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Extended Abstract

Optimization of Oil Bulking Agents Based on Inulin, Persian Gum and Alginate by Response Surface Methodology

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Abstract

Nowadays, the food industry is looking for new ways to reduce the levels of saturated and trans fatty acids in processed foods and to produce suitable fat substitutes for high-fat products that provide all or some of the functional properties of fats and have health benefits. In this study, sesame oil in gel matrices for the production of inulin-based oil bulking agents in three levels (0.5 to 1.5%), Persian gum (1 to 2.5%) And alginate was used at three levels (0.5 to 1%) as a new way to improve the fat content of pragmatic food products. Oil migration percentage, thermal stability, color parameters such as L*, a*, and b*, rheological properties such as hardness, adhesiveness, consistency, adhesion force of oil bulking agents produced were investigated. The two-phase structured system was optimized by the response surface method with three-variable responses in maximum thermal stability, lowest oil migration percentage, best color and desirable texture properties, and optimal values in percent concentrations (1.32) of Persian gum (1.5) inulin and (0.96) sodium alginate were obtained. In the study of regression model, hardness, consistency, brightness and yellow color with an explanation coefficient above 85% showed a good fit of the model compared to the experimental data.

Keywords: Back extrusion method, Oil bulking agent, Reduced fat, Two-phase structured system

Introduction

Due to the concerns about cardiovascular disease, consumers are attempting to minimize fat levels in their diets (Demirkesen Mert, 2016; Limpimwong *et al.*, 2017). So far, research has focused on fat alternatives with a variety of forms, including carbohydrates, and proteins (Bemiller, 2010; Martins *et al.*, 2018; Stortz *et al.*, 2012). The use of organogel to create structured oil is a novel way to improve fat content and produce low-fat products (Cerqueira *et al.*, 2017; Martins *et al.*, 2016; Panagiotopoulou *et al.*, 2016). Oil Bulking Agents are one approach for creating this two-phase structured system. The oil drops are scattered and trapped in a hydrogel matrix to form these combinations (Patel, 2015). Hydrocolloids like konjac glucomannan and alginates have been examined in combinations with inulin and dextrin for structural systems including beneficial oils like fish oil, flaxseed, and olive oil (Patel *et al.*, 2014; Patel *et al.*, 2014). various investigations have been conducted on applying structured oil in the formulation and stabilization of fresh meat products, cooked, sausages (Zetzl *et al.*, 2012), sauces, chocolate, and chocolate dough (Patel *et al.*, 2014) margarine and spreads (Patel *et al.*, 2014; Yilmaz & öğütcü, 2015), bread, pasty products and, culinary products (Demirkesen Mert, 2016; Jang *et al.*, 2015; Patel *et al.*, 2014; Patel *et al.*, 2014), Creamy cheese (Bemer *et al.*, 2016), Ice Cream (Botega *et al.*, 2013) And cream (Naji-Tabasi *et al.*, 2020). The objective of this research is to create oil bulking agents based on inulin, Persian gum, and sodium alginate that contains sesame oil. The bulk oil matrix properties (oil migration percentage, thermal stability, color, and texture characteristics) were examined. Finally, the optimized sample was determined based on thermal stability, oil migration, color, and texture characteristics.

Materials and Methods

Polysaccharide mixtures were prepared using Herrero *et al.* (2014) procedure. Persian gum, inulin and alginate, sesame oil was used with a set proportion (40%), and inulin, Persian gum, and alginate in three levels with the Minitab software version 18 and the response surface methodology to produce oil bulking agents.

The percentage of two- phase structured system oil migration (Yılmaz & Öğütcü, 2014), thermal stability (Herrero *et al.*, 2014), and colorimeter (model: WF 30, company: Wave China) of oil bulking were evaluated.

Texture properties (PA XT Plus Made in England) were examined with a 40 mm diameter plate prop to assess the consistency, hardness, cohesiveness and adhesive force properties by back extrusion examination.

Optimization was employed to get the best formulation of thermal stability, oil migiration, and the best color and texture as a response. The objective of maximizing or minimizing the amount of response variable defined the optimal conditions of independent variables.

Results and discussions

There was less oil loss (%) in the sample with greater hardness or strength. The sample with 2.5% Persian gum also had less oil loss (%). samples containing 2.5% Persian gum and 0.5% sodium alginates were more capable of trapping oil inside the 3D network and had the best capacity of liquid oil connection due to the firm structure of generated oil bulking agents. According to the findings, increasing the weight of Persian gum from 1 to 2.5 % reduced oil loss (%) (oil migration percentage). The existence of Persian gum in the proper amount of sodium alginates results in a more stable emulsion with better mechanical strength and structures with a tighter network. The oil connection capacity in the sample is related to the mechanical consistency of the volume generated, and the stronger the mechanical resistance, the better the oil connection capacity. The sample with the lowest Persian gum had the minimum stability and the maximum level of oil loss (%) (oil migration %).

The lowest amount of Persian gum and the highest proportion of inulin, sodium alginate, and alginate were associated with the highest brightness. The sample had the most yellowish because it included the greatest amount of Persian gum and inulin and the least amount of alginate.

The hues of the samples are generated by the scattering of light reflected by fat cells and colloidal particles. The color usually lightens as the size of the gel particles shrinks, which is due to greater light dispersion (Golkar *et al.*, 2016). While the sample with the maximum color brightness included the least quantity of Persian gum and the highest percentage of inulin and sodium alginates. The appearance of the oil bulking agents created by increasing the concentration of Persian gum from 1% to 1.75 and 2.5 % was totally visible, as was the enhanced strength and tightness of the matrix.

The sample with the highest Persian gum and alginate quantities had the greatest consistency coefficient whereas the sample with the fewest Persian gum and alginate quantities had the lowest consistency. The firmness of the sample containing the greatest Persian gum and sodium alginate was more than other samples and was meaningful. A harder sample exhibited a firmer network structure than the others, which might be attributed to the formation of a thicker surface layer around the pores in the existence of Persian gum. The quantity of adhesion in the matrix created with the greatest level of Persian gum and the minimum level of alginate was greater than in the other samples, but the difference was not significant.

Conclusions

The firmness, consistency, brightness, and yellowing with coefficients of explanation of more than 85 demonstrated a satisfactory fit of the model to the experimental results. The best sample was achieved by varying the percentage concentrations of Persian gum (1.182), inulin (1.5), and sodium alginate (0.9646). In this research, the optimal conditions are based on the maximum value of the consistency response variable, cohesiveness, adhesion force, thermal stability and L * and b * factors related to color and the minimum values of hardness response variables, factors a * and c related to color and the oil migration percentage.

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