J. Food and Dairy Sci., Mansoura Univ., Vol. 9 (1): 31- 35 , 2018

Impact of High Hydrostatic Pressure on Composition and Quality of Yoghurt

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

ABSTRACT

Yoghurt was made of different levels of high hydrostatic pressure processing (HHP) (500, 600 and 700 MPa at 25^{o}C for 10 min), compared with that made by using heat treatment (93^{o}C for 20 min) as a control. The resultant yoghurts were analyzed for chemical, physical and sensory properties. The pH during fermentation time was significantly higher for 700 MPa treated sample, compared to the other samples. The pressurized samples were lower in TS ($P \leq 0.05$) than heat treated sample (control). 500 MPa-treated sample had significant lower gel firmness, compared to other tested samples, whereas the highest value was recorded by 700 MPa. Applying 600 and 700 MPa of HHP on the used milk increased significantly the viscosity, compared to 500 MPa and the control samples. Considerable decrease on wheying-off was observed when the milks were pressurized with all of the applied levels. The application of HHP (600 and 700 MPa/ 10 min) to yoghurt milk improved colour and taste of the resultant yoghurt, whereas 500 MPa decreased the most of the tested sensory properties.

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

INTRODUCTION

High pressure processing (HPP) is one of the novel technologies that used recently to produce safe food, with better nutritional value and desirable sensory properties (Stewart *et al*., 2006; Penna *et al.,* 2007). Many recent studies compared between the use of HPP and heat treatment on the chemical, physical, microbiological, sensory and nutritional value of milk. It could be concluded that HPP at 400– 600 MPa could be used as an alternative process of pasteurization (72 ^{0}C, 15 s) to produce safe milk products with higher sensory properties and enhance the nutritional quality due to the lack of thermal damage on the minerals, vitamins and protein (Taylor, 2002; Lopez-Fandino, 2006 a, b; Huppertz *et al*., 2006; Harte *et al*., 2007; Swelam *et al*., 2017). In addition, HPP is recently used in yoghurt manufacture which improves the coagulation characteristics of milk to establish the balance between soluble and insoluble forms of nitrogen, calcium and phosphorus, therefore more acceptable yoghurt is produced (Kheadr *et al*. 2002; Trujillo, 2002; Patrignani *et al*.; 2007; Serra *et al*. 2008). HPP improved the rheological properties such as viscosity, firmness and syneresis resistance of gels yoghurt after 15 min pressurization at 400 MPa and after 5 min at 600 MPa with slight further increases up to 60 min. Furthermore, the gel firmness was increased by increase HPP level from 350 to 500 MPa at 25 and 55 ^{0}C, respectively (Johnston *et al*., 1993 and 1994;Ferragut *et al*., 2000)

In the present study, the sensory and the physicochemical properties of yoghurt made from HP-treated milk with different levels were studied comparing to yoghurt made with traditional method (heat treatment). To know the possibilities of using HHP instead of thermal processing on the manufacturing of yoghurt.

MATERIALS AND METHODS

Raw cow's milk was obtained from a Hungarian private farm (Fuchs Tej Ltd., Valkó, Hungary). Some of the samples were heat-treated using thermostatically controlled water bath at 93^{o}C for 20 min., whereas the other milk samples were pressurized at different levels of HHP (500, 600 and 700 MPa at 25^{o}C for 10 min) 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 yoghurt by traditional method given by Tamime and Robinson (1999), using 0.2% (v/v) starter culture of *Streptococcu. thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. All yoghurt samples were stored for 2 weeks at refrigeration temperature (5±1 ^{o}C)

Chemical and physical properties:-

All samples were analyzed for total solids (TS) content and pH according to AOAC (2000). The centrifugation method was used for the measuring the wheying-off the resultant yoghurt (Harwalkar and Kalab. 1983). Apparent viscosity data were measured by using a laboratory Anton Paar DV-3 P Digital Viscometer (at 20°C and shear rate of 34 s-1) (Anton Paar GmbH, Austria). Gel firmness was measured with TA. XT Plus (Stable Micro Systems, Great Britain) texture analyzer. The samples were tempered to 10 °C, while the measurement was done using a 20 mm diameter cylinder probe. The gel firmness was the force recorded at 10 mm penetration depth. Data evaluation was performed with the software of the Texture Exponent 32 instrument.

