PHYSICAL STATE CHANGE OF FOOD IN DEEP-FAT FRYING AND OIL ABSORPTION MECHANISM

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by

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ABSTRACT

Deep fat frying is the unit operation that widely used in food preparation because this method is the short time process for dehydration, and provided the crispy texture and the unique flavor product. However, the oil absorption in fried food is considered to induce the health problems. Therefore, the reduction of oil content in fried food was extensively investigated. From the previous researches; they reported that there are many factors influence on oil absorption through the process, such as the food composition, moisture content, quality of frying oil, frying temperature and duration, shape of food, and surface roughness. However, the systematic understanding for the mechanism of oil uptake is still unclear. Until now, it is considered that the oil uptake occurs in both processes of frying and post-frying. Furthermore, the existing knowledge of oil absorption depends on the kind of product and is limited in the narrow range of initial moisture content. The objective of this study is to understand the oil absorption mechanism during frying and post frying process more generally, from dough to batter in the wheat flour model food.

In Chapter 3, the state diagram of the model-frying products was constructed in order to determine the physicochemical changes in wheat flour included melting and glass transition temperature. As a result, the frying pathway was established on the state diagram of wheat flour for describing the microstructure formation of fried food. At the initial stage of frying the samples looked alike leathery, which is defined as rubbery state. The enlargement in porous structure continuously extended when the sample is in the rubbery state. As the frying time prolongs, the products turns into glassy state due to decrease in water content, resulted in the ceasing of porous enlargement. This study revealed that physicochemical changes during frying influence the alteration of microstructure and quality of fried food, and the state diagram could be applied to explain the formation of microstructure during frying process.

Oil absorption in frying process was investigated in Chapter 4. The initial moisture content on wheat flour-water model food was adjusted to be 40-80%. The results revealed that the absorbed oil content for all moisture content samples was a function of frying time. The amount of absorbed

oil in 80% sample was lower than the other three samples. In the sample containing 40-70% initial moisture, all products possessed the developed structure with the difference in pore size. On the other hand, the less pores were observed in 80% sample. The difference in the initial moisture content affected the starch gelatinization, and consequently caused the microstructure formation. The number of pores and pore size affected the amount of oil absorption during frying process by capillary action.

In Chapter 5, the oil absorption in wheat flour-water model food of wheat flour model with the various moisture contents in post-frying process was investigated. The surface roughness of the fried sample was evaluated by fractal analysis. The results revealed that the surface roughness that was generated during frying increased as the sample's initial moisture was increased. Surface roughness affected the amount of oil located on the sample surface, so-called adhered oil. The amount of adhered oil at initial cooling stage was higher for the high initial moisture content sample than that of the lower initial moisture content sample. As cooling progresses, the surface oil is absorbed by the sample in proportion to the fractal dimension and the initial moisture content. Thus, the adhered oil on the surface decreased with cooling time, however, the absorbed oil increased. From this study, it was found that the majority of oil absorption during frying process occurred in the 40 and 60% sample, while for 80% the majority of oil penetration took place in post-frying process.

The possibility to reduce oil absorption and improve fried food quality by using ball milled wheat flour in the fried sample was investigated in Chapter 6. The absorbed oil content in 40% sample made of ball-milled flour was higher than that in the sample prepared from the native wheat flour. While the result in 60% sample was in the opposite way. The oil absorption in both samples was the result from the microstructure that was generated during frying. The 40% sample made of wheat flour with higher ball milling time provided the smaller pore, while the 60% sample made of wheat flour with higher ball milling time gave the larger pore. The lower pore size resulted in the higher oil absorption. This suggests that capillary action govern the oil uptake in frying process. Using the ball milled wheat flour in fried sample containing 60% initial moisture provided the low-fat fried food. Moreover, the yellow-brown color in this sample developed in the shorter frying time.

The present study clearly brought out a systematic information on oil absorption mechanism. The physicochemical changes governed the microstructure structure and consequently oil absorption both in frying and post-frying process. Furthermore, it was suggested that the using the ball-milled wheat flour in the fried batter could provide the low-fat fried food with the better quality parameters. These results manifested the oil absorption mechanism, and could be the knowledge for controlling the oil absorption in commercial fried food products for response to the consumer desired.