Effect of calcium chloride and freezing on vacuum fried okra quality

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Abstract

The research was designed to determine the effect of calcium chloride and freezing as a pretreatment method for improving the crispness attribute of vacuum fried okra. The experiment was conducted by blanching the okra in calcium chloride solutions (0.5, 1.0 and 1.5% w/v) at 100°C for 90 sec. Then product was frozen by using air blast system with the varying conditions of –20, -25 and -30°C for 4 and 6 h. After that, it was vacuum frying at 80°C for 2 h. The hardness and crispness value, color (CIELab), moisture and fat content, including sensory qualities of vacuum fried okra were monitored. The study results unveiled that the increasing in calcium chloride concentration and freezing level improved crispness value of vacuum fried okra. The moisture content and sensory qualities of those treatments were decreased, while fat contents were increased. The higher level of calcium chloride concentration induced increasing in brightness (L*) value, meanwhile the higher level of freezing induced decreasing in brightness. According to the results, the complete treatments for producing vacuum fried okra could be achieved by blanching with calcium chloride solution at 0.5% w/v for 90 sec. Following the frozen step, the samples were frozen at -30°C for 4 h and were then, finally, vacuum fried at 80°C for 2 h.

Keywords: calcium chloride, freezing, vacuum fry, crispness

1. Introduction

Okra (*Abelmochusesculentus* L.) is one of the most important vegetables in Thailand because of its economic value and nutritional content (Arlai et al., 2012). However, the okra has a limit shelf life and extremely perishable inducing the low economic value. Therefore, several processed okra are accomplished, especially in small scale industry as a vacuum fried product. One of the significant problems of the product is losing of crispness attribute after frying processed. This influences on the storage life and undesirable characters. There are numerous studies have reported that pretreatment conditions before processing can improve the texture of processed fruit and vegetables, e.g., applying calcium chloride, blanching, osmotic pressure and

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frozen raw material etc (Shyu and Hwang, 2001; Irfan et al., 2013; Troncoso et al., 2009; Galetto et al., 2010). Therefore the purpose of this study was to investigate the effect of blanching and freezing okra prior to vacuum fried on quality and texture attributes of final product.

2. Materials and Methods

2.1. Effect of calcium chloride on vacuum fried okra quality

Okra (*Abelmochusesculentus* L.) was purchased from Ladsakae cooperation group, Banglan district, NakhonPathom province, Thailand. The okra was cleaned, sorted (7-8 cm. length) and graded for uniform color and free of defects. Samples were blanched in hot calcium chloride solution with various concentrations (0.5, 1.0and1.5% w/v) for 90 s. then, were air blast freezed at - 25°C for 4hr. For each treatment, the okra with 400- 600grams per replication was vacuum fried (ONV-15i, Thailand model) at 80°C for 2 hr. The machine was maintained at 760 mmHg absolute. The experiment was carried out by complete randomized design with three replications. Duncan New Multiple Range Test at the 95% significance levels was evaluated to determine the statistical significance of differences among mean samples.

2.2 Effect of freezing on vacuum fried okra quality

Okra from the suitable treatment by 2.1 was used in the experiment. It was performed by air blast freezing with varying temperatures (-20, -25 and -30 °C) and the time of freezing (4 and 6 hr). The statistical randomized factorial experiment design was used to analyze the treatments at 3x2 type design with 6 experiments run. The statistical significance of the effects of the factor and their interaction was analyzed by Duncan New Multiple Range Test at 95% confidence level.

2.3 Analytical method

Color: Color parameters (brightness *(L*),* redness*(a*)* and yellowness*(b**) were measured with a Hunterlab (Miniscan XE Plus) colorimeter. The instrument was standardized each time monitoring. Samples were scanned at 30 different locations as the average data. Five samples from each treatment were used for evaluation.

Texture: Attributes related to texture were evaluated using a TA-XT plus texture analyzer (Stable Micro system, UK). It was done at room temperature by a cutting probe (HDP/BS) in order to evaluate hardness and crispness values. Test results were conducted using 5 replicate samples.

Moisture content: The moisture of samples was determined by hot air oven according to AOAC (1995). Measurements were done at least in triplicate with sample sizes of 10 g per time.

Crude fat: The fat content of vacuum fried okra was determined using a Soxhlet extraction with petroleum ether as solvent (AOAC, 1995). Measurements were also made at least in triplicate.

2.4 Sensory evaluation

Fifteen trained panelists scores the sensory quality of the vacuum fries okra on the color, undesirable flavor, crispness, taste, appearance and overall preference attributes. A nine-point hedonic scale was used for evaluation the sample. A score 1 represented attributes most disliked and a score 9 represented attributes most liked, meanwhile a score 5 were considered acceptable.

