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RESEARCH ARTICLE

Acoustic-Assited Osmotic Dehydration of Dried Pumpkin Jam

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Abstract

Acoustic drying accelerates the mass transfer rate during dehydration. Osmotic dehydration has recently gained a significant interest. It consists of immersing the material to be dried in a hypertonic solution. Acoustic-assisted osmotic dehydration, have been implemented as an alternative pretreatment associated to drying procedures. This study focused on the synergistic effect of osmotic and acoustic dehydration in the dried pumpkin jam production. Our results revealed that pumpkin slices should be soaked in 40% sugar and then dried by convective drier for 4 hours under assistance of ultrasonic wave at frequency 37 kHz in power 500 W. From this combination, the dried pumpkin jam would be obtained with the safe moisture content and high beta-caroten retention.

Keywords: *Pumpkin, Acoustic, Osmotic, Drying, Jam, Beta-caroten.*

Introduction

Pumpkin is a large climbing herb, annual or perennial widely cultivated as vegetable in Vietnam. It's normally consumed via cooking or steaming. As a source of very high content of beta-carotene, pumpkins possess attractive color and also valuable biological properties. However it's decomposed quickly under light, heat, and oxidizing agents. The beta-carotene has a strong antioxidant capacity against degenerative diseases [1, 2]. Osmotic dehydration has ability to reduce moisture content with a significant influence on physico-chemical properties of bioproducts [3].

It involves immersing the materials in a hypertonic solution to partial removal of moisture from the immersed biomaterial. Acoustic wave affects the mass movement between solid and liquid interfaces through various physico-chemical effects via cavitation phenomena, and enhance the nutritional composition in dried foodstuffs [4, 5].

Acoustic assisted osmotic dehydration accelerates effectively the moisture diffusivity. It also changes the viscosity and surface tension, and deforms porous solid materials [6]. Acoustic-assited osmotic dehydration was successfully applied on carrot [2, 7], strawberry [8], cranberry [9], apple [10, 6], papaya [11], melon [12], pineapple [13]. Pupose of our study focused on the synergistic effect of acoustic and osmotic dehydration to the dried pumpkin jam production.

Material and Method

Material

Pumpkin fruits were obtained from Hau Giang province, Vietnam. After collecting, they must be quickly conveyed to laboratory for experiments. Chemical substances and reagents were all analytical grade supplied from Rainbow Trading Co. Ltd., Vietnam.

Researching Procedure

Experiments were executed on pumpkin slices (40 mm diameter and 5 mm thickness). The samples were subjected to osmotic dehydration (30%, 35%, 40%, 45% sugar) with and without acoustic assistance (25 kHz, 37 kHz, 40 kHz) at ultrasonic power 500 W. These samples were dried convectively at temperature 45°C for 4 hours. All treated samples were then stored in dry cool place before evaluating the beta-caroten (mg/100g), moisture content (%).

Antioxidant Capacity and Statistical Analysis

Beta-caroten (mg/100) was determined by HPLC. Moisture content was evaluated by comparison of the changed mass of samples. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Effect of Sugar Concentration as Osmotic Dehydration of Pumpkin Jam

The partial dehydration was performed by immersion of pumpkin slice in a concentrated aqueous sugar solution (30%, 35%, 40%, 45%) for 4 hours. There were two major simultaneous countercurrent flows: one flow of solutes from the solution into the food matrix and another from the food into the osmotic solution [10]. Our results revealed that 40% sugar was appropriate to create a hypertonic pressure to partialy remove moisture content in pumpkin slice ready for the next dehydration.

Table 1: Effect of sugar concentration as osmotic dehydration of pumpkin jam

Parameter		Sugar concentration (%)			
	Control	30	35	40	45
Moisture (%)	89.31±0.03^{a}	74.63±0.00^{b}	71.38±0.01^{bc}	67.45±0.00^{bc}	66.13±0.02^{c}
Beta-caroten (mg/100g)	0.61±0.02^{c}	0.95±0.01^{b}	1.19±0.00^{ab}	1.34±0.01^{a}	1.37±0.00^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Effect of Acoustic-assistic Osmotic Drying to the Quality of Dried Pumpkin Jam

Osmotic dehydration used alone during pretreatment increased total processing duration, whereas osmotic dehydration combined with ultrasonic wave during pretreatment reduced total processing duration and increased effective moisture diffusivity. Formation of microchannels through ultrasonic application and effects of osmotic pressure differential were considered to be largely responsible for reducing drying time (Juan Garcia-Noguera et al., 2010). In our research, the pumpkin slices were soaked with 40% sugar in 4 hours and then dried under acoustic wave at different frequencies (25 kHz, 37 kHz, 40 kHz) at ultrasonic power 500 W. Our findings revealed that the dried pumpkin jam would be achieved with the safe moisture content and high beta-caroten retention by the acoustic drying at ultrasonic frequency 37 kHz at 500 W (see Table 2).

Table 2: Effect of acoustic-assistic osmotic drying to the quality of dried pumpkin jam

Parameter		Ultrasonic frequency (kHz)		
	Control	25	37	40
Moisture (%)	21.35±0.03^{a}	16.59±0.01^{c}	18.64±0.03^{bc}	19.87±0.02^{b}
Beta-caroten (mg/100g)	1.84±0.02^{b}	2.04±0.00^{a}	1.95±0.01^{ab}	1.89±0.00^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Conclusion

The application of acoustic-assisted osmotic dehydration at high-frequency enhances the mass transfer rate during osmo-concentration. Ultrasound in synergistic effect with high sugar concentration accelerates the speed of moisture withdrawal from the tissue and may significantly decrease the osmo-dehydration duration. We have realized that acoustic-assisted osmotic dehydration greatly affected to moisture removal as well as beta-carotenoid content in the dried pumpkin jam.

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