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Production of Muffins with Reduced Fat Using Organogel Based on Carnauba Wax

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Abstract

The aim of this study was to produce low fat muffins using oleogels using carnauba wax and grape seed oil. The oil in the muffins formulation was replaced with various levels (0 and 100%). The rheological properties of different dough samples showed that all samples had shear-thinning behavior. By increasing the percentage of oleogels, the density of the dough increased significantly (P<0.05), but increasing the oleogel to 50% compared to the control sample did not have a significant effect on the density of the dough. Water activity of muffin cake samples containing oleogel were higher than the control sample. With increasing the percentage of using oleogels to the level of 50%, the specific volume of cakes increased. The use of oleogel up to 50% level had no significant effect (P>0.05) on L* index. With increasing the percentage of using oleogels to the level of 50%, the hardness decreased. However, further increase of oleogels from 50 to 100% significantly (P<0.05) led to an increased hardness. Increasing the storage time significantly increased hardness (P<0.05). Samples containing oleogel from 10 to 50% in terms of sensory properties were not significantly different from the control sample (P<0.05) but by increasing the percentage of oleogel application from 50% and above, it led to a significant decrease in all sensory properties of muffin samples compared to the control sample. Therefore, in general, a sample containing 50% oleogel based on carnauba wax and grape seed oil instead of oil can be selected as the superior sample.

Keywords: Carnauba wax, Grape seed oil, Hardness, Low fat, Muffin

Introduction

Muffins are popular as breakfast and evening snacks in some countries. They are known as a soft sponge product with a porous crumb structure and a large volume. Muffins and other baked goods are usually high in fat and sugar, which health-conscious consumers avoid. Fats in bakery products entrap air inside the dough so that the dough develops well and produces a well-baked product. It also contributes to the taste of the final products. Therefore, fat leads to the accumulation of air bubbles inside the structure of the dough during mixing, which will help the product development, crisp the pieces and improve the mouthfeel. Therefore, replacing fat during muffin preparation can have a negative effect on the product's crumb texture and sensory properties. For this reason, the choice of fat replacement system and type of replacement to simulate the behavior of fat is of particular importance (Galali *et al.*, 2022; Rodríguez-García *et al.*, 2012).

The use of oleogels is a potential solution for a healthier daily diet by replacing saturated and hydrogenated fats with natural vegetable oils. With the significant increase in demand for

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solid fat substitutes in meat, bakery and confectionery products, protein or polysaccharide oleogels are suitable options for this purpose due to their high consumer acceptability and textural and sensory characteristics (Li *et al.*, 2022).

Compared to other oils, grape seed oil has a less fatty taste, and therefore it not only does not affect the main taste of the food, but also gives it a buttery taste. Also, this oil can be used for frying at high temperatures without burning and smoke (Al Juhaimi *et al.*, 2017; Shinagawa *et al.*, 2017). The study showed that using carnauba wax oleogel and soybean oil as a frying medium to prepare Indian snacks can reduce the fat and calorie content of the product (Chauhan *et al.*, 2022). Therefore, the purpose of this research is to use oleogel based on carnauba wax and grape seed oil to produce muffins with reduced fat and to investigate the properties of the dough and the final product.

Materials and methods

Preparation of organogel based on grape seed oil

Preparation of organogel based on grape seed oil was conducted according to the method suggested by Aliasl khiabani *et al.* (2020).

Preparation of muffins containing organogel

Muffin samples were first prepared and then the fat in their formulation was replaced with grape seed oil organogel. In order to prepare muffin cakes with reduced fat, the shortening used was replaced with different levels of organogel (0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100%). Finally, the dough of the prepared muffin cakes was poured into a cake mold and baked for 20 min at a temperature of 200 °C (Galali *et al.*, 2022).

Dough density and water activity (Aĝirbaş *et al.*, 2021), hardness (Topkaya & Isik, 2019), color properties (Trehan *et al.*, 2018), specific volume (Kaur *et al.*, 2018) and sensory evaluation (Heo *et al.*, 2019) were performed on the dough and the final product.

