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Effects of Aluminium Alloy on the Oxidative Stability of Frying Oil

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Abstract

Aluminium alloy, comprising water, silicone manganese and porous aluminium carrier added into soybean oil in order to investigated its effect on polar lipid content, polymer content, conjugated dienoic acid and free fatty acid value during deep-fat frying at 185℃.

Increase rates of polar lipid and polymer content of the frying oil were reduced about one thirds of the oil without aluminium alloy during deep-fat frying. The aluminium alloy, however, have no significantly effect to inhibit the increase of conjugated dienoic acid and free fatty acid value.

Treatment of the frying oil with aluminium alloy was found to be able to inhibit polymer and polar lipid formation.

Key words : frying oil, oxidative stability, aluminium alloy

INTRODUCTION

Deep-fat frying is one of the most commonly used procedures for the preparation of foods with rich flavor and nutrition in the world. During deep-fat frying, oils are continuously or repeatedly used at elevated temperatures ranging from 140 to 200℃ in the presence of air[1].

Under such conditions, both thermal and oxidative decomposition of the oils may take place[2,3]. Such unavoildable chemical reactions cause the formation of both volatile and nonvolatile decomposition products which may have a significant effect upon the flavor, flavor stability, color and texture of the fried foods as well as the length of time a batch of oil can be safely used for frying[4].

Thermal and oxidative decomposition of frying oil during deep-fat frying should be controlled, not only for technological reasons, but also for the safety and nutrition of deep fried products.

Some sterols isolated from cereals germ oil were found to inhibit destruction of linoleic acid in frying oil[5]. The silicones have been used to minimize oxidative deterioration during deep-fat frying[6]. These apparently foam a film at the air-oil interface which acts as an oxygen barrier. Adding chemicals such as MgO to the frying oils could reduce the free fatty acids content[7]. To purify the frying oils already used during foods preparation, addition of magnesium oxide, bleaching clay and charcol was found to be effective to reduce peroxide value and addition of SnCl drastically eradicate epoxide while increasing peroxide value[8, 9]. The object of this work was to investigate the effect of composited alloy on the oxidative stability of frying oil during potato frying.

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METERIALS AND METHODS

1. Materials

The commmercial soybean oil(Dong Bang Manufacturing Co., Seoul) was used for preparation of frying oil. The peroxide, free fatty acid and iodine values of the oil prior to experiment were 0.9±0.1 meq/kg oil, 0.05±0.01 and 130.2±0.5, respectively. Potato slices prefried and freezed for french fried potato was purchased from local market and stored in a deep freezer(−20℃) until deep-fat frying. The aluminium alloy was obtained from commercial source(Clean waste Co., Japan).

2. Deep-fat frying conditions

Deep fat frying was conducted in oil fryer (nominal volume 4.5L) which were filled with soybean oil(3.6L) and heated at 185±1℃ for 84 hr.

During the heating, the potato slice(200 g) was repeatedly fried for 3 min at the intervals of one hour. Before frying, aluminium alloy was directly added to the soybean oil in oil fryer. Fifty ml of frying oil was take out every 7 hour from oil fryers, and the frying oil was used for analysis.

3. Analytical methods

Free fatty acid value(AV) and conjugated dienoic acid value(CDNV) were determined according to the AOAC method Cd 3a-63[10] and Ti-1a-64[11].

Polar lipid content of the frying oil was determined by separation with silica gel column according to the method of Bilek et al[12]. Polymer content of the frying oil was determined by the method described by Peled et al[13].

RESULTS AND DISCUSSION

1. The changes of physico-chemical properties

The changes of polar lipid content of frying oil with and without aluminium alloy were presented in Fig. 1. The polar lipid contents of frying oil were apparently redarded by the treatment of the aluminium alloy. The polar lipid contents of frying oil with and without aluminium alloy were 29.0 and 40.1, respectively, after 84 hours.

The polar lipid contents in the used frying oil were a good indicator of the deterioration. According to recommendation for the quality assessment, a used frying oil id deteriorated If the concentration of the polar lipid component is 27% or higher[14]. Oxidized polar lipid components of both frying oil with and without aluminium alloy increased as the frying time increased. However, the increase rates were significantly reduced by treatment of the aluminium alloy. The polar lipid contents for the frying oil without aluminium alloy increased to the limit value of 27% after 56 hours, whereas those of the frying oil with aluminium alloy reached the limit value after 70 hours.

