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Composition and Quality of Soft Cheese Made from Milk Treated with High Hydrostatic Pressure

Seham Swelam
Dairy Department, Faculty of Agriculture, Kafrelsheikh University, Kafrelsheikh, Egypt

ABSTRACT

High hydrostatic pressure (HHP) with different levels (500 and 700 MPa at 25°C for 10 min) was applied on the milk being used in making of soft cheese. Chemical and physical properties of the resultant cheese were studied, compared to cheese made from pasteurized milk (72°C for 15 sec) as control. The coagulation time decreased significantly by applying HHP on milk cheese, compared to the control. 700 MPa increased ($P \leq 0.05$) the yield of cheese, compared to the other treatments. The pH was higher for cheese mad from 500 MPa-treated milk, compared to other treated samples. Using 700 MPa resulted in the lowest pH value. The lowest ($P \leq 0.05$) TS and fat contents were observed in cheese made from 700 MPa. The highest firmness was achieved by applying 500 MPa, whereas the lowest firmness was detected when 700 MPa was applied. The most sensory attributes were significantly improved in cheese made of HHP treated milk, compared to the control cheese.

Keywords: High hydrostatic pressure, Cheese, Composition and quality.

INTRODUCTION

The applications of HHP on dairy products have recently increased. The studies mentioned to 300 and 600 MPa as a suitable pressure for depressing microorganism's growth without negative effects on vitamins and nutrients values. Furthermore, the favorable effect of HHP on sensory properties of milk such as taste and flavour (Patterson *et al.,* 1995; Koncz *et al*., 2007; Naik *et al.,* 2013; Swelam *et al*., 2017). Microflora of raw milk including total bacterial count, psychrotrophs, lactobacilli, *Enterobacteriaceae* and *Micrococcaceae* could be decreased by HHP at 500 MPa (20°C, 15 min) as alternative process of pasteurization (72°C, 15 s). The studies reported that Pressurization of milk at 450 and 600 MPa at 25°C for 10 min inactivated the raw milk content of *Enterobacteriaceae* and coliforms bacteria (Trujillo *et al*. 1999; Buffa *et al*. 2001; Swelam *et al.* 2017).

The main goals of using HHP for cheese making could be summarized as: accelerating cheese ripening, depressing pathogenic microorganisms and increasing safety with high shelf life (Trujillo *et al.,* 2000). Drake *et al*. (1997) reported that treated milk by high-pressure technique at ≤ 300MPa decreased the rennet coagulation time (RCT). The high yield was obvious in semi hard goat milk cheese and Cheddar cheese with applying HPP (Drake *et al*., 1997; Trujillo *et al*., 1999). Moreover, Torres-Mora *et al*. (1996) found that the content of moisture of low fat Cheddar cheese was decreased with desirable texture by applying HHP. Also, when HHP was applied on cheese milk, it accelerated the ripping of Cheddar cheese (Yokoyama *et al*., 1992), as well as, it improved the texture of low-fat semi hard cheese (Molina *et al*., 2000). In the case of Gouda and Camembert cheeses, HHP inactivated pathogenic microorganisms (Kolakowski *et al*., 1998). In addition, higher shelf life of Cheddar cheeses was also noted by Trujillo e*t al.* (2000).

Although, applying HHP in production of hard and semi hard cheeses was focus of attention of many studies; there was a leakage knowledge regarding its effect on the properties of soft cheese. The objectives of the present study were, therefore focused on studying the composition and quality of soft cheese produced from HHP treated milk, compared to cheese produced from pasteurized milk.

MATERIALS AND METHODS

Raw cow's milk was obtained from a Hungarian farm (Fuchs Tej Ltd., Valkó, Hungary). Part of milk sample was pasteurized (72°C for 15 sec) using thermostatically controlled water bath. Different levels of HHP (500 and 700 MPa at 25°C for 10 min) were applied on the other milk parts using a Resato FPU 100-2000 high pressure equipment model S-FL-850-9-W (Resato International BV, the Netherlands). All treated samples were used for manufacturing soft cheese. Cheese was manufactured by adding 2% lactic acid starter (*Lactococcus lactis* ssp. *lactis* and *Lactococcus*. *Lactis* ssp. *cremoris*). Milk was held for 15 min at 32 °C. $CaCl_2$ was added by 0.025% (v/w) and calf rennet by 0.02% (v/w). After coagulation, the curd was cut and drained. After draining the salt was added by 5g/100g of the used milk. Cheese was covered by polyethylene sheets and kept at refrigeration temperature (4 °C) for 1 month.

