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Full Length Research Paper

Rheological properties and oxidative stability during storage of dough fried made from corn oil with medium-chain triacylglycerols (MCT)

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The rheological properties, oxidative stability, and water contents of the fried dough made from corn oil with medium-chain triacylglycerols (MCT), which is a mixture of MCT and corn oil at a volume ratio of 0% (0:100), 10% (10:90), 20% (20:80) and 30% (30:70) were studied. Flour dough was fried at 140°C for 6 min in fried dough and stored in a glass bottle at 50°C in the dark for 20 days. The water contents and the decreasing rate with storage time were lower in fried dough in corn oil containing MCT than in fried dough in 100% corn oil. The concentration of hydroperoxides in fried dough increased slightly for 8 days storage and increased rapidly thereafter. The concentration of hydroperoxides and the increasing rate with storage time were lower in fried dough in corn oil containing MCT than in fried dough in 100% corn oil. The hardness decreased slightly with 20 and 30% MCT oils for 20 days. In contrast, 0 and 10% MCT oils significantly increased the hardness. Adhesion of fried dough was slight with 20 and 30% MCT oil fried dough. From these results, it is a very high functional property to deep-fry dough that has been clarified with MCT.

Key words: Medium-chain triacylglycerols (MCT), fried dough, corn oil, rheological properties, oxidative stability, hydroperoxide.

INTRODUCTION

Medium-chain triacylglycerols (MCT) composed exclusively of medium chain fatty acids (C8 and C10) were first used in the 1950s for dietary treatment of malabsorption syndromes caused by rapid absorption. Since then, they have been widely studied. Although a large number of excellent reports have been published, most of these focus on clinical nutritional or biochemical standpoints (Seaton et al., 1986; Lavau and Hashim, 1978; Gelebter et al., 1983; Chanez et al., 1991; Kris-Etherton and Yu, 1997; Kritchevsky and Tepper, 1965; Leveilie et al., 1967; Ecelbarger et al., 1991; Papamandjaris et al., 1998). In contrast, very few studies have been conducted from a food science standpoint.

The quality of deep-fried foods during storage deteriorates as a result of oxidation of lipids, which are transferred mainly from frying oil. Compounds such as antioxidants and some thermal and oxidative decomposition reaction products formed in oil during frying

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are transferred to food products and this affect their quality (Chung and Perterson,1978; Sebedio et al., 1996; Sebedio et al., 1987; May et al., 1983; Frankel et al., 1984; Cuesta et al., 1993; Buczenko et al., 2003; Toyosaki and Sakane, 2013). Health aspects of thermally oxidized oils and fats are under constant research. The classes of compounds determined to be toxic are the cyclic fatty acid monomers and the oxidatively modified triacylglycerols bearing aldehydic groups that remain in the oil as non-volatile cleavage products of the triacylglycerol alkoxy radicals produced from the normal triacylglycerols during frying. For functional properties of MCT for the dough, it has not been studied with respect to rheological properties. Therefore, when considering the function of characterization of MCT, to elucidate the rheological properties to the fabric is a very important issue.

The object of the current study was to investigate rheological properties and oxidative stability of dough fried made in corn oil with MCT.

MATERIALS AND METHODS

Materials were purchased from the following sources. Ammonium thiocyanate and ferrous chloride were obtained from Sigma-Aldrich Co. (St Louis, MO, USA). Other reagents were of special grade and were obtained from Nacalai Tesque Inc. (Kyoto, Japan).

Flour was purchased from Nippon Suisan (Tokyo, Japan). The contents of protein, ash, lipid and water were 13.1 (Kjeldahl, N x 6.25), 0.4, 1.8 and 15.0%, respectively. More than 95% of the flour granules were sifted through the sieve of 132-mm mesh.

Preparation and storage of samples

The formula of fried dough was as follows: 300 g flour, 6 g sodium chloride, 20 g sucrose, 200 g whole egg and 60 g water. The mixture except egg was stirred at 25°C at 50 rpm for 10 min. After mixing, whole egg was added to the mixture. After mixing, dough was fried at 140°C for 6 min in a mixture of MCT and corn oil at volume ratio of 0% (0:100), 10% (10:90), 20% (20:80) and 30% (30:70). Fried dough was put into a glass bottle that was tightly screwed capped wrapped with aluminum foil, and then placed in incubator at 50°C for 20 days. All samples were prepared in triplicate.

