The effect of *Prunus cerasus* gum exudates addition on physic-chemical, rheological and sensory properties of yogurt

Sara Khosrowshahi[1] and Mohammad Ali Hesarinejad[2]

[1] Linger Co. 18th Km of Ghoochan-Mashhad Highway, Mashhad, Iran. Postal code: 9185177137
[2] Research Group for Food Production Engineering, National Food Institute, Technical University of Denmark

ABSTRACT
In this work, the influence of *Prunus cerasus* gum exudates (PCGE) at various concentrations on rheological, technological, chemical and sensory characteristics of yogurt was evaluated. The use of PCGE in the yogurt significantly decreased the values of pH. The degree of syneresis of the samples decreased from 4.3 to 2.4 (mg/30g) when PCGE concentration elevated from 0 to 4%. Rheological measurement indicated that with increasing PCGE concentration, consistency coefficient values increased which is a typical change of yogurt as a consequence of hydration of molecules and added stabilizers. With the incorporation of PCGE to yogurt formulation, the degree of whiteness decreased. Based on sensory evaluation, addition of PCGE led to improve taste, texture and overall acceptability values of the samples. Yogurt containing 4% PCGE had highest overall acceptability.

INTRODUCTION

Natural biopolymers are broadly used in food systems as stabilizer, thickener, edible coating, and flavor encapsulator. Increasingly public awareness about the role of fiber in the diet has increased the consumption of different natural polymers in food systems[1].

Prunus cerasus gum exudates (PCGE) is a member of *Rosaceae* family which is distributed widely in China and another part of temperate Asia. PCGE is a high molecular weight polysaccharide, constituent of L-arabinose, D-galactose, mannose, rhamnose and xylose. This gum is an ellipsoidal polymer with an arabinogalactan structure. Due to high viscosity observed at low concentrations, this exudates gum can be introduced as a proper thickener/stabilizer agent in food industries[2].

Yogurt is one of the most important fermented milk products. This product comprises beneficial bacteria which compete with pathogenic micro-organism for space and nutrients. Natural polymers are usually incorporated into yogurt formulation not only as a thickening agent to obtain a desired viscosity and texture, but also as a nutritional agent for improvement of nutraceutical characteristics. A number of studies have been performed to assess the influence of gum addition on physic-chemical properties of yogurt[3,4,5,6].

According to available literature, no study has conducted to evaluate the effect of PCGE addition on physic-chemical, rheological and sensory properties of yogurt. The purpose of the present article was, thus to elucidate the influences of adding PCGE on physicochemical, rheological, and sensory properties of yogurt as a starting point for the assessment of the potential use of this new source of hydrocolloid in yogurt formulation.

MATERIALS AND METHODS

Materials

Prunus cerasus gum exudates (PCGE) was purchased from a local market in Mashhad, Iran. PCGE was purified based on a previous study[7].

Preparation of yogurt samples

In order to manufacture yogurt samples, PCGE (2 and 4%) were added to milk. To maximize solubilization of the gums, samples placed on a magnetic stirrer (at 200 rpm for 20 min). All the samples were heated (at 90 °C for 10 min), inculated with 2% yogurt starter, and then incubated at 4 °C for 4 hours. All the samples were stored at 4 °C and evaluated after one, five and ten days of storage.

Rheological measurements

Rheological behavior of yogurt samples was analyzed by a rotational viscometer, fitted with a R3-spindle at 25 °C. The steady shear measurement was investigated at a range of shear rate from 1 to 300 s^{-1}. Consistency coefficient and flow behavior index was quantified using the power-law model:

$$\tau = k\dot{\gamma}^n \quad (1)$$

here, $\dot{\gamma}$ is the shear rate (s^{-1}), τ is the shear stress (Pa), k is the consistency coefficient (Pa s^n) and n is flow behavior index (dimensionless).

Syneresis

The measurement of degree of syneresis was carried out based on earlier reported method[8]. Briefly, 30 g of samples were centrifuged (222 g) at 25 °C for 10 min and then, the extent of trapped serum phase was investigated. The result expressed as the volume of separated whey.

Chemical properties

Total solids of the samples were determined according to the AOAC method[9]. A pH meter was utilized for quantification of pH.

Sensory evaluation

The sensory analysis was done using the earlier described assay. A group of 40 panelists evaluated all samples. The sensory test was carried out over 3 consecutive days to avoid the panelists from becoming overly fatigued[10]. Three yogurt samples were provided for each panelist. Some qualitative parameter such as texture, taste and overall acceptance were determined using a 9-point verbal hedonic scale (1 = dislike extremely to 9 = like extremely).

Color properties

The color properties of the samples were investigated using colorimeter calibrated with black and white plates. Some color parameters including lightness, redness and yellowness were reported.

Statistical analysis

Analysis of variance (ANOVA) was performed using SPSS software (Version 16.0). Significant difference at 95% confidence interval was analyzed using Duncan's multiple range test for comparison different treatment means.

