Development and application of durian seed starch film for reducing oil uptake in production of deep-fried durian chip

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Abstract
Recent trends in food processing have emphasized the development and improvement of reduced fat foods. The objective of this study was to evaluate the effectiveness of edible coating formulated from durian seed starch in restricting oil absorption during deep-fat frying of durian chip. Durian seed starch solutions (5% w/v) with 30% (w/w starch) glycerol as plasticizer cooled after being held at 85°C for 1 h provided suitable films. Coating was applied, dried at room temperature (30°C and 60%RH) for 30 min. The effect of frying temperature (150, 170 and 190°C) was studied. The products were characterized with respect to their moisture and crude fat contents. Total moisture content of all coated samples was significantly higher than the uncoated control. There was a significant fat reduction between fried uncoated and coated samples, especially at lower frying temperature. For all applications, the coated samples appeared to be soggy and less brown when compared to the control samples.

Keywords: Durian chip, oil uptake, deep-fat frying, edible coating, durian seed starch

1. Introduction
Deep-fat frying is a popular way to prepare tasty foods quickly (Mellema, 2003). Frying is often selected as a method for creating unique flavors and texture in processed foods that improved their overall palatability (Moyano and Pedreschi, 2006). Fried foods normally absorb great amounts of oil during frying. Over the last decade, it has been recognized that reduction of fat content of deep-fat fried products is desirable, since excess fat consumption is considered as the key dietary contributor to high blood cholesterol, high blood pressure, and coronary heart disease (Abert and Mittal, 2002; Shih et al., 2005). In order to obtain the low-fat durian chip, the present study has experimented with the use of edible film as a barrier to the incorporation of oil during the frying process. The main coating material is formed from durian seed starch. The effect of three different oil temperatures on oil absorption was also investigated.

2. Materials and Methods
Preparation of the durian seed film solution
A simple extraction of durian seed starch was employed according to Pimpa and Pimpa (2007). The film solution was prepared by mixing 5% (w/v) of durian seed starch, 30% (w/w of starch) of glycerol and 10% (w/w starch) of citric acid. This suspension was heated at 85°C for 1 h with agitation and then cooled at room temperature. Film solution was immediately used for coating application.
Application of the coating
The coating was applied by the technique of immersion. Samples without coating were used as the control. After coating, the samples were dried at room condition (30°C and 60%RH) for 30 min, and then fried in palm oil at different oil temperatures (150, 170 and 190°C) by an electrical fryer with a capacity for 3 L. After removal of the fried products from the oil bath, the basket was left to drain for 1 min at room temperature, and the samples were placed on paper towels to remove excess fat, and weight.

Characterization of the fried durian chip products
The moisture content was determined in the oven at 105°C gravimetrically (AOAC, 2000). The total lipid content was extracted by petroleum ether in Soxhlet extractor (AOAC, 1996). The microstructure of fried durian chips were examined using a scanning electron microscope (model Leo 1455 Vp).

3. Results and Discussion
In this experiment, the durian chip samples were fired at 3 different oil temperatures (150, 170 and 190°C) for 10 min. Frying in hot oil at these temperatures is characterized by drying velocities too high (Baumann and Escher; 1995). This fast drying is critical to improve the mechanical and structural properties of the final product. These conditions lead to high heat transfer rates, rapid cooking, browning, texture and flavor development.

Figure 1 shows that for frying temperature of 150°C, both moisture content and oil absorption of 3-mm durian slices changed with time. When the samples were fired for 10 min their moisture content decreased from around 60% to about 6%. Fried products contained significant amount of fat, reaching almost 1/3 of the total food product by weight. The same trend was found for the other oil temperatures tested. Most of the oil in the fried piece surface does not penetrate during frying and it adheres to the piece surface at the end of the frying and high proportion of it penetrates into the food microstructure during post-frying (Aguilera and Gloria-Hernandez, 2000; Bouchon et al., 2003).

Oil uptake of fried samples with durian seed starch coating was lower than the controls especially during the first 2 min of the frying process (Figure 2). The highest oil reduction upto 80% was found for 150°C oil temperature frying. This result indicated that durian seed starch film might form a protective layer and consequently prevent the oil penetration into the fried durian chips. In addition, it was more effective for limiting fat uptake at the lower frying temperature (150°C) than those fried at higher temperatures (170 and 190°C).

The coated samples appeared to be soggy and less brown when compared to the control samples. Fried food color is the result of Maillard reaction (Marquez and Anon, 1986) that depends on the superficial reducing sugar and asparagines content, and the temperature and frying period. The inner crust morphology of fried durian chips was measured by scanning electron microscope. The uncoated sample showed ruptured cells with large void spaces due to migration of water. In contrast, the coated sample showed a higher degree of cellular integrity, which might explain the results of differences in fat uptake (Figure 3).
4. Conclusion
Durian seed starch was extracted and formulated to be the edible films, applying to reduce fat uptake of the durian chip in frying. The coating efficiency depended on the temperature of frying oil. About 79.4%, 22.0% and 4.5% of fat contents were reduced by frying for 2 min at 150, 170 and 190°C, respectively. This means that durian seed starch can form a protective layer between food samples and frying medium, and can be applied to the food industry as frying materials to reduce fat uptake.

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![Figure 1](image1.png)
**Figure 1** The change of crude fat and moisture contents during deep-fat frying process of the durian chip at 150°C oil temperature for 10 min

![Figure 2](image2.png)
**Figure 2** Effect of the durian seed starch film on oil reduction efficiency during frying at different oil temperatures for 2, 4 and 6 min
Figure 3 Scanning electron micrographs of cross section areas of (a) uncoated and (b) coated durian chips fried at 150°C for 2 and 6 min

References