Dehydration and Drying Characteristics of Gingers Using Dehydrating Agent by Dextrose Equivalent and Molecular Weight Condition

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Abstract

We examined variations in ginger dehydration and recovery rate upon use of dextrose of different equivalence values. The dehydration rate varied with dextrose equivalent and the dehydration rate increased as the equivalence value increased. Both dehydration and recovery rates varied with dextrose molecular weight. Moisture content was lowest in samples prepared by freeze-drying, and neither dextrose equivalent nor molecular weight affected moisture level. Upon color analysis, ginger dried using dextrose varying in equivalence and molecular weight was similar in color to the original material, unlike ginger dried by other methods. Hot-air-dried ginger scored lowest in all sensory tests, compared with ginger prepared by molecular press dehydration using dextrose varying in equivalence and molecular weight. With respect to the appearance of ginger, freeze-dried samples were optimal, but molecular press dehydration yielded samples that scored best upon overall evaluation. When all quality evaluation items were taken together, molecular press dehydration resulted in a better quality product than the older hot-air or freeze-drying methods.

Key words: dextrose equivalent, molecular weight condition, maltodextrin, polyethylene glycol

Introduction

Ginger (Zingiber officinale Roscas) is native to tropical and subtropical area including Egypt and Iraq and is a rhizome of perennial herbaceous plant belonging to Zingiberaceae that has been grown from the prehistoric times (1). It acts as a spice and has functions for various medical actions and protective actions for a living body as it contains unique flavor and taste (2,3). Seosan, Chungchon-mo and Wanju, Jellahugdo area produce 40,000 tons of gingers, which account for 95.6% of the total production (4). Gingers have physiological disorders below 10°C and germinate at temperatures above 18°C, which makes it difficult to store and dry for long term storage (5). Typical drying methods used for vegetables and fruits among food to increase the storage period are heated-air drying, freeze drying, and osmotic drying (6). Heated-air drying is a simple treatment and one of the economic methods among the existing drying methods but can loose color, nutritive components and taste by the high temperature during the drying period and cause a resiliency problem by the rapid contraction of the cellular tissue (7). Freeze drying makes up for the shortcoming of heated-air drying with less loss of taste, flavor component and functional component and has advantage not to destruct much cellular tissues. Osmotic drying minimizes the damage of color, taste and flavor by the heat and prevents discoloration during the drying. It also is a drying method to remove sour
taste and increase sweetness enhancing the preference but it can reduce the dehydration efficiency by the separation of cell membrane and can cause degradation of sample quality (9). Recently, molecular press dehydration (10), a new drying method using the cytoryhysis by the pressure generated between the cell walls without causing separation of cell membrane is being utilized by using maltodextrin to supplement the impregnation soaking process with the solute bigger than the size of sample hole. This molecular press dehydration was also reported by Lee et al. (11) who studied quality characteristics of ginseng powder. Therefore, in this study, the drying method of molecular press dehydration was applied to dry gingers different from previous drying methods to prepare drying characteristics by the maltodextrin equivalent which was applied as the dehydrator, and to prepare drying characteristics by the molecular weight condition of the Poly Ethylene Glycol. The possibility to maximize the dehydration condition and the quality evaluation was also conducted in the study.

Materials and Methods

Experimental and materials

The ginger used in the experiment was harvested in 2009 in Seosan City, Chungcheongnam-do (producer: Seosan Ginger Cluster Agency). The ginger prepared by Seosan Agricultural Cooperative was purchased on the date of experiment at the Hanaro Mart in Seongnam. Only product with good appearance was selected and screened out gingers with any damage or decay. The Maltodextrin (Maltodextrin, Dae Sang Co., Seoul, Korea) product which was used as dehydrator were selectively purchased with moisture content (%) less than 10.0%. Maltodextrin (Maltodextrin, Sigma Co., St. Louis, MO, USA) was purchased according to Dextrose Equivalent and PEG (Polyethylene glycol) 200, PEG 400, PEG 600, PEG 4000 molecular dehydrating agent (Polyethylene glycol, DAE JUNG Chem. Co., Siheung, Korea) and PEG 1000, PEG 2000, PEG 8000 molecular dehydrating agent (Polyethylene glycol, Yakuri Pure Chem. Co. Kyoto, Japan) were used according to molecular equivalent.

Pretreatment of samples

To apply in the experiment, 200 g of ginger sample sliced in 1-1.5mm was applied to powder type dehydrating agent maltodextrin with D.E. values (D.E. 4~7, 9~12, 13~17, 16.5~19.5). Then, 80% (w/w) in proportion to weight was added and well mixed in LPDE container and hydrated for 7 hours with the velocity of 2-3 rpm. In the same manner, different molecular weights were applied (PEG 200, 400, 600, 1000, 2000, 4000, 8000). After hydration, the samples of dried matter and hydrated liquid was separated by centrifugation at 3000 rpm for 5 minutes. The hydrated matter was stored and dried in the incubator at 30°C. For freeze drying, 1 kg was mounted on the freeze drying shelf and was frozen at -20°C for 48 hours, followed by freeze drying in the free dryer (PVTFD100R, Ilishin Lab Co., Yangjungun, Korea) for 72 hours(heating device -40°C, 999mm torr). For heated-air drying, heated-air dryer (HK-DO1000F, Korea General Equipment Manufacturing, Hwaseong, Korea) was used at 60°C with 1 kg mounted on the rack(wind velocity 0.5m/sec). Thereafter, all dried samples were used in the product analysis.

Dehydration rate

For Dehydration rate, modified Kim et al’s method (12) was used. After mixing the input sample and dehydrating agent, the mixture was centrifuged in proportion to weight and the rate of the hydrated liquid was calculated using the following equation.

\[
Dehydration\text{rate}(\%) = \frac{\text{liquid after centrifugation}}{\text{sample + dehydrating agent}} \times 100 \quad (\text{Eq}n2)
\]

Recovery rate

For recovery rate, 50 mL of distilled water was added to dehydrated dry sample 1 g in 100 mL beaker and soaked at 25°C water bath for 60 minutes and reabsorbed. Then the sample was taken out of the bath and moisture was removed, followed by measurement of weight and the rate of recovery, which was calculated using the following equation (12).

\[
\text{Recovery\ rate}(\%) = \frac{\text{absorbed sample weight - dehydrated dry sample weight}}{\text{reabsorbed sample weight}} \times 100 \quad (\text{Eq}n2)
\]

Moisture content

For moisture content, approximately 5 g of sample was taken in a constant weight dish for each treatment and dried in the dry oven (Korea General Equipment Manufacturing, Korea). Experimental was conducted with 105°C drying method and the drying was continued until constant when the average and standard deviation was determined.