JRIFST

www.journals.rifst.ac.ir
Journal of Research and Innovation
in Food Science and Technology

Research Institute of Food Science and Technology

Volume 9, Issue 3, Autumn 2020, Pages 269-282
Document Type: Extended Abstract
DOI: 10.22101/JRIFST.2020.229269.1168

Extended Abstract

Investigation of Oleogel Properties Prepared by Pickering Emulsion-Templated Stabilized with Solid Particles of Basil Seed Gum and Isolated Soy Protein as a Fat Substitute in Cream

Sima Naji-Tabasi[1], Elham Mahdian[2]*, Akram Arianfar[2], Sara Naji-Tabasi[3]

1- PhD. Graduated, Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran
2- Assistant Professor, Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran
* Corresponding author (elhammahdian@iauq.ac.ir)
3- Assistant Professor, Department of Food Nanotechnology, Research Institute of Food Science and Technology, Mashhad, Iran

Received: 2020.05.03; **Accepted**: 2020.07.03

Abstract

According to the multiple role of fat in food products, it is necessary to use a substance as a substitute of fat to maintain the rheological, texture and sensory characteristics of low-fat products. In this study, oleogel system was applied to produce low-fat product. Pickering emulsion-templated was applied to produce oleogels. Isolated soy protein (ISP) and basil seed gum (ISP-BSG) were used for the preparation of Pickering. ISP-BSG particles were prepared with different mass ratios of ISP-BSG, 1:0, 1:1, 2:1 and 3:1 and named 1S:0B, 1S:1B, 2S:1B and 3S:1B, respectively. The type and structure of the Pickering used affected the amount of oil retention in the oleogel ($P<0.05$). The presence of basil seed gum in a suitable ratio with protein (2S:1B) caused a more stable oleogel, higher mechanical strength, and more compact network. Finally, the oleogels were prepared with better oil bonding capacity. The highest and lowest thermal stability rates were for the 2S:1B and 1S:1B samples, respectively. The highest and lowest consistency levels were observed in 2S:1B and 1S: 0B samples, respectively ($P<0.05$). Investigation of the viscoelastic properties confirmed the gel formation in the oleogel system. According to the stability and textural properties of oleogel samples, two formulas 1S:0B and 2S:1B were used to produce cream with reduced fat (5, 10 and 15%). The highest overall acceptance was obtained in the 2S:1B sample with a 5% reduction in fat, which had no significant difference with control cream.

Keywords: Cream, Emulsion gel template, Oleogel, Pickering, Protein-polysaccharide complex

Introduction

Fat is an important source of energy for the body, but high fat intake is associated with an increased risk of various diseases. Therefore, there has been a significant increase in demand for low-fat foods (Katsiari, Voutsinas, Kondyli, & Alichanidis, 2002; Kavas, Oysun, Kinik, & Uysal, 2004). There are several types of fat substitutes. Oleogel structures (structured oils) are new methods for producing low-fat products (Dassanayake, Kodali, & Ueno, 2011). There are several methods to create oleogels, such as direct and indirect methods. One of the indirect methods is the emulsion template method. This method requires the formation of a structural framework in an aqueous solvent or continuous water emulsion. The gel network must be maintained during complete removal of water. In the indirect method, polymers such as proteins and polysaccharides can be considered as structural agents.

One of the new methods for emulsion formation is emulsion picking. In this method, instead of using surface activating agents, solid particles are used for emulsion stability. The most important advantage of this method is the high stability of the emulsion (Linke & Drusch, 2018). Therefore, in this research, emulsion picking gel as an oleogel template was investigated.

Therefore, the aim of this study was to produce oleogels using pickering emulsion gel of polysaccharide (basil seed gum)-protein (soy protein isolate) complex. Finally, using the oleogel system as a fat substitute in cream. In this study, the properties of oleogels were investigated.