Measurement of water content in the dough fried

Water contents of each fried dough using dough made in corn oil with MCT was determined according to AACC methods 44-15A and 44-40 (AACC, 1995).

Extract of total lipids from fried dough

Crude total lipids in fried dough were extracted by the method of Folch et al. (1975).

Determination of rheological properties

Hardness and adhesion of fried dough were measured using a rheometer (TPU-2S, YAMADEN Co., Ltd., Japan). A fried dough was set into a rheometer cell of 42 mm long and 16 mm high. The cylinder type plunger of a diameter of 15 mm was compressed into the fried dough in the cell at 5 mm intervals and at a compression rate of 1 mm a second. Quarterly, mean of four trials on each sample were carried out within 5 min of each other. Each value represents the mean ± standard deviation.

Measurement of hydroperoxide in fried dough

Oxidative stability was evaluated by the ferric thiocyanate method (Chen et al., 1996) as follows: to the extracted total lipids (50 µl), 75% ethanol (2.35 ml) and 30% HCl (50 µl) were added. After 3 min, the absorbance of the solution was read at 500 nm in a 1-cm cuvette with a UV spectrophotometer (U-2000, HITACHI Co. Ltd., Tokyo, Japan).

Statistical analysis

All data are given as means ± standard deviations. Statistical analysis was performed using the unpaired student’s *t*-test (KaleidaGraph, Ver. 4.0, Synergy software, PA, USA). Difference in the mean values among groups were assessed using the Tukey-Kramer multiple comparisons test (Instat Ver. 3.0, GraphPad software, Inc., CA, USA). The level of significance was set at $p<0.05$ for all statistical tests.

RESULTS AND DISCUSSION

Observation of fried dough

An example of the shape of fried dough is shown in Figure 1. The overall shape of the dough that is fried in oil was adjusted showing the shape and plump as the ratio of MCT increases. The cross section of the dough fried, showed a soft shape along with increase in the mixing ratio of MCT to corn oil. From this result, it was suggested that as MCT addition ratio was increased, the effect to be given to fried dough is very good.

Changes of water contents of fried dough

Figure 2 shows changes of the water content in the fried dough storage for 20 days in the dark at 50°C. The content of water in all fried dough decreased slightly during 20 days. The water content and the decreasing rate with storage time were lower in fried dough in corn oil containing MCT than in dried dough in 100% corn oil. The higher the MCT in corn oil, the lower the rate of MCT in the fried dough during storage. The results clearly suggest that MCT in corn oil protects retention of water content of fried dough during storage in the dark.

Oxidative stability of fried dough

Figure 3 shows the results for lipid peroxidation of the fried dough storage for 20 days in the dark at 50°C. The

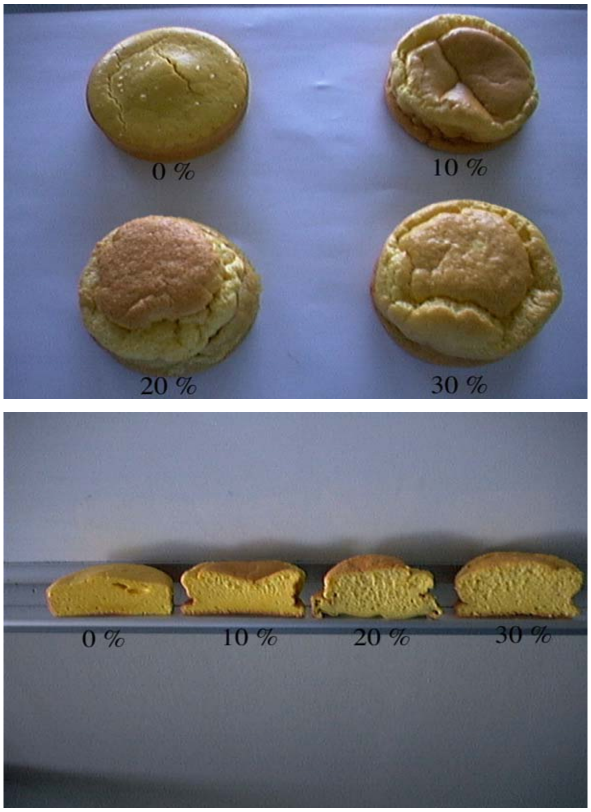

Figure 1. Observation of fried dough.

