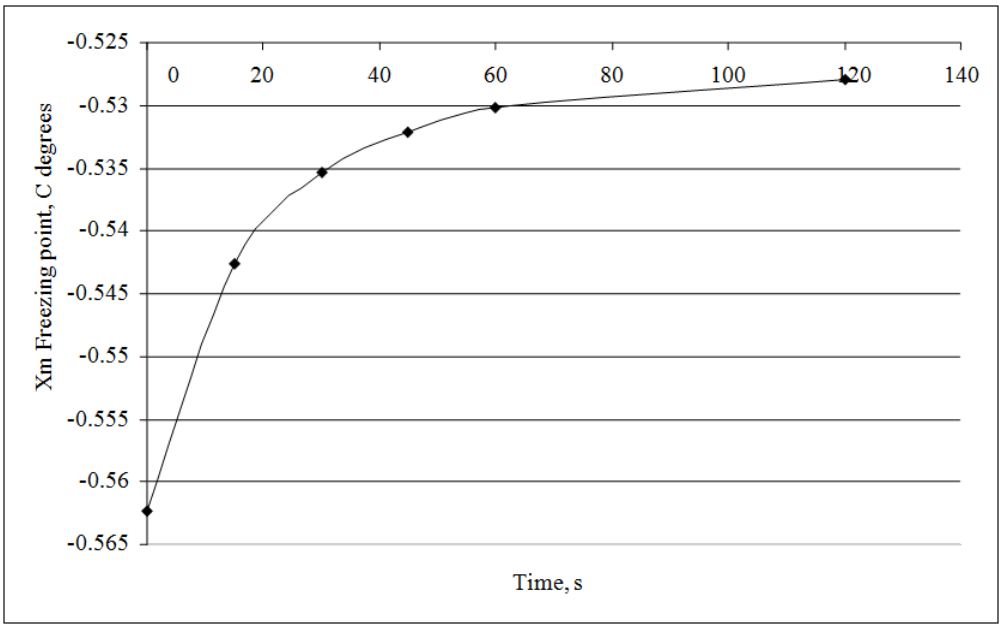

Figure 1. Freezing point averages variation during the microwave treatment

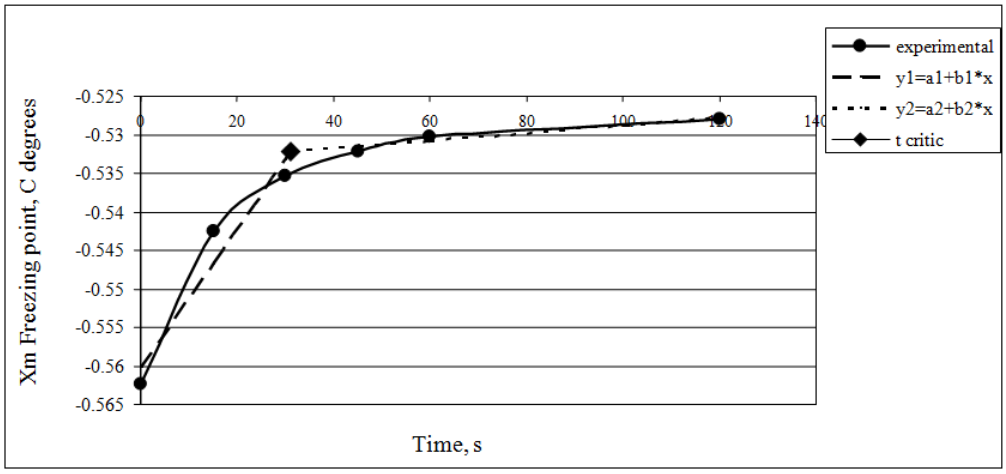

Figure 2. The critical point corresponding to y critical freezing point

4. Conclusion

The freezing point value is influenced by the microwave treatment of milk. This characteristic of milk increases while the exposure to the microwave action arises. The dynamic of the freezing point variation is not constant, being similar for the first 3 periods and allied for the rest of them. By the modelation of this variation using linear regression we obtained 2 equations which characterize the 2 lines by whose intersection the critical point of the freezing point values was generated. This critical point is situated at -0.53 °C and is obtained after 31.06 s of the microwave exposure, indicating the moment when the dynamic of the freezing point values changes. It shows the instant in which the milk macro components become more affected by the microwave action as the dynamic of the freezing point is in inverse ratio to the variation of the milk solids.

References

1. Guzun, V.; Musteaţă, Gr.; Rubţov, S.; Banu, C.; Vizireanu, C., *Industrializarea laptelui,* Editura Tehnica-Info, Chişinău, 2001, pp.42
2. Guş, C., *Laptele şi produsele lactate*, Editura Risoprint, Cluj-Napoca, 2002, pp.24
3. Giurgiulescu, L., *Procese şi tehnologii în industria laptelui*, Editura Universităţii de Nord, Baia Mare, 2009, pp. 136
4. Potter, N.N.; Hotchkiss, J.H., *Irradiation, Microwave and Ohmic Processing of Foods.* In: *Food Science, 5th Edition, Ch. 11*, Chapman and Hall, USA, 1996, pp. 245
5. Zhu, J.; Kuznetsov, A.V.; Sandeep, K.P., Mathematical modeling of continuous flow microwave heatinf of liquids (effects of dielectric properties and design parameters), *International Journal of Thermal Sciences* **2007**, *46*, 328-341, doi: 10.1016/j.ijthermalsci.2006.06.005
6. Meshref, A.A.-R., Effect of heating treatments, processing methods and refrigerated storage of milk and some dairy products on lipids oxidation, *Pakistan Journal of Nutrition* **2008**, *7*, 118-125
7. Semma, M., Trans fatty acids: properties, benefits and risks, *Journal of Health Science* **2002***, 48,* 7-13, doi: 10.1248/jhs.48.7
8. Patrick, P.S.; Swaisgood, H.E., Sulfhydryl and disulfide groups in skim milk as affected by direct ultra-high temperature heating and subsequent storage, *Journal of Dairy Science* **1976**, *59*, 594-600, doi: 10.3168/jds.S0022-0302(76)84246-4
9. Mazzei, F.; Botrè F.; Favero G.; Podestà E.; Botrè C., Partially disposable biosensors for the quick assessment of damage in foodstuff after thermal treatment, *Microchemical Journal* **2009***, 9,* 209-213, doi: 10.1016/j.microc.2008.11.003
10. Sieber, R.; Eberhard, P.; Gallmann P.U., Heat treatment of milk in domestic microwave ovens, *International Dairy Journal* **1996***, 6,* 231-246, doi: 10.1016/0958-6946(95)00009-7