The changes of polymer content of frying oil with and without aluminium alloy were presented in Fig. 2. The polymer contents of frying oil were also reduced by treatment of the aluminium alloy. The polymer contents of frying oil with and without aluminium alloy were 8.08 and 9.67%, respectively, after 84 hours. Polymers such as dimer and trimer occur from thermal and oxidative pathway involving the alkoxy radical combinations. Polymerization results in a substantial increase in the viscosity of the frying oil[15].

It seemed, therefore, that treatment of the

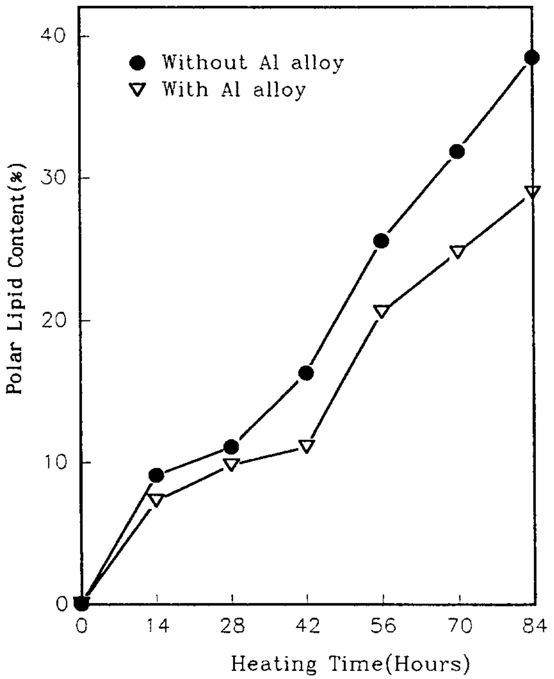

Fig. 1. Changes of polar lipid content of frying oil during deep-fat frying with and without aluminium alloy at 185℃.

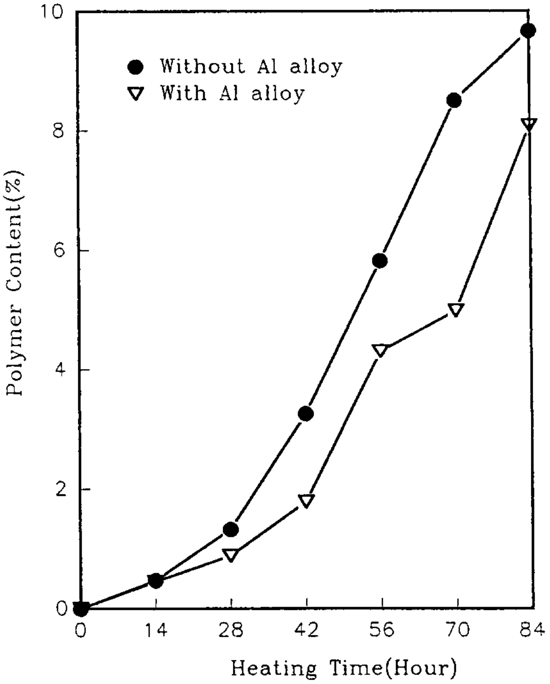

Fig. 2. Changes of polymer content of frying oil during deep-fat frying with and without aluminium alloy at 185℃.

frying oil with aluminium alloy was inhibited the formation of the polymer which would produced by thermal and oxidative process.

The changes of conjugated dienoic acid value of frying oil with and without aluminium alloy were presented in Fig. 3. The coujugated dienoic acid values of both frying oil with and without aluminium alloy increased almost linearly with frying time. Also the coujugated dienoic acid values of frying oil were slightly redarded by the treatment of the aluminium alloy. The conjugated dienoic acid values of frying oil with and without aluminium alloy were 2.37 and 2.41, respectively, after 84 hours.

The changes of free fatty acid value of frying oil with and without aluminium alloy were presented in Fig. 4.

The treatment of aluminium alloy, however, did not affect the free fatty acid value of frying oil. As shown in Fig. 4, the free fatty acid values of frying oil with composited alloy were rather higher than those of frying oil without aluminium alloy.

The free fatty acid values of frying oil with and without aluminium alloy were 1.25 and 1.19, respectively, after 84 hours.

