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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

A method for extracting aroma compounds from edible oils/fats and high-fat foods
（食用油脂および高脂肪食品からの香気成分抽出法）

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Fat is an essential nutrition for us and is mainly used for energy and a component of cell membrane. In general, oil-enriched foods such as chocolate and potato chips are palatable for us. Volatile compounds (aroma compounds) in food affect the palatability and eating behavior. Therefore, understanding the native aroma profile of the foods is important for food science and health science. However, volatile compounds in edible oils/fats and high-fat foods are poorly understood due to a strong matrix effect of oils/fats (middle- and long-chain triacylglycerols). To reveal the native profile of volatile compounds in edible oils/fats and high-fat foods, an effective approach is desired.

The aim of this study was to develop an effective method for isolation of volatile compounds from oily samples with the strong matrix effect. A big gap among the partition coefficients (log *P*) of triacylglycerols and volatile compounds was focused to separate volatile compounds from the oily matrix. Using a model study, cocoa butter (long-chain triacylglycerols) changed the ratio of the hexane-methanol bilayer solution, resulting in that liquid-liquid extraction can be performed. In addition, the triacylglycerols were maintained in the hexane layer, and volatile compounds were pushed out into the methanol layer using recovery test. This phenomenon is similar to the “salting-out effect” of chemicals in aqueous solution by adding sodium chloride (Na^+ and Cl^-). As with the salting-out effect, adding extremely low polarity compounds to the hexane layer may change the polarity of the hexane layer and push out relatively hydrophilic compounds into the methanol layer. This phenomenon, the “oiling-out effect”, was demonstrated and defined.

The oiling-out assisted liquid-liquid extraction (OA-LLE) proposed here was able to isolate a wide range and large number of volatile compounds from only 5.0 g of oily samples (dark chocolate, extra virgin coconut oil (EVCO), extra virgin olive oil (EVOO), and beef tallow). Compared with the conventional methods, the extraction efficiency was dramatically improved using OA-LLE. OA-LLE consists of two small scale LLE and there is no heating process. With regard to EVCO, the sensory analysis revealed that the aroma extracts had a similar aroma of the reference sample (EVCO). From the result of GC-MS analysis, 44 volatile compounds in EVCO were identified and the ratio of the enantiomers of δ-lactones was revealed. Using odor activity value (OAV), 14 potent aroma compounds for EVCO were also determined. To the best my knowledge, this is the first report on the potential odorants and the enantiomer ratio of δ-lactones for coconut oil. By combining OA-LLE and solvent assisted flavor evaporation (SAFE), OA-LLE followed by SAFE (OA-LLE + SAFE) was also developed for extracting volatile compounds from EVOO. OA-LLE + SAFE allowed us

to obtain aroma extracts in which non-volatiles were completely removed. Since the dichloromethane layer of OA-LLE did not contain triacylglycerols, it was able to carry out without decreasing the performance of SAFE. Using OA-LLE + SAFE, 41 of volatile compounds were identified in the aroma extracts obtained by only 5.0 g of EVOO. For gaining a deeper insight into the aroma profile of EVOO, OA-LLE × 3 + SAFE were also demonstrated. It is worth mentioning that some semi-volatiles such as nonanoic acid and methyl palmitate were also recovered. There were many kinds of aroma compound exceeding RI 2000. We have focused on the C5 and C6 aliphatic aroma compounds in EVOO so far. In this study, additional potential aroma compounds in olive oil were revealed. To characterize the flavor property of oily samples, we should focus on not only volatile compounds but also semi-volatile compounds and compounds with high affinity for triacylglycerols.

OA-LLE has overcome the strong matrix effect of the oily matrix, resulting in that an extraction efficiency was dramatically improved. These findings indicate that the method based on the oiling-out effect is useful to understand the aroma profile of edible oils/fats and high-fat foods. Moreover, OA-LLE can be applied for various kinds of fat-rich foods. OA-LLE should help to investigate the native aroma profile of edible oils/fats and high-fat foods and will encourage researches in the fields of food science, its industry, and health science.