The resultant cheese samples were analyzed for pH, total solids (TS) and fat according the methods of AOAC (2000). A cheese yield was calculated according to Mehaia (2002) formula. TA XT Plus instrument (Stable Micro Systems, Great Britain) was used to determine the cheese firmness. The sensory attributes of the resultant cheeses were evaluated following the IDF standards method (FIL-IDF 99B, 1995). Fifteen panelists determined the sensory of the resultant cheese (colour, flavour, taste, texture and overall acceptability). The measured attributes were scored from range 1 (bad) to 5 (excellent). All measurements were done at least in 3 replicates. The statistical software SAS, version 9.22 (SAS Institute 2010) were used to analyzed the obtained results statistically using ANOVA and significance was indicated at $P \leq 0.05$.

RESULTS AND DISCUSSION

Results in Table (1) show that the coagulation time decreased ($P \leq 0.05$) from 3.13 h in the control cheese to 1.30h and 2.33 when HHP was used by 500 MPa and 700 MPa, respectively. The yield of the resultant cheese increased significantly when 700 MPa was applied, whereas there were insignificant differences between 500 MPa and control samples.

Table 1. Effect of HHP on the coagulation time (hours) and yield (%) of soft cheese

Treatments	Coagulation time	Yield (%)
Control	3.13 a	16.25 b
500 MPa	1.30 c	16.35 b
700 MPa	2.33 b	19.31 a

Means with different superscripts are significantly different (P≤0.05)

Present results are in the same line with those given by Trujillo *et al*., (1999); Arias *et al*., (2000); Needs et al., (2000); Buffa *et al*., (2001) and Huppertz *et al.,* (2002). The decrease of RCT was attributed to the diffusion of casein micelles into smaller particles, thus extensive the specific surface area, and increased the connections between the particles (Kolakowski *et al.,* 2000). However, the increase of the yield of cheese made from HHP treated milk was related to the denaturation of β-Lg with casein micelles, resulting in an increase of the water holding capacity of the curd leading to higher cheese yield (Arias *et al*., 2000 ; Huppertz *et a*l., 2002).

As with the pH value of the examined cheese. fresh cheese was of significantly higher pH by applying 500 MPa- compared, to the other samples, while 700 MPa and control samples were almost of the same pH (Fig 1). After 2 weeks of the storage period, the pH decreased sharply in 700 MPa treated sample from 4.75 to 4.40, compared with the control and 500 MPa treatments as the pH decreased from 4.70 to 4.60 and 4.92 to 4.72 in the same order. The same tend was almost observed when the cheese samples were stored for 4 weeks. In general, 500 MPa treated cheese characterized with the highest (P≤0.05) pH value, whereas the lowest (P≤0.05) value was recorded by 700 MPa.

Pasteurized milk cheeses was found (Trujillo *et al.* 1999) of lower pH value than HP-treated-milk cheeses, which might be due to enhancing the growth of LAB in pressurized milk, resulting in faster acidification of milk (Huppertz *et al.* 2004).

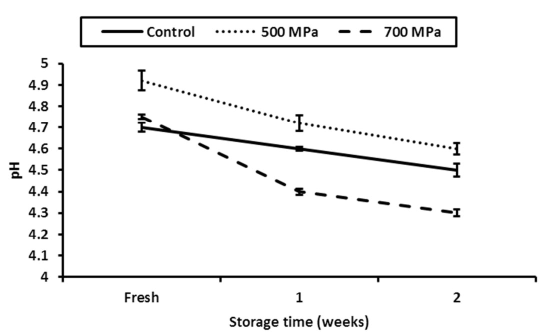

Fig. 1. Effect of HHP and storage period on the pH of soft cheese

Insignificant differences were noticed with respect to TS content of the resultant cheese between control and 500 MPa treated samples (Fig 2). Whereas, TS decreased significantly when the used milk was pressurized at 700 MPa. These results are in agreement with Trujillo *et al.* (1999) and Molina *et al.* (2000) who reported that HHP milk cheese had higher moisture content, compared to pasteurized milk cheese. The higher moisture content (lower TS) of cheese made from high-pressure treated milk might be due to the fact that casein molecules and fat globules may not aggregate closely, that allow more moisture to be held in cheese (Drake *et al*., 1997).