RESULTS AND DISCUSSIONS

Rheological behavior

Investigation of the rheological properties of yogurt is needed for design, quality control and analyzing of unit operations, processing equipments, and process parameters.

The values of consistency coefficient and flow behavior index are presented in Table 1. The magnitude of coefficient determinations (R^2) were near to 1, exhibiting the appropriateness of power law equation for evaluation the rheological behavior of yogurt samples containing different concentration levels of PCGE. With increasing PCGE concentration, consistency coefficient values increased which is a typical change of yogurt as a consequence of hydration of molecules and added stabilizers. This increasing effect may be associated with enhancement of network

formation within the diluted yogurt system. Additionally, it can be attributed to the increasing synergy between casein micelles and PCGE chains[11]. Similar results were obtained in researches conducted to investigate yogurt supplemented with other biopolymers[12,13,14]. Staffolo et al[14] demonstrated that the addition of apple fibre to yogurt led to improvement the apparent viscosity of yogurt. Additionally, Langendorff et al. [15] assessed the influence of k-carrageenan on consistency of yogurt. The authors indicated that k-carrageenan can improved rheological properties of yogurt because of the gelation and interaction with casein micelles of milk.

PCGE is a gum with remarkable level of nutrients, particularly magnesium and calcium[7]. Therefore, it can be proposed that PCGE can be utilized not only as a nutritional supplement to enhance nutraceutical features of yogurt, but also as a thickener to produce of yogurt.

Sensory properties

According to Table 2, application of PCGE significantly affected the texture, taste and overall acceptability of yogurt samples. The samples containing PCGE at a concentration of 4% obtained the highest scores for overall acceptance, while the control had lowest scores for this parameter. In the case of body and texture, due to the fact that PCGE have high level of viscosity[7], a considerable enhancement was observed. These results are in line of those reported in previous studies. Rossi et al. [16] indicated that the use of guar gum as a mixture with xanthan gum enhanced the texture of soy whey yogurt. In another research, El-Sayed et al.[17] reported that the yogurt containing xanthan gum (0.01%) gained the highest score, while control samples had the lowest one. Other finding demonstrated that the addition of guar gum and Arabic gum had a significant influence on texture, flavor and total acceptability of frozen yogurt[18]. Additionally, the panelists stated that yogurt taste markedly increased when PCGE was used in the formulation.

Physicochemical properties

pH and acidity

The changes in pH values of yogurt with different amount of *Prunus cerasus* gum exudates (PCGE) are given in Table 3. The obtained results indicated that the increasing the concentration of PCGE from 0 to 4% led to a significant decrease in pH values from 4.99 to 4.61. This result is in agreement those of reported by Seo, et al.[19] and Lee and Chang[12]. On the other hand, as expected, the addition of PCGE at evaluated concentrations had an increasing effect on total solids contents of yogurt.

Color properties

The color properties of food products have a key role in consumer perception and acceptance of these products. The values of L*, a* and b* parameters for yogurt supplemented with various concentrations of PCGE stored at 4°C are tabulated in Table 3. The magnitude of L* parameter for the PCGE supplemented treatment was significantly less when compared that of obtained for control samples. L* value is an indicator for degree of lightness, more value of this parameter indicates a higher degree of lightness. Therefore, it can be found that with the addition of PCGE to yogurt formulation, the level of whiteness decreased. Furthermore, as expected, following increasing in the PCGE concentration, the degree of whiteness decreased. On the other hand, a significant increase in *a** parameter of the film was observed when PCGE was added, demonstrating that the greenness diminished with increasing PCGE concentration. Additionally, an increase in the PCGE concentration led to an increase in *b** value. Accordingly, it can be found that the degree of yellowness increased with increasing PCGE content. These results are consistent

with those reported by Lee and Chang [12] and Peker and Arslan[6].

Syneresis

From a technological point of view, higher water holding capacity has an important role in the prevention of syneresis[20]. Addition of PCGE had a significant effect on syneresis. PCGE addition to the yogurt formulation resulted in an steady decrease in the syneresis which may be attributed to the interaction of hydrocolloid with milk component like protein and consequently, elevation of water holding capacity[21,22]. This result is consistent with that of observed in rheological examination where increase in PCGE concentration led to increasing the gel network. Abd El-Salam et al.[23], Harwalkar and Kalab[24] and El-Sayed et al.[17] have reported that the utilization of thickener can be utilized as an appropriate method for controlling syneresis of fermented milk.

CONCLUSION

The physicochemical, rheological and sensory properties of yogurt were affected by incorporation of PCGE in yogurt formulation. The degree of syneresis was inversely related to the amount of PCGE added. It was realized that PCGE can be used to enhance the rheological and sensory properties of yogurt. The results obtained in this study are useful from economical and thechnological point of view for dairy industry, because PCGE is a novel source of biopolymer with priced fairly minor.

REFERENCES

1. Williams, P., & Phillips, G. (2003). Gums: properties of individual gums. *Encyclopedia of food sciences and nutrition*, 2992-3001.

2. Fathi, M., Mohebbi, M., & Koocheki, A. (2016). Introducing Prunus cerasus gum exudates: Chemical structure, molecular weight, and rheological properties. *Food Hydrocolloids*.

