Drying behavior of a Japanese dry-cured meat model in the different drying conditions

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Objectives: Drying operations are important processes in the food industry. The drying process of meat processing results in microbial control and appreciated flavor, but under-drying and over-drying must be avoided to preserve hygiene and quality. To control hygiene and the quality of dried meat product, it is important to optimize the drying process. The aim of this study was to deter- mine the effective moisture diffusivity of a Japanese dry-cured meat model containing uniformly distributed brine under different drying conditions. The moisture transfer was discussed in relation to the changes in the activation energy, and the moisture distribution inside a Japanese dry-cured meat model was determined by magnetic resonance imaging. Furthermore, the energy consumption in the different drying conditions was evaluated in the context of practical applications.

Materials and Methods: A model of Japanese dry-cured meat was prepared by mixing minced pork meat and brine. The mixture meat was placed into a water-vapor-permeable casing (50 mm in diameter and 100 mm in length) by using a stuffing machine, and this was used as a cylindrical sample for the drying experiments. A constanttemperature, constant-humidity chamber (PDR-3J, ES- PEC Corp., Japan) was used for the drying experiments. The three samples were suspended in the drying chamber. The drying experiments were performed at temperatures of 18°C, 27°C, and 35°C and relative humidity (RH) values of 10%, 40%, and 70%. The effective moisture diffusivity during the drying experiment was calculated by the approximate formula of Carslaw and Jaeger (1959) and Konishi *et al*. (1999). ^{1}H nuclear magnetic resonance imaging was performed with a nuclear magnetic resonance spectrometer (DRX 300WB, Bruker, Germany). The total energy consumption was calculated by integrating the time up to a moisture content 175%-dry basis of the samples.

Result and Discussion: In terms of drying rate, the lower the RH, the faster the drying rate at any temperature condition. Under the conditions of low RH of 10% and 40%, the drying rate at the initial stage of drying was remarkably high, and the drying rate de- creased with the lapse of the drying time. However, under the condition of 70% RH, the drying rate decreased steadily from the initial stage to the late stage of drying, and no rapid change in the drying rate was observed. As regards effective moisture diffusiv- ity, a higher effective moisture diffusivity was obtained at a lower RH level. The activation energy of effective moisture diffusivity at 40% and 70% RH increased with decreasing moisture content and was almost constant in the late stage of drying. Therefore, the moisture likely diffuses without a large difference in the moisture distribution in the sample. In contrast, under low (10%) RH, the activation energy drastically increased with decreasing moisture content in the initial stage of drying. From the results of magnetic resonance imaging, the moisture content on the surface region was drastically decreased; the surface region was dried and hardened temporarily (i.e., case hardened) by the fast transfer of moisture. In the middle to late stages of drying, the activation energy gradu- ally decreased to the similar values as at 40% and 70% RH in the late stage of drying. From the results of magnetic resonance im- aging analysis after drying, the moisture distribution near the surface region no longer exhibited a sharp difference in moisture con- centration. The partly dried state of the surface region in the initial stage of drying could be alleviated by transfer of moisture from the interior of the sample. From the point of view of only energy consumption, the drying condition of 35°C and 40% RH was the most efficient.

References:

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