The free fatty acids are the major compounds produced from thermolytic decomposition of lipids. When fat and oil are heated in the presence of moisture, free fatty acids are released via hydrolysis of the ester linkage, a reaction requiring a molecule of water for each ester group[15].

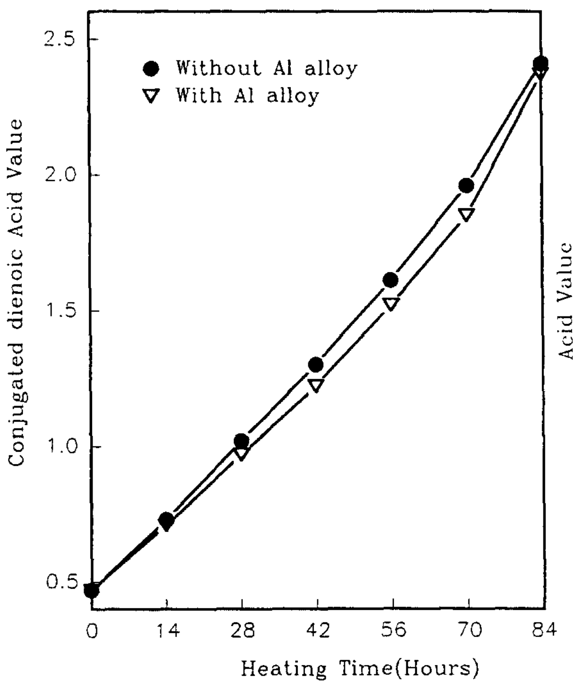

Fig. 3. Changes of conjugate dienoic acid value of frying oil during deep-fat frying with and without aluminium alloy at 185℃.

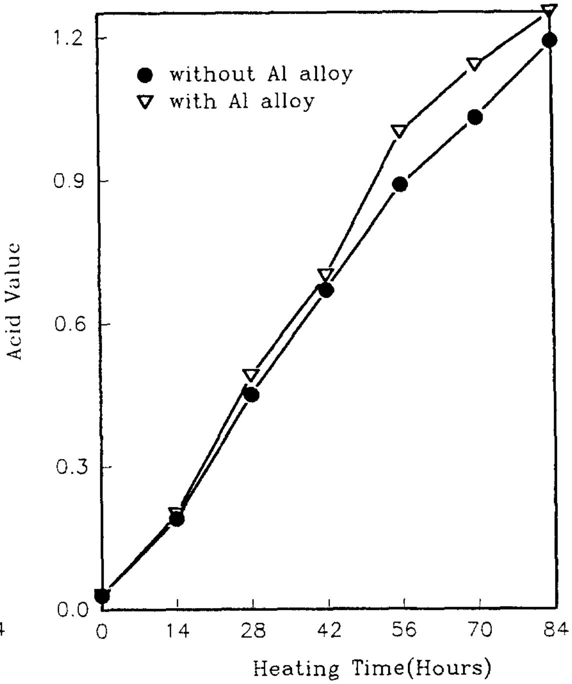

Fig. 4. Changes of free fatty acid value of frying oil during deep-fat frying with and without aluminium alloy at 185℃.

It seemed, therefore, that aluminium alloy have no effect to inhibit of free fatty acids which would be specifically produced by thermal hydrolysis of the ester linkage.

Therefore, treatment of the frying oil with aluminium alloy was found to be able to inhibit polymer and polar lipid formation.

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튀김유 산화 안정성에 미치는 Aluminium Alloy의 효과

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요 약

대두유를 튀김유로 사용하여 french fried potato를 185℃에서 제조하면서 84시간 튀김한 후 aluminium alloy(물, silicone, manganese, porous aluminium carrier을 함유)를 처리한 감자튀김유와 대조구의 물리화학적 변화를 측정하였다. 물리화학적 변화의 척도로는 극성지질, 중합체의 함량, 공액이중산가 및 유리지방산가를 사용하였다. Aluminium alloy를 처리한 시료는 대조구에 비해 극성지질 및 중합체 형성을 크게 억제하였으며 공액이중산가 및 유리지방산가의 증가 억제에는 영향을 주지 않았으며 유리지방산가의 경우 오히려 촉진되는 결과를 보였다. 따라서 튀김유에 대한 aluminium alloy의 처리는 유리지방산이나 공액이중산의 형성억제보다는 극성지질 및 중합체의 형성억제에 효과적임을 알 수 있었다.