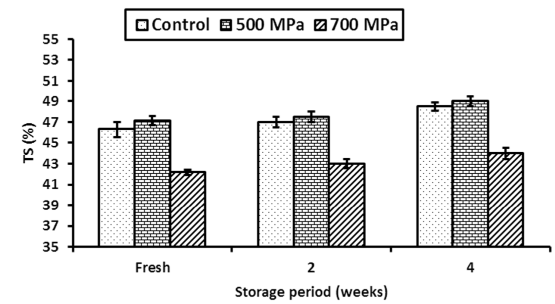

Fig. 2. Effect of HHP and storage period on the total solids (%) of soft cheese

Regarding the fat content if the examined cheese, Fig (3) shows that applying HHP by 500 MPa on the milk used on cheese manufacturing did not affect the fact content of the resultant cheese. Whereas, applying 700 MPa led to significant decrease on the fat content. The fat content gradually increased during storage period for all tested samples. These results came in agreement of those mentioned by (Trujillo *et al.* 1999; Molina *et al.* 2000), who observed a higher fat content in cheese made from pasteurized milk, compared to pressurized milk, which might be due to the higher content of moisture in the resultant cheese made from HHP-milk.

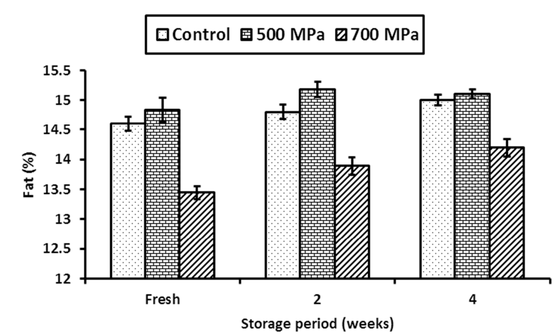

Fig. 3. Effect of HHP and storage period on fat content (%) of soft cheese

It could be seen in Fig (4) that the cheese firmness of the resultant cheese was markedly affected by the applied pressure levels. Since the cheese became harder (P≤0.05) when 500 MPa was used, while it became softer (P≤0.05) when 700 MPa was applied, compared to the control. The firmness of all of the resultant cheese samples gradually increased by prolonging the storage period. The lower firmness might be due to the higher moisture content of the cheese made by applying 700 MPa treated milk. Cheese made from HHP treated milk were also found to be firmer than cheeses made from pasteurized milk, but the differences became less notable toward the end of ripening(Buffa *et al.*, (2001). Applying HHP to milk cheese by 500 MPa at 20^{o}C increased the firmness and elasticity of the resultant cheese, compared with pasteurized milk (72^{o}C, 15 sec) (Trujillo *et al.* 1999).

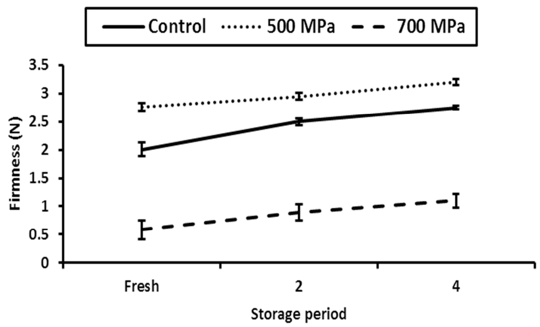

Fig. 4. Effect of HHP and storage period on the Firmness of soft cheese

Regarding the sensory properties of the examined cheese, results in Fig (5a) reveal that pressurized milk by 500 and 700 MPa increased (P≤0.05) the taste and texture attributes of fresh cheese compared, to the control. While applying HHP did not affect the score of other tested attributes (colour and flavour). The same trend was almost observed when the cheeses were stored for 2 and 4 weeks (Fig 5 b and c). While, after 4 weeks of the storage period, cheese made of pressurized milk (500 and 700 MPa) characterized with significantly higher flavour score, compared to the control. These results are in agreement with Patrignani *et al*., (2007), who found that sensory properties (whiter color, better and flavor) were higher for cheese made from high pressure milk compared to untreated sample. Kolakowski *et al*. (1998), on the other hand, reported that applying HHP up to 500 MPa on cheese milk improved the sensory properties of cheese, compared to untreated cheeses. Torres-Mora *et al.* (1996) and Molina *et al*. (2000) added that using HHP improved the texture of low fat cheese.