Twenty trained evaluators tested the sensory evaluation of the resultant yoghurt according to ISO Standard 8589 (ISO,1988). The sensory properties included colour, flavour, taste, and firmness. All attributes were scored from range 0 (very poor) to 10 (excellent). The attained data were statistically analyzed using ANOVA and significance was indicated at $P \leq 0.05$, using the statistical software SAS, version 9.22 (SAS Institute 2010).

RESULTS AND DISCUSSION

Results in Fig (1) show that pressurized yoghurt milk by 700 MPa for 10 min had the higher pH ($p \leq 0.05$) during fermentation time, compared to the other treated samples. Almost there were insignificant differences between control and the other pressurized samples (500 and 600 MPa) during fermentation time.

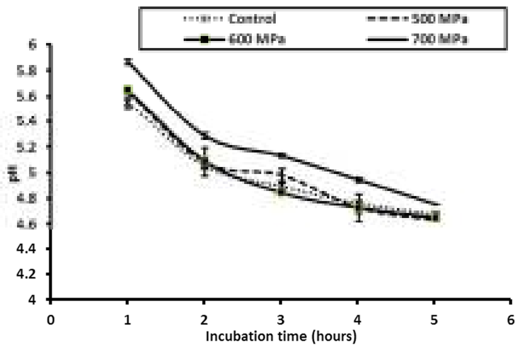

Fig. 1. pH profile of yoghurt as effected by applying different levels of high pressure process.

The present results came in agreement with Penna *et al*., (2007) who reported that using HPP (676 MPa for 5 min) increased the pH of the resultant yoghurt. It could also be established a relationship of applying HPP to the milk, which leads to the disrupt of casein micelles and whey protein into smaller casein micelle clusters or aggregates, which result in an increase in the pH of the milk coagulation and started at a higher pH. (Desobry-Banon *et al*., 1994; Famelart *et al*., 1997; Harte *et al*., 2002; Huppertz *et al*., 2002).

After keeping yoghurt overnight at refrigeration temperature (fresh yoghurt) and after 1 week of storage period the differences between the pH values disappeared among all tested yoghurt samples (Fig, 2). After 2 weeks of storage period, yoghurt made from pressurized milk recorded significant lower pH, compared to control. The lowest value was recorded by 600 MPa treated milk. Tanaka and Hatanaka (1992) reported that pressures above 300MPa reduced the acidifying activity of yoghurt bacteria. While, Jankowska *et al.* (2005) noticed that the pressurized yoghurt (400–600 MPa for 2 min) kept the initial pH after four weeks of storage at 4°C.

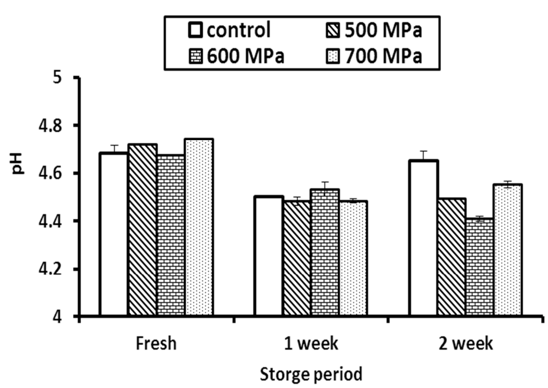

Fig. 2. pH of yoghurt as effected by applying different levels of high pressure process during storage period.

It can be noticed from Fig (3) that yoghurt made from heat-treated milk (control sample) hade significant higher TS compared to pressurized milk. There are insignificant differences between the different levels of the used HHP.

