Nathdanai Harnkarnsujarit 2012: The Effect of Freeze-dried Mango Structure on β-carotene Degradation During Storage. Doctor of Philosophy (Food Science), Major Field: Food Science, Department of Food Science and Technology.
Thesis Advisor: Associate Professor Sanguansri Charoenrein, Ph.D. 190 pages.

The main objective of this research was to investigate the effect of freeze-dried food structures and water activity (a_w) on the rate of β-carotene loss as naturally dispersed in foods as well as the encapsulated components in carbohydrate systems. The research was divided in five parts which composed of the study in mango as a real food (part1 and 2) and the agar-maltodextrin-sugar (glucose, fructose and sucrose) mixtures as fruit model systems (part 3, 4 and 5). The results indicated that the degradation of β-carotene in freeze-dried materials followed first order kinetics. Freeze-dried mango powders stored at $a_w \geq 0.4$ showed the loss of initially sorbed water as a result of sugar crystallization which was confirmed by the X-ray powder diffraction as well as scanning electron microscope. In addition, increased rate of β-carotene degradation was observed above such a_w. The β-carotene loss decreased as increased a_w from 0.1 to 0.4 which was coincident with the collapse or sticky of mango powder. The various freeze-drying conditions effectively controlled the porosity and structural collapse of freeze-dried mangoes. The structural collapse of glassy freeze-dried mangoes showed an effective stabilization of β-carotene by the prevention of oxygen permeation to expose with β-carotene. Various freezing temperature and molecular size of solutes influenced the porosity and structural collapse of freeze-dried agar-maltodextrin-sugars systems. Sugars depressed the glass transition and onset temperatures of ice melting of maximally-freeze-concentrated systems and affected collapse during freeze-drying, but controlled microstructure of non-collapsed solids. In the glassy solids, pore microstructure had a major effect on stability of both crystalline and oil-dispersed β-carotene in solids. Smaller pores corresponding to thinner membrane walls and a larger surface area allowed more oxygen accessibility through solids and led to a higher β-carotene loss. The relaxation times derived from dynamic mechanical analysis correlated well to the rate of β-carotene degradation above glass transition temperature. Moreover, the coalescence of dispersed lipid increased the size of droplets and reduced surface area for oxygen exposure which effectively enhanced β-carotene stability in freeze-dried foods.

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