Materials and methods

Isolated soy protein was purchased from Shandong Yuxin Bio-Tech Co. (China). Basil seeds were purchased from Mashhad market. Sodium azide was purchased from Applichem Inc. (Dramstadt, Germany). Sodium dodecyl sulphate (SDS) was obtained from Merck, Germany. Pickering (solid particles) of soy isolate isolate (ISP) and ISP-basil seed gum (ISP-BSG) complex used as emulsifier for stabilization of cold emulsion (Naji-Tabasi, Mahdian, Arianfar, & Naji-Tabasi, 2019). ISP-BSG particles were prepared with different mass ratios of ISP: BSG, 1:0, 1:1, 2:1 and 3:1 and named 1S:0B, 1S:1B, 2S:1B and 3S:1B, respectively. These solid particles were used as Pickering for emulsion preparation. Oleogels were prepared based on emulsion-template method. The oil binding capacity, oil binding capacity after thermal treatments, microscopic structure, textural properties and viscoelastic properties of oleogels were studied. Then, the best structure of oleogel used as a fat substitute in cream (5, 10 and 15%).

Results and discussion

Oleogel structure

All emulsions were stable during freeze drying and no phase separation occurred. Formation of a gel-like network improves the stability of particle-stabilized emulsions against creaming during freezing (Zhu, Zhang, Lin, & Tang, 2017). The effect of the type of Pickering used in the emulsion on the oleogel structure indicate that uniform distribution of oil particles in the oleogel structure. By using ISP-BSG nanoparticles in emulsion stabilization, the structure became slightly more compact and the holes became smaller.

Oil binding capacity

The effect of the type of picking particles on the oil binding capacity of oleogel was summarized in Table (1). The oil binding capacity of 1S:0B and 2S:1B oleogel was 82.53 and 83.42%, respectively. 2S:1B Sample had the best oil binding capacity due to its strong oleogel structure. It can be found that the presence of basil seed gum in the right ratio with the protein causes a more stable emulsion with higher mechanical strength and then leads to a dried product with a more compact network.

After applying the heat treatment (80-30 min °C), the amount of oil leakage increased (55-72%). The highest and lowest thermal stability were related to 2S:1B and 1S:1B samples. However, there was no significant difference between 1S:0B, 2S:1B and 3S:1B.

Table 1. Stability of oleogels during 4 weeks of storage at 25 °C *.

Oleogel samples	Oil binding capacity (%)	Thermal stability (%)
1S:0B	82.53±3.29[a]	70.33±1.79[a]
1S:1B	66.52±3.32[c]	55.91±3.83[c]
2S:1B	83.42±2.37[a]	72.50±2.19[a]
3S:1B	74.88±2.21[b]	70.81±3.19[a]

* Different letters indicate significant differences between oleogels (Duncan test, $P<0.05$).

Viscoelastic properties

The viscoelastic properties of oleogel are reported in Fig. (1A). The frequency sweep test of oleogel was performed at a constant strain of 0.5%. Fig. (2B) showed the gel strength of 1S:0B and 2S:1B oleogel samples. The prepared oleogel samples showed weak dependence of G' and G" on the frequency and behaved as "solid" (G'>G") and the gel strength of the samples was similar. The value of the storage modulus 1S:0B (112000 Pa) was more than 2S:1B (Pa 108000), although this difference was not significant.