Similar results were given by Penna *et al*., (2007) who cited that the yoghurt made from pressurized milk (676 MPa for 5 min) had significant lower TS compare to that made from heated milk. This is may be related to the loss of some moisture during heat treatment of the control sample.

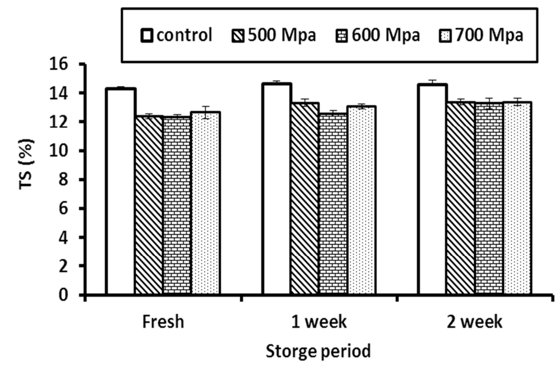

Fig. 3. Total solid of yoghurt as affected by applying different levels of high pressure process during storage period.

It could be noticed in Fig.(4) that there were a marked increase in the firmness of yoghurt made from pressurized milk (700 MPa for 10 min). Compared to the other treated samples, followed by the control one. The lowest firmness was recorded in 500 MPa treated sample, followed by 600 MPa sample. The data showed the same trend when the yoghurts were stored for 1 week without insignificant differences between 700 MPa and the control samples. After 2 weeks storage period, the differences almost disappeared among the control and pressurized (600 and 700 MPa) yoghurt samples. However, 500 MPa treated sample characterized with significant lower firmness value, compared to the other yoghurt samples. The present results came in harmony of those reported with Johnston *et al*., 1993, Desobry-Banon *et al*., 1994 and Ferragut *et al.* (2000))

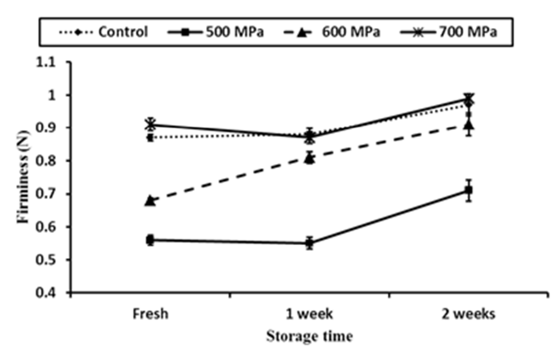

Fig. 4. Firmness of yoghurt as affected by applying different levels of high pressure process during storage period.

Fig (5) shows that the viscosity of yoghurt sharply increased ($P \leq 0.05$) in yoghurt being made of pressurized milk at 700 MPa for 10 min, compared to the control and the other treated samples, followed by 600 MPa treated sample. Meanwhile, there were no significant differences between the control and 500 MPa treated sample. The same trend was noticed when the yoghurt samples were stored for 1 and 2 weeks. The viscosity was increased gradually by advancing the storage period, which agreed with the results mentioned by Johnston *et al.* (1994). The increase of viscosity and firmness with pressure could be illustrated with the casein–fat or casein–casein interactions and the denatured whey proteins binding with water and fat which are caused by HPP treatment (Lanciotti *et al.* 2004 and Shah, 2007). Also the decrease in soluble protein content, which is connected with the production of insoluble high molecular weight coaggregates due to whey protein denaturation during HPP treatment, enhance viscosity (Trujillo *et al*., 2002).

Considerable decrease of wheying-off of the yoghurt samples was observed when the milks were pressurized to 500, 600and 700 MPa/10mins, compared to the control sample (Fig 6). Insignificant differences were noticed between treated samples when different levels of HPP were applied. The wheying-off did not significantly increase when the yoghurt samples were stored for 1 week. However, significant increase was noticed after 2 weeks of the storage period for all the tested samples.

