Sorption Isotherm and Water Activity of Fried Durian Slice

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Abstract. *This research aimed to study the sorption isotherm and effect of water activity on crispness of fried durian slice. The water content of fried durian slice was adjusted using saturated salt solution at different relative humidity levels. The water content and crispness of fired durian slice were then evaluated. The sorption isotherm data of dried durian slice was fitted to BET and GAB models. The experimental result showed that water content of fried durian slice was in range of 0.02 to 0.13 g water/g solids when its water activity was in range of 0.20 to 0.80. BET and GAB models can be used to predict sorption isotherm of fried durian slice at R2 equal to 0.99 and 0.99, respectively. In case of crispness, the result indicated that the crispness of fried durian slice significantly decreased when its water activity increased. Moreover, the fired durian slice was not crispy when its water activity was higher than 0.64.*

Keywords:

crispness, durian, sorption isotherm

1. Introduction

After Durian (Durio zibethinus Murr) is one of the important tropical fruits in South-East Asia. It is rich in nutrients such as carbohydrate, protein, fat, phosphorus, iron, and vitamin [1]. During the harvesting season, durian is excessive which causes dropping of its price. Therefore, various value-added processes of durian were applied, especially frying process. Fried durian slice is one of the most favorite durian products. The process stars with slicing durian. Then the durian slice is deep-fried before packing in plastic bag [2, 3].

Recently, traditional packing process produces a short-shelf life of fried durian slice. During storage, texture of fried durian slice always changed, especially crispness. The instability of fried durian slice crispness causes unacceptability of customers. Therefore, the parameters affecting the crispness of fried durian slice should be studied.

Crispness is sensed through a combination of tactile, kinesthetic, visual and auditory. It represents the texture of foods products. Normally, crispness of the food products has been related to their water activity during storage [4]. Therefore, this research aimed to study at water activity of fried durian slice. The sorption isotherm of fried durian slice was presented. Moreover, crispness values of fried durian slice at different water contents were evaluated. The obtain results can be used to find approach to improve packing process of fried durian slice.

2. Experimental

2.1 Raw Material

Fried durian slice was purchased from local durian processor at Chantaburi province, Thailand. The water content of the fried durian slice was immediately evaluated.

2.2 Studying of Water Activity of Fried Durian Slice

For adsorption studies, fried durian slice was placed in the container containing P_2O_5 to reduce water content of the fried durian slice. The fried durian slice was kept in the container until its weight was constant. After that the fried durian slice samples were placed at 35˚C in the container containing saturated salt solutions including Lithium Chloride, Magnesium Chloride, Magnesium Nitrate, Potassium Iodide, Sodium Chloride and Ammonium Sulphate to receive relative humidity (RH) was ranging 20 to 80%. The samples weights were controlled until a constant value ($\Delta m < \pm$ 0.0005 g) was reached. The water activity of the samples was assumed to be equal to the corresponding RH/100. The final water contents of the samples were then measured. The BET and GAB model as following equations were used to predict water activity of the samples [5, 6].

BET model

$$W_e = \frac{W_o C a_w}{(1-a_w)(1+(C-1)a_w)} \quad (1)$$

Where; W_e is water content (g water/g solids), a_w is water activity, W_o is monolayer water content (g water/g solids), and C is sorption energy constant.

GAB model

$$W_e = \frac{W_o C K a_w}{(1-Ka_w)(1+(C-1)Ka_w)} \quad (2)$$

Where; W_e is water content (g water/g solids), a_w is water activity, W_o is monolayer water content (g water/g solids), C is constant related to monolayer sorption heat, and K is constant related to multilayer sorption heat.

2.3 Crispness Measurement

A compression test was performed to analyze the crispness of fried durian slice samples. The test was performed using a texture analyzer (Stable Micro Systems, TA.XT. Plus, UK). One piece of sample was placed on a hollow base. A 5-mm spherical probe was used with a constant speed of 2 mm/s until the sample was cracked. The numbers of peak in the force-deformation curve of the sample were investigated. The value was considered as the crispness of the sample.

2.4 Statistical Analysis

All experiments were performed in triplicate. The obtained data were analyzed using an analysis of variance. Duncan's multiple range test was used to establish the multiple comparisons of the mean values at 95% confidence level.

3. Results and Discussions

3.1 Water Activity of Fried Durian Slice

Water adsorption isotherms of fried durian slice was presented in Fig. 1. It exhibited sigmoid shape behavior. The fried durian slice showed the typical behavior of product containing high sugar content. In the low aw range, the equilibrium water content slow increased. A sharp increase was exhibited at intermediate and high aw values due to the prevailing effect of solute-solvent interaction that associated to sugar dissolution [7, 8, 9, 10].