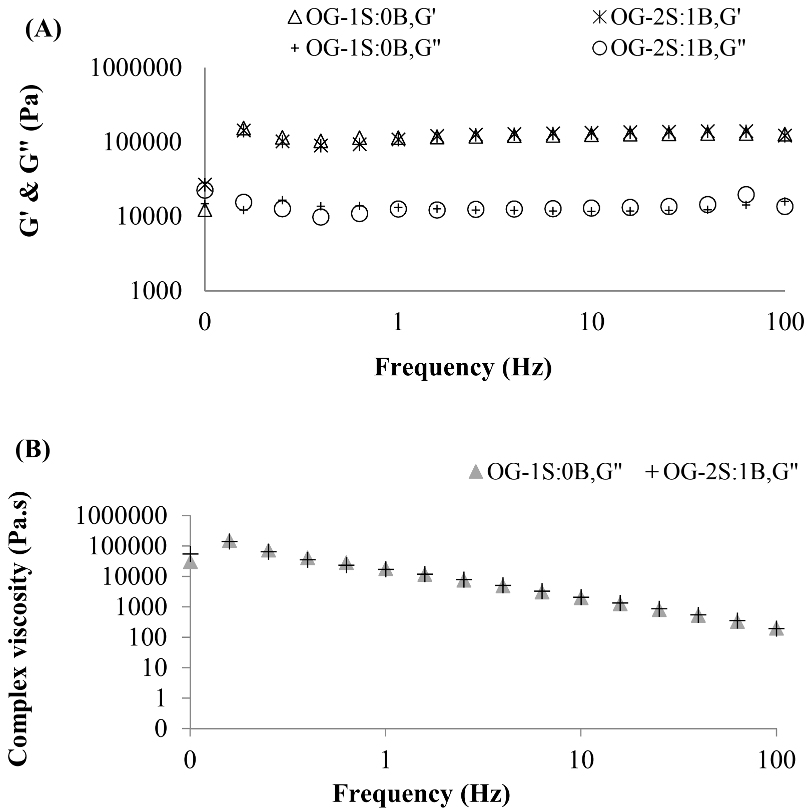

Fig. 1. Mechanical spectra of oleogel samples determined by frequency sweep test (20 °C, strain 0.5%)

Organoleptic properties of low fat cream

The 1S:0B and 2S:1B formulas of oleogels were used to produce low fat cream at 5, 10 and 15% level. The amount of fat in food products affects the sensory properties of food products. Therefore, the sensory properties of low-fat creams were investigated by 5-point hedonic test. Regarding the appearance and texture characteristics, the presence of fat replacement system (oleogels) maintained the desired quality in low-fat cream. In all samples, a score higher than 3 was obtained. The results showed that the highest mean scores were related to the control cream samples, 2S:1B 5% and 1S:0B 5%, respectively. Because of complete removal of water, the presence of oil structure in the oleogel texture was able to create a cohesive structure in the cream, which was highly desirable. Low replacement levels (5%) had higher texture desirability. The 2S:1B at 5% substitution and the control cream had the most value of overall acceptance ($P<0.05$).

Conclusion

The results showed ISP and ISP-BSG solid particles as the Picking emulsion were able to stabilize emulsion-template for oleogel fabrication. The type of Pickering used was effective in oleogel stability. The presence of BSG, especially in the 2:1 ratio, significantly increased the stability of the oleogel system. The presence of BSG changed the morphology and surface properties of nanoparticles and improved the adsorption of particles between oil and water interface. The ISP-BSG oleogel was more stable and had less oil leakage. It can be found that the presence of BSG in the right ratio with protein made a more stable oleogel with higher mechanical strength. Higher values of G' than G" confirmed the gel formation in the oleogel system. Low fat cream was prepared using 1S: 0B and 2S:1B oleogel systems. Based on the results of sensory test, it was found that the quality characteristics of cream samples were more dependent on the percent of replacement. In general acceptance, the highest score belonged to 5OG-2S:1B sample and control cream sample ($P<0.05$). However, most of the samples scored higher than 3, which indicates the desirability of the low fat cream.

References

Dassanayake, L. S. K., Kodali, D. R., & Ueno, S. (2011). Formation of oleogels based on edible lipid materials. *Current Opinion in Colloid & Interface Science, 16*(5), 432-439. doi:https://doi.org/10.1016/j.cocis.2011.05.005

Katsiari, M., Voutsinas, L., Kondyli, E., & Alichanidis, E. (2002). Flavour enhancement of low-fat Feta-type cheese using a commercial adjunct culture. *Food chemistry, 79*(2), 193-198. doi:https://doi.org/10.1016/S0308-8146(02)00131-0

Kavas, G., Oysun, G., Kinik, O., & Uysal, H. (2004). Effect of some fat replacers on chemical, physical and sensory attributes of low-fat white pickled cheese. *Food chemistry, 88*(3), 381-388. doi:https://doi.org/10.1016/j.foodchem.2004.01.054

Linke, C., & Drusch, S. (2018). Pickering emulsions in foods-opportunities and limitations. *Critical reviews in food science and nutrition, 58*(12), 1971-1985. doi:https://doi.org/10.1080/10408398.2017.1290578

Naji-Tabasi, S., Mahdian, E., Arianfar, A., & Naji-Tabasi, S. (2019). Nanoparticles fabrication of soy protein isolate and basil seed gum (Ocimum bacilicum L.) complex as pickering stabilizers in emulsions. *Journal of Dispersion Science and Technology*, 1-8. doi:https://doi.org/10.1080/01932691.2019.1703736

Zhu, X.-F., Zhang, N., Lin, W.-F., & Tang, C.-H. (2017). Freeze-thaw stability of pickering emulsions stabilized by soy and whey protein particles. *Food hydrocolloids, 69*, 173-184. doi:https://doi.org/10.1016/j.foodhyd.2017.02.001