Sharp decrease in wheying-off of yoghurt when being made from treated milk by 350 and 500 MPa at 25 and 55 ^{O}C, respectively (Ferragut *et al.* 2000). Applying HPP increased syneresis resistance of the gels, measured by drainage or by centrifugation (Johnston *et al.*1994).

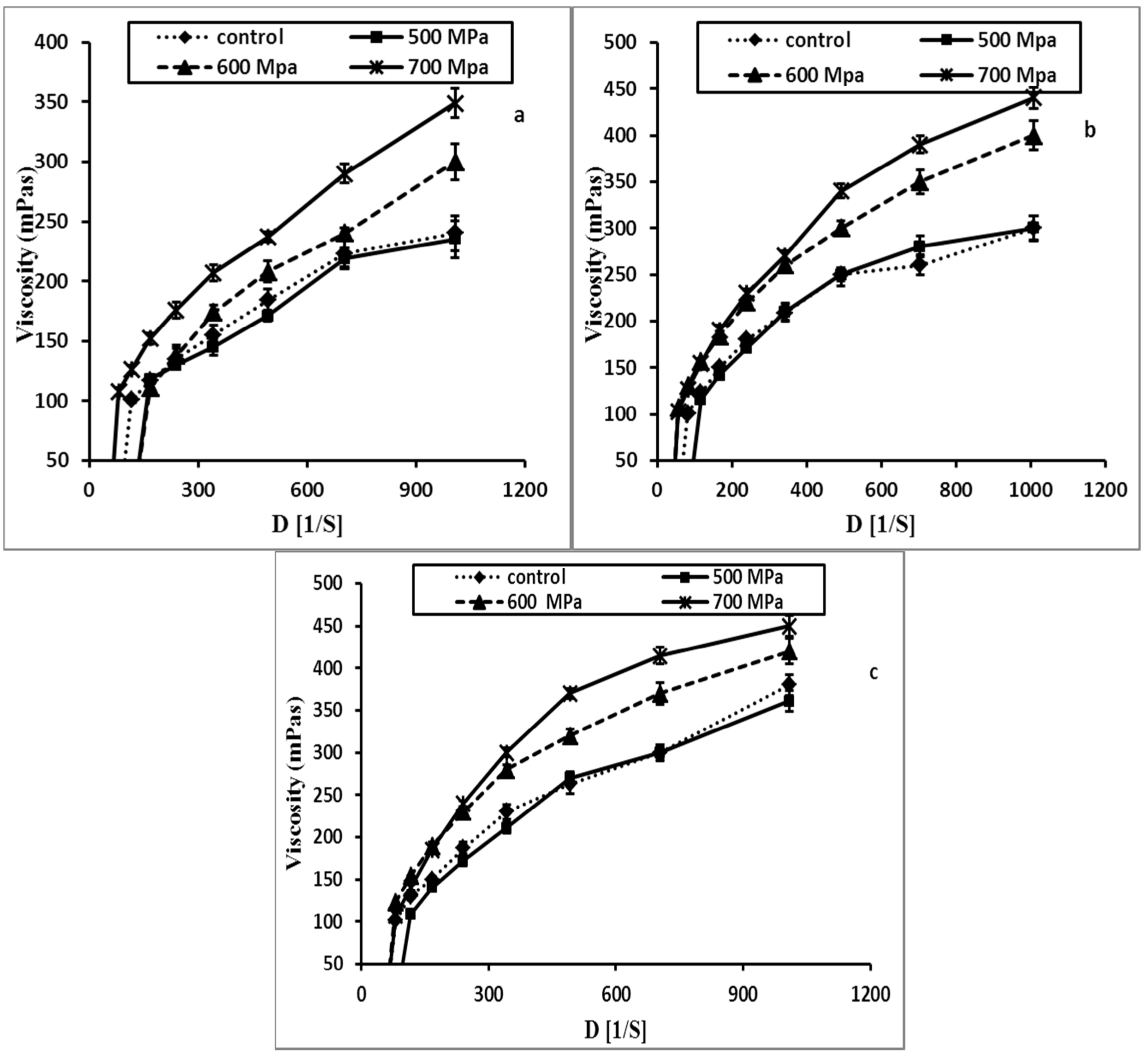

Fig. 5. Viscosity at different shear rates of fresh yoghurt (a) and after 1 (b) and 2 weeks (c) of storage period as affected by applying different levels of high pressure process.