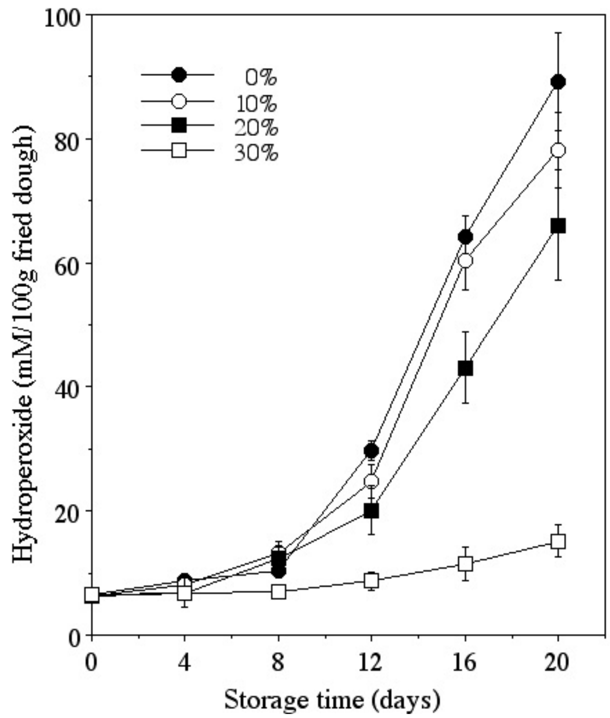

Figure 3. Oxidative stability of fried dough storage for 20 days in the dark at 50°C. Each value represents the mean ± standard deviation.

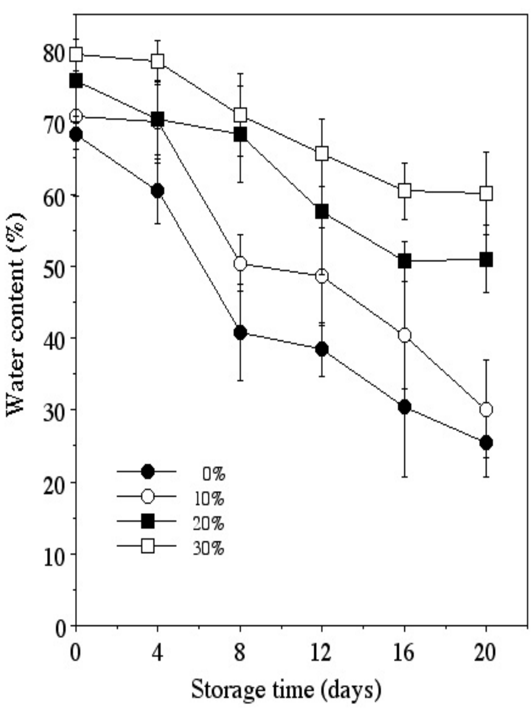

Figure 2. Changes of water contents in the fried dough storage for 20 days in the dark at 50°C. Each value represents the mean ± standard deviation.

concentration of hydroperoxides in fried dough increased slightly during for 8 days storage, and increased rapid thereafter. The concentration of hydroperoxides and the increasing rate with storage time were lower in fried dough in corn oil containing MCT than in fried dough in 100% corn oil. The more the MCT in corn oil, the lower the rate of MCT increase in the fried dough during storage. The results clearly suggest that MCT in corn oil lowers lipid peroxidation of fried dough during storage in the dark.