Results and discussion

Dough density

By increasing the oleogels level based on carnauba wax and grape seed oil instead of oil up to 50%, the density of the dough increased, but this increase was not significant compared to the density of the control sample ($P>0.05$). On the other hand, with the increase of oleogel from 50 to 100%, the density of muffin cake dough increased significantly ($P<0.05$) compared to the control sample and other samples. The dough density has a strong dependence on its rheological properties. If the dough has enough viscosity, in this case, the air bubbles will be entrapped inside the three-dimensional network of the dough during the kneading and development of the dough, and the dough will increase in volume (Yazici & Ozer, 2021; Zhou *et al.*, 2011). Increasing the volume of the dough will cause a small amount of dough to occupy a large volume, which ultimately leads to a decrease in the density of the dough (Lindarte Artunduaga & Gutiérrez, 2019).

Water activity

The water activity of the control muffin samples was significantly ($P<0.05$) lower than the water activity of the samples containing different oleogels based on carnauba wax and grape seed oil during 30 days of storage. It was also found that with increasing storage time, water activity of all muffin samples decreased significantly ($P<0.05$). Gums are able to enclose a large amount of water in their structure due to their hydrophilicity and ability to absorb and hold water. This capability is due to the ability to form three-dimensional and gel-like structures by gums. Also, the presence of many hydroxyl groups in their polysaccharide chain are able to form hydrogen bonds with water molecules, which will lead to an increase in

moisture content and, as a result, an increase in the water activity of the final product (Thombare *et al.*, 2016).

Color

By increasing the oleogel level based on carnauba wax and grape seed oil up to 50%, the lightness of the samples decreased, but the decrease in the lightness of the samples was not significant compared to the control sample (P<0.05). However, increasing oil replacement by oleogel based on carnauba wax and grape seed oil from 50 to 100% significantly (P<0.05) decreased the lightness of the samples. Changes in the color characteristics of cake crust and bakery products are related to non-enzymatic browning and caramelization of sugars. In the samples prepared with oleogels, due to the presence of xanthan in their formulation, the conditions for non-enzymatic browning reaction (Millard reaction) are provided (Onacik-Gür & Żbikowska, 2020). Also, during the storage period, part of the product's moisture evaporates, which is accompanied by a decrease in the lightness index of the muffin samples.

Specific volume

By increasing the oleogel based on carnauba wax and grape seed oil from 10 to 50%, the specific volume of muffin samples increases significantly (P<0.05), however, increasing the using oleogels from 50 to 100% significantly (P<0.05) led to a decrease in the specific volume of muffin samples. These behaviors are probably due to changes in the viscosity of the dough. The higher viscosity of the dough in the control sample and muffin samples containing oleogel based on carnauba wax and grape seed oil causes a change in the rate of diffusion of gases and water vapor inside the dough and helps to maintain gas during the initial stages of baking (Rosell *et al.*, 2001).

Hardness

By increasing the oil replacement by oleogel based on carnauba wax and grape seed oil from 10 to 50%, the hardness decreased significantly (P<0.05). However, it was found that with the increase of oil replacement from 50 to 100%, the hardness increased significantly (P<0.05). It was also found that the hardness of all samples increased significantly (P<0.05) throughout the storage period. In bakery products, several factors such as amylopectin retrogradation, amylose recrystallization, and moisture migration from crumb to crust are effective on hardness (Bárcenas & Rosell, 2007; Gray & Bemiller, 2003).

Sensory evaluation

The score of sensory characteristics (taste, color, texture and acceptability) did not differ significantly between the control sample and the samples up to 50% of fat replaced with oleogel, but with the increase of replacement percentage from 60 to 100%, the score of all sensory characteristics decreased significantly (P<0.05).

Conclusions

In general, it can be said that the muffin sample containing 50% oleogel based on carnauba wax and grape seed oil instead of oil has favorable characteristics for the production of low-fat muffins.

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