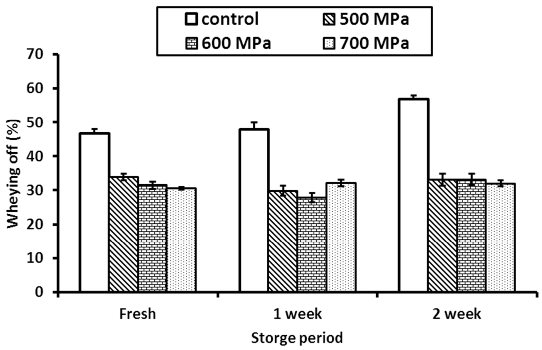

Fig. 6. Wheying off of yoghurt as affected by applying different levels of high pressure process during storage period.

Data in Fig (7a) show that all of the applied pressure levels improved the colour compared, to the heat-treated sample (control) for the fresh yoghurt. The flavour of yoghurt made from pressurized milk (600 and 700 MPa) did not differ significantly with the control, however 500 MPa treated sample scored the lowest value of flavour. The best taste was detected in 700 MPa treated sample, followed by 600 MPa. Whereas 500 MPa gained the lowest score. Insignificant differences were observed between control and 700 MPa in the firmness attribute, however 500MPa scored the lowest value followed by 600 MPa. Almost the same trend was observed when the samples were stored for 1 and 2 weeks. Almost similar results were given by Patrignani *et al*. (2007). In addition, the application of HHP to milk for yoghurt preparation could be an alternative to the use of additives to improve the physical properties of yoghurt without affect the sensor properties (Ancos *et al*., 2000)