Rheologic properties of fried dough

Figure 4 shows the results for rheological properties of fried dough storage for 20 days in the dark at 50°C. The hardness decreased slightly with 20% and 30% MCT oils for 20 days. In contrast, 0% and 10% MCT oils significantly increased the hardness. Apparently, MCT oil showed grater rheologic toward hardness than corn oil did. The results clearly show that MCT in corn oil lowered hardness of frying oil during storage. Adhesion of fried dough during storage for 20 days in the dark at 50°C is as shown in Figure 5. Adhesion of fried dough was lesser with 10%, 20% and 30% MCT oil fried dough. In contrast, adhesion of 0% MCT oil fried dough was higher and the highest value was observed for 0% MCT (11.3×10^{-5} J) in 20 days.

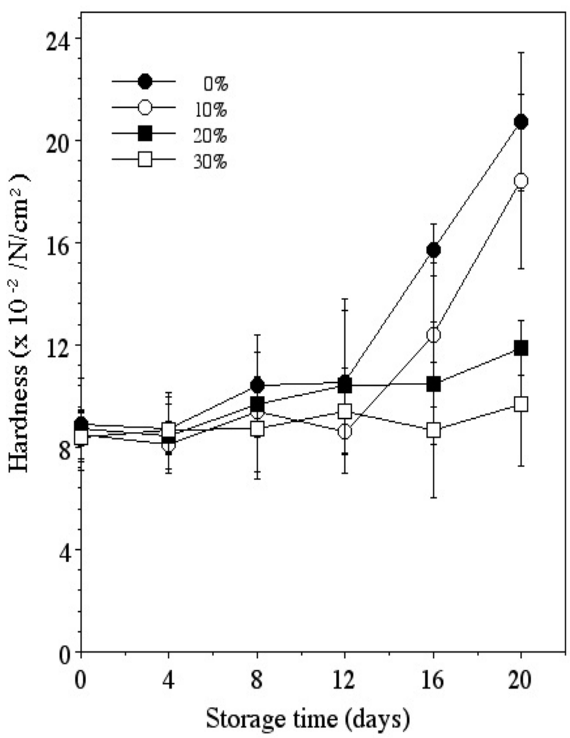

Figure 4. Comparison of hardness of the fried dough storage for 20 days in the dark at 50°C. Each value represents the mean ± standard deviation.

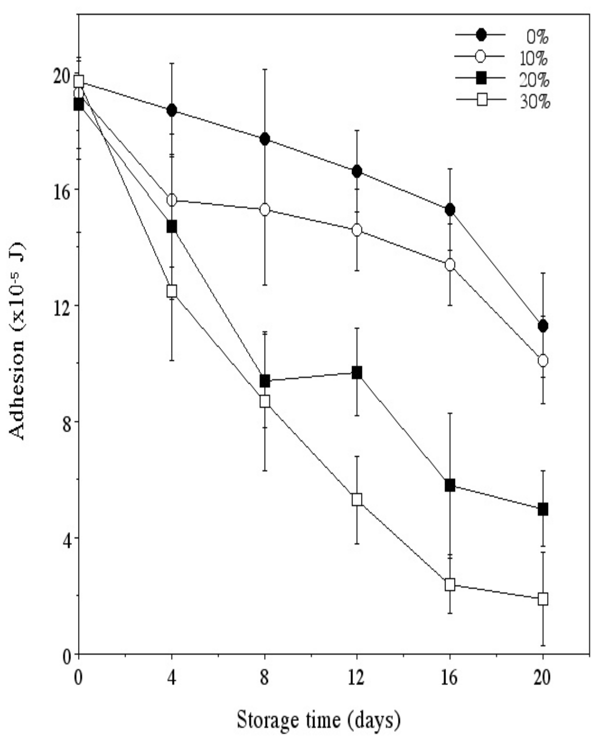

Figure 5. Comparison of adhesion of the fried dough storage for 20 days in the dark at 50°C. Each value represents the mean ± standard deviation.

Conclusion

This study aimed to elucidate the functional food properties of MCT. Rheological properties and oxidative stability during storage of dough fried by addition ratio of MCT in corn oil, and fried dough was studied. From the results of this study, MCT downward trend was confirmed as a factor leading to adhesion increase and when MCT addition ratio is high the dough become soft. As for oxidative stability, a tendency that as MCT addition ratio is increased, oxidation stability is improved has been confirmed. From these results, it is a very high functional property to deep-fry dough that has been clarified with MCT.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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