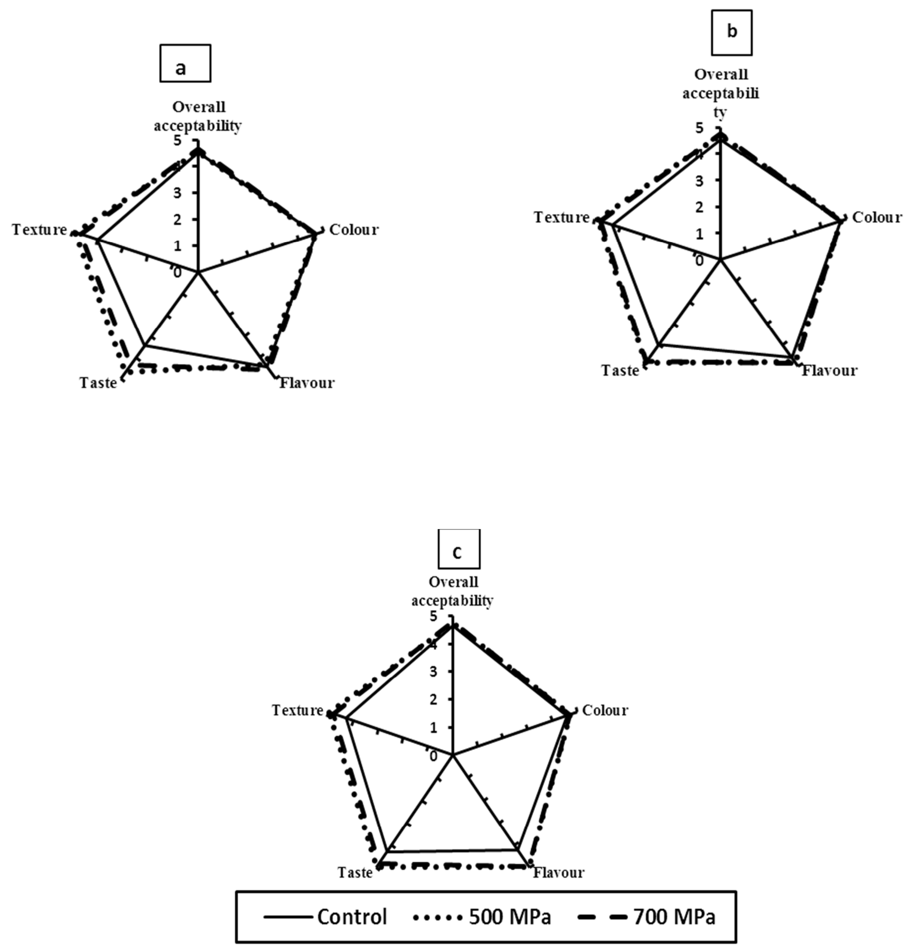

Fig. 5. Effect of HHP on the sensory scoring of fresh soft cheese (a) and after 2 (b) and 4 weeks (c) of storage period.

CONCLUSION

The present results suggest that applying HHP at 500 MPa at 25°C for 10 min on cheese milk could be used as alternative process of pasteurization of cheese milk to decrease the coagulation time, increase the firmness and improve of the most of the sensory evaluation such as favour, taste and texture. Whereas, 700 MPa is too high that resulted in a detrimental effect on the firmness and decrease the pH during fermentation but it enhance the yield and sensory properties.

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خواص وجوده الجبن الطري الناتج من لبن معامل بتقنيه الضغط الهيدروستاتيكي العالي

سهام سويلم

قسم الالبان- كليه الزراعه- جامعه كفرالشيخ

تم صناعه الجبن الطري من لبن معامل بالضغط العالي بمستويات ٥٠٠و ٧٠٠ ميجابسكال لمده ١٠ق علي ٢٥م° وتم مقارنتها بجبن مصنع من لبن مبستر(٧٣م° لمده ١٥ث) للمقارنه. تم دراسه الخواص الكيماويه والطبيعيه والحسيه للجبن الناتج. اوضحت النتائج انخفاض وقت التجبن معنويا للجبن المصنع من اللبن المعامل بالضغط العالي بكلا المستوين (٥٠٠ و ٧٠٠ميجابسكال). كما ارتفع تصافي الجبن الناتج من اللبن المعامل بضغط ٧٠٠ ميجابسكال بينما لم تختلف تصافي اللجبن الناتج من اللبن المعامل بضغط ٥٠٠ ميجابسكال عن معامله جبن المقارنه. ارتفع الرقم الايدروجيني للجبن المصنع من اللبن المعامل بضغط ٥٠٠ ميجابسكال مقارنه بالكنترول بينما انخفض الرقم الايدروجيني معنويا لجبن اللبن المعامل بضغط ٧٠٠ ميجابسكال. سجل الجبن الناتج من اللبن المعامل بضغط ٧٠٠ ميجابسكال اقل محتوي من الجوامد الصلبه الكليه والدهن ولم يكن هناك فروقا معنويه بين جبن اللبن المعامل ب ٥٠٠ ميجابسكال والكنترول. سجل جبن اللبن المعامل ب ٥٠٠ ميجابسكال اعلي صلابه بينما سجل الجبن الناتج من اللبن المعامل بضغط ٧٠٠ ميجابسكال اقل صلابه. تحسنت معظم الخواص الحسيه بوضوح من حيث النكهه والطعم والقوام في الجبن المعامل ب ٥٠٠ و ٧٠٠ ميجابسكال مقارنه بجبن المقارنه.