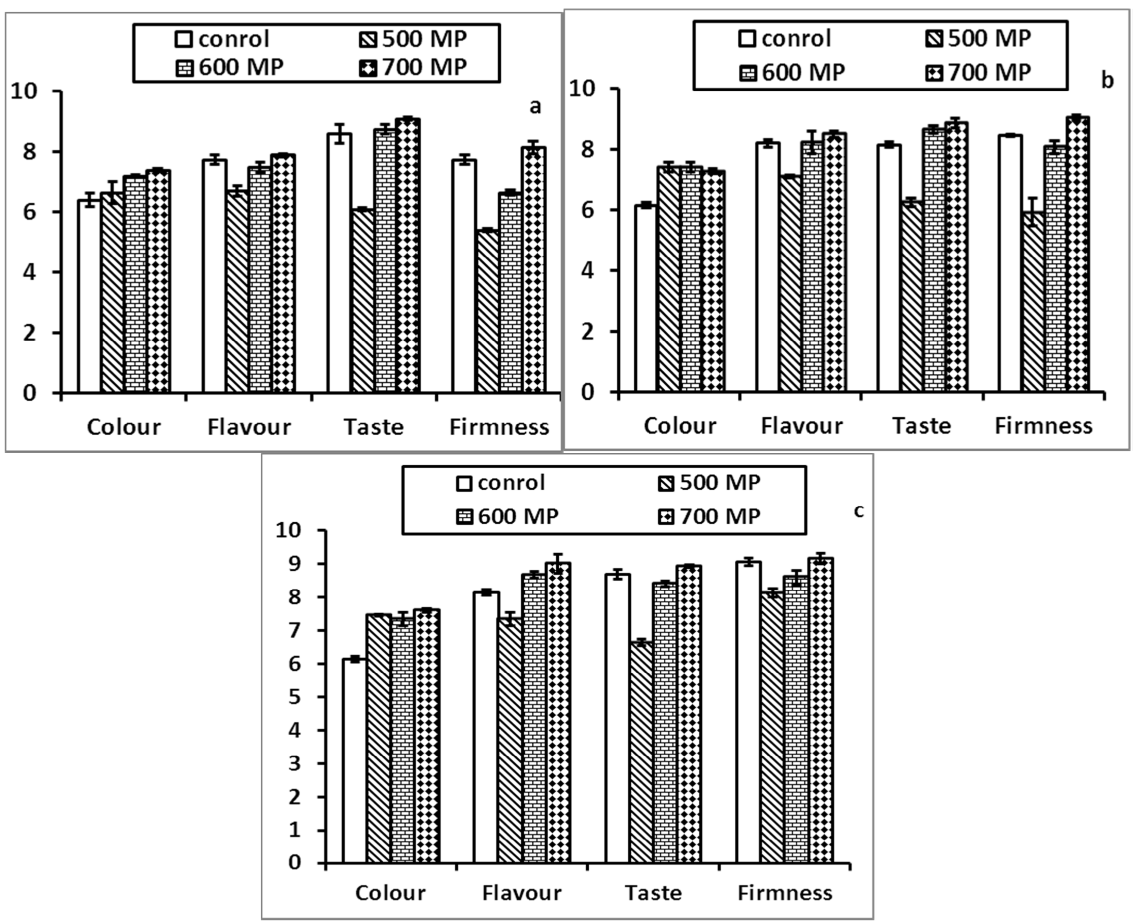

Fig.7 Sensory scoring of fresh yoghurt (a) and after 1 (b) and 2 weeks (c) of storage period as affected by applying different levels of high pressure

CONCLUSION

It could be concluded from the present study that, HHP could be applied by 600 and 700 MPa for 10 min as alternative processes of the thermal treatment to produce yoghurt with better texture (rigidity and resistance to breaking), viscosity and sensory attributes in addition minimized wheying off.

REFERENCES

Ancos, B.; M. Pilar-Cano and R. Gómez (2000). Characteristics of stirred low-fat yogurt as affected by high pressure. Inter. Dairy J. 10:105.

A.O.A.C. (2000). Official Methods of Analysis. Association of Official Analytical Chemists.17th Ed. Washington, DC, USA.

ISO. (1988). Sensory analysis. Standard 8589: General guidance for the design of test rooms. International Organization for Standardization, Geneva, Switzerland.

Jankowska, A; A. Reps; A. Proszek and M. Krasowska (2005). Effect of high pressure on microflora and sensory characteristics of yoghurt. . Polish J. Food Nutr. Sci., 14: 79.

Johnston, D. E.; B.A. Austin and R.J. Murphy (1993). Properties of acid-set gels prepared from high pressure treated skim milk. Milchwissenschaft. 48: 206.

Johnston, D. E.; R. J. Murphy and A. W. Birks (1994). Stirred style yogurt type product prepared from pressure treated skim milk. High Pressure Res. 12: 215.

Kheadr, E. E.; J. F. Vachon; P. Paquin and I. Fliss (2002). Effect of dynamic pressure on microbial, rheological and microstructural quality of Cheddar cheese," Int. Dairy J., 12: 435.

Lanciotti, R.; L. Vannini; L. Pittia and M. E. Guerzoni (2004). Suitability of high-dynamicpressure-treatedmilk for the production of yogurt, Food Microbiol, 21: 753.

Lopez-Fandino, R. (2006a). High pressure-induced changes in milk proteins and possible applications in dairy technology. Int. Dairy J. 16: 1119.

Lopez-Fandino, R. (2006b). Functional improvement of milk whey proteins by high pressure treatment. Crit. Rev. Food Sci., 46: 351.

Patrignani, F.; L. Iucci; R. Lanciotti; M. Vallicelli; J. M. Maina; W. H. Holzapfel and M. Guerzoni (2007). Effect of high–pressure homogenization, nonfat milk solids, and milk fat on the technological performance of a functional strain for the production of probiotic fermented milks, J. Dairy Sci., 90: 4513.