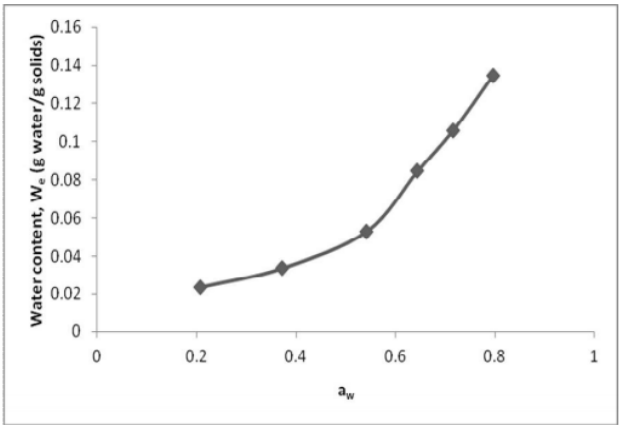

Fig. 1: Sorption isotherm of fried durian slice

The parameters in BET and GAB models were shown in Table 1. For the BET model, the monolayer water content (*Wo*) was 0.03 g water/g solids. The value revealed the amount of water that was adsorbed to specific sits on the food surface and had related to food stability. In case of sorption energy constant (*C*), the value was 6.04. Brunauer et al. [11] classified that the sorption isotherm that has sorption energy constant higher than 2 is sorption isotherm type II.

In term of GAB model which has been used to predict sorption isotherm in water activity range of 0.1 to 0.9 [12]. The monolayer water content (*Wo*), constant related to monolayer sorption heat (*C*), and constant related to multilayer sorption heat (*K*) were 0.05 g water/g solids, 2.14, and 0.90, respectively. This parameter values were different from the parameter values of BET model. The reason may be both model can used to predict sorption isotherm in difference range of water activity.

Table 1: Parameter values of the models fitted to experimental water activity results

Models	Parameters	Values
BET	W_o (g water/g solids)	0.03
	C	6.04
	R^2	0.99
GAB	W_o (g water/g solids)	0.05
	C	2.14
	K	0.90
	R^2	0.99

3.2 Effect of Water Activity on Crispness of Fried durian slice

The crispness values of fried durian slice samples at different water content were shown in Fig. 2. The values were in the range of 0 to 35. The results showed that the water content significantly affected on the crispness of fried durian slice. The crispness value of the fried durian slice decreased with increasing of it water content. This might be due to the plasticizing effect of water that affected on glass transition temperature of fried durian slice.

As in Fig. 2, the crispness values of fried durian slice could not be measured when the water activity of the fried durian slice more than 0.64. The results indicated that the fried durian slice was not crispy when the water content more than 0.08 g water/g solids. However, the result should be compare with the sensory results.

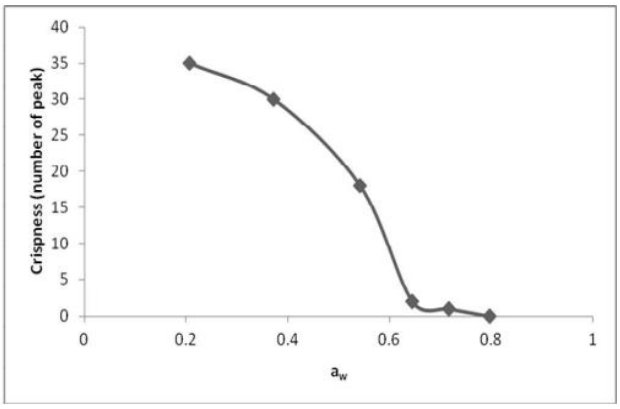

Fig. 2: Crispness of fried durian slice at different water content

4. Conclusion

From the results, sorption isotherm of fried durian slice was classified as sorption isotherm type II that usually found in fruits and vegetables. BET and GAB models can be used to predict sorption isotherm of the fried durian slice. The relation between water content and crispness of fired durian slice was found. The crispness of fried durian slice reduced which increasing of its water activity. The fried durian slice was not crispy when the water content more than 0.08 g water/g solids.

5. Acknowledgement

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Biography

Sawanit Aichayawanich received her bachelor degree in Food Science and Technology from Thammasart University, Thailand. She received his master degree and doctoral degree of Engineering, in Food Engineering from King Mongkut's University of Technology Thonburi, in 2003 and 2010. She is currently a lecturer at the Industrial Technology and Management, King Mongkut's University of Technology North Bangkok, Thailand. Her research interests include starch technology, food engineering, food science and technology.