3. Hematyar, N., Samarin, A. M., Poorazarang, H., & Elhamirad, A. H. (2012). Effect of gums on yogurt characteristics. *World applied sciences journal, 20*(5), 661-665.

4. Kök, M. S. (2010). Characterization of galactomannan stabilised yogurt drink using dynamic rheology. *International Journal of Food Properties, 13*(1), 209-220.

5. Pavón, Y. L., Lazzaroni, S. M., Sabbag, N. G., & Rozycki, S. D. (2014). Simultaneous effects of gelatin and espina corona gum on rheological, physical and sensory properties of cholesterol-reduced probiotic yoghurts. *International journal of food science & technology, 49*(10), 2245-2251.

6. Peker, H., & Arslan, S. (2013). Effects of addition of locust bean gum on sensory, chemical, and physical properties of low-fat yoghurt. *Journal of Food, Agriculture & Environment, 11*(2), 274-277.

7. Fathi, M., Mohebbi, M., & Koocheki, A. (2016). Introducing Prunus cerasus gum exudates: Chemical structure, molecular weight, and rheological properties. *Food Hydrocolloids, 61*, 946-955.

8. Keogh, M., & O'kennedy, B. (1998). Rheology of stirred yogurt as affected by added milk fat, protein and hydrocolloids. *Journal of Food Science, 63*(1), 108-112.

9. Firestone, D. (1990). Official methods of analysis of the Association of Official Analytical Chemists. *Arlington, USA*.

10. Harker, F., Maindonald, J., Murray, S., Gunson, F., Hallett, I., & Walker, S. (2002). Sensory interpretation of instrumental measurements 1: texture of apple fruit.

Postharvest biology and technology, 24(3), 225-239.

11. Bourriot, S., Garnier, C., & Doublier, J.-L. (1999). Micellar-casein–κ-carrageenan mixtures. I. Phase separation and ultrastructure. *Carbohydrate polymers, 40*(2), 145-157.

12. Lee, Y., & Chang, Y. H. (2016). Influence of guar gum addition on physicochemical, microbial, rheological and sensory properties of stirred yoghurt. *International Journal of Dairy Technology*.

13. Ramírez-Sucre, M. O., & Vélez-Ruiz, J. F. (2013). Physicochemical, rheological and stability characterization of a caramel flavored yogurt. *LWT-Food Science and Technology, 51*(1), 233-241.

14. Staffolo, M. D., Bertola, N., & Martino, M. (2004). Influence of dietary fiber addition on sensory and rheological properties of yogurt. *International Dairy Journal, 14*(3), 263-268.

15. Langendorff, V., Cuvelier, G., Michon, C., Launay, B., & Parker, A. (2000). Effects of carrageenan type on the behaviour of carrageenan/milk mixtures. *Food Hydrocolloids, 14*(4), 273-280.

16. Rossi, E., Faria, J., Borsato, D., & Baldochi, F. (1990). Optimization of a stabilizer system for a soya-whey yoghurt. *Alimentos e Nutricao, 2*, 83-92.

17. El-Sayed, E., El-Gawad, I. A., Murad, H., & Salah, S. (2002). Utilization of laboratory-produced xanthan gum in the manufacture of yogurt and soy yogurt. *European Food Research and Technology, 215*(4), 298-304.

18. Rezaei, R., Khomeiri, M., Kashaninejad, M., & Aalami, M. (2011). Effects of guar gum and arabic gum on the physicochemical, sensory and flow behaviour characteristics of frozen yoghurt. *International Journal of Dairy Technology, 64*(4), 563-568.

19. Seo, M., Lee, S., Chang, Y., & Kwak, H. (2009). Physicochemical, microbial, and sensory properties of yogurt supplemented with nanopowdered chitosan during storage. *Journal of dairy science, 92*(12), 5907-5916.

20. Tril, U., Fernández-López, J., Álvarez, J. Á. P., & Viuda-Martos, M. (2014). Chemical, physicochemical, technological, antibacterial and antioxidant properties of rich-fibre powder extract obtained from tamarind (Tamarindus indica L.). *Industrial Crops and Products, 55*, 155-162.

21. Shiroodi, S. G., Mohammadifar, M. A., Gorji, E. G., Ezzatpanah, H., & Zohouri, N. (2012). Influence of gum tragacanth on the physicochemical and rheological properties of kashk. *Journal of dairy research, 79*(01), 93-101.

22. Tamime, A. Y., & Robinson, R. K. (1999). *Yoghurt: science and technology*. Woodhead Publishing.

23. Abd El-Salam, M., El-Etriby, H., & Shahein, N. (1996). Influence of some stabilizers on some chemical and physical properties of yoghurt. Egyptian Journal of Diary Science*, 24*, 25-36.

24. Harwalkar, V., & Kalab, M. (1986). Relationship between microstructure and susceptibility to syneresis in yogurt made from reconstituted nonfat dry milk. *Food Microstructure, 5*(2), 287-294.