Penna, A.L.B.; S. R. Gurram and G.V. Barbosa-Cánovas (2007). Effect of milk treatment on acidification, physicochemical characteristics, and probiotic cell counts in low fat yogurt. *Milchwissenschaft.,* 62: 48-51.

SAS Institute (2010). Users Guide: version 9.22. SAS Institute. Inc., Cary, NC, USA.

Serra, M.; A. J. Trujillo; P. D. Jaramillo; B. Guamis and V. Ferragut (2008). Ultra-high pressure homogenization-induced changes in skim milk: impact on acid coagulation properties," J. Dairy Res.,75: 69.

Shah, N. P. (2007). Functional cultures and health benefits, Int. Dairy J., 17: 1262.

Stewart, D. I., A. L. Kelly; T. P. Guinee and T. P. Beresford (2006). High pressure processing: Review of application to cheese manufacture and ripening. Aust. J. Dairy Technol. 61: 170.

Swelam, S; K. Pasztor-Huszar and N. M. Mehanna (2017). Comparative study on the effects of high hydrostatic pressure or heat treatments on some properties of cow milk. Egyptian J. Dairy Sci., 45: 121.

Tamime A.Y. and R.K. Robinson (1999). Yoghurt: Science and technology (2nd ed.), Woodhead, Cambridge, UK.

Tanaka, T. and K. Hatanaka (1992). Application of hydrostatic pressure to yoghurt to prevent its after acidification . Jap. Soc. Food Sci. Technol., 39: 173.

Taylor, P. (2002). An applications of high-hydrostatic pressure on milk and dairy products. High Pressure Research. 22: 619.

Trujillo, A. J.; M. Capellas; J. Saldo; R. Gervilla and B. Guamis (2002). Applications of high-hydrostatic pressure on milk and dairy products: A review, Innov. Food Sci. Emerg. Technol., 4: 295.

تأثير استخدام تقنيه الضغط الهيدروستاتيكي العالي علي تركيب وجوده اليوجورت

سهام سويلم
قسم الالبان- كليه الزراعه- جامعه كفرالشيخ

تم صناعه اليوغورت من اللبن المعامل بالضغط العالي بمستويات ٥٠٠، ٦٠٠، ٧٠٠ ميجابسكال لمده ١٠ق علي ٢٥م° وتم مقارنتها بزبادي مصنع من لبن معامل حراريا علي ٩٣م° لمده ٢٠ق (للمقارنه). تم تحليل الخواص الكيماويه والطبيعيه والحسيه لليوغورت الناتج. اوضحت النتائج ان الرقم الايدروجيني ارتفع معنويا للبن المعامل علي ٧٠٠ ميجابسكال خلال فتره التخمر مقارنه بباقي المعاملات وزبادي المقارنه. انخفضت الجوامد الصلبه الكليه للزبادي المعامل بالضغط العالي مقارنه بالكنترول. أعطي الزبادي الناتج من لبن معامل ب ٥٠٠ ميجابسكال اقل صلابه بينما اعلي صلابه اتصف بها الزبادي المعامل ب ٧٠٠ ميجابسكال. ارتفعت لزوجه الزبادي معنويا عند تصنيعه من لبن معامل ب ٦٠٠ و٧٠٠ ميجابسكال مقارنه ب ٥٠٠ ميجابسكال وزبادي المقارنه. انخفض التشريش بصوره كبيره في الزبادي الناتج من لبن معامل بكل مستويات الضغط العالي مقارنه بالكنترول. تحسنت الخواص الحسيه بوضوح من حيث الطعم واللون في الزبادي المعامل ب ٦٠٠ و ٧٠٠ ميجابسكال مقارنه ب ٥٠٠ ميجابسكال وزبادي المقارنه. بينما اعطت عينه ٥٠٠ ميجابسكال اقل خواص حسيه مقارنه بباقي العينات.