3. Results and Discussion

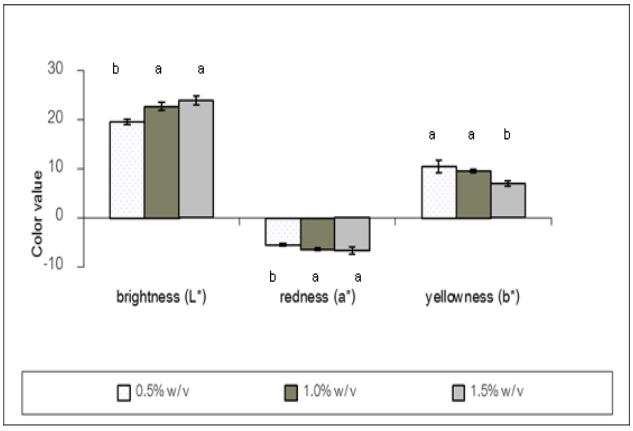
3.1. Effect of calcium chloride on vacuum fried okra quality.

Table 1 presents the effect of calcium chloride on the crispness, amount of moisture and fat content on vacuum fried okra. The moisture content and hardness value were increased with increasing calcium chloride concentration, but the crispness value (showing by slope and number of peak in texture analysis which data was not shown in the paper) and the fat content were decreased. The reason why the study result unveiled like above mentioned was the interacted calcium ion performed as cross bridge among polygalacturonides polymers in the cell wall inducing the formation ofegg–box structure (Belitz et al., 2009) and maintaining the cell wall integrity. From the earlier reasons, the cell wall structure was strengthened and it, then, caused tolimit the amount of water evaporating out from food. Furthermore, the oil uptake of the final product was also noticed to be less. These results were in agreement with recent involving researches (Rastogi et al., 2008; Galetto et al., 2010; Irfan et al., 2013). Additionally, the study result also expressed that the color, the brightness and the redness value were increased, but the yellowness value was decreased with high calcium chloride concentration on the vacuum fried okra (Fig. 1). This result could be explained that the high amounts of calcium deposition in the cell wall of treated okra was performed as egg box which could maintain and release sugar less on the vacuum fried okra (Irfan et al., 2013). This phenomenon led to eliminate the Maillard reaction during the frying. However, the sensory evaluation (Fig. 1) showed no significant effect ($p>0.05$), exceptionally color and crispness characteristics were significantly scoring decreased when the calcium chloride levels was

increased ($p \leq 0.05$). Those effective treatments were calcium chloride at 0.5 and 1.0% (w/v) concentration.

Table1. Comparison among hardness value, moisture and fat content of the vacuum fried okra after blanching in different calcium chloride concentrations. The data was recorded from 400 g okra per replication.

Calcium chloride concentration (%w/v)	Hardness (N)	Moisture content (% wet basis)	Fat content (% wet basis)
0.5	$10.81^{b} \pm 0.87$	$4.69^{b} \pm 0.30$	$39.07^{a} \pm 0.65$
1.0	$12.33^{ab} \pm 1.50$	$5.20^{b} \pm 0.12$	$38.48^{ab} \pm 0.50$
1.5	$13.88^{a} \pm 0.91$	$6.23^{a} \pm 0.42$	$37.71^{b} \pm 0.27$



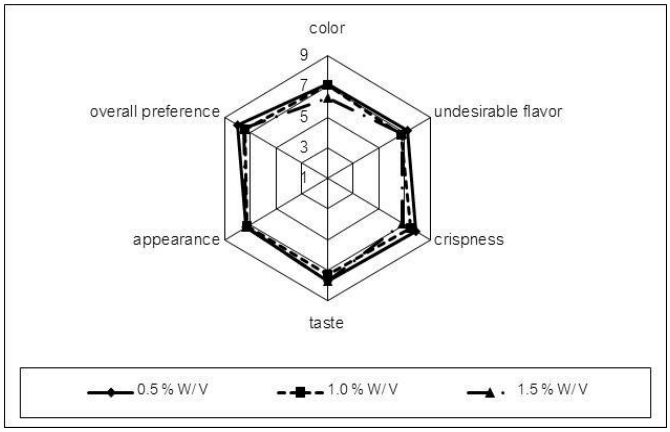


Figure 1. Changes in color and sensory qualities of the vacuum fried okra as affected by blanching in different calcium chloride concentrations.The different superscript (a,b,c..) in row means the average values were significant difference at 95%.The data was recorded from 400 g okra per replication.

3.2. Effect of freezing on vacuum fried okra quality.

The effective treatment of calcium chloride concentration was applied prior to freeze the product. The blanched okra with 600 g per replication was frozen at different temperatures and periods. The moisture content and hardness value were significantly decreased affecting by those treatments (Table 2), meanwhile the data indicated that the treated sample had higher value in crispness and fat content. These results might be caused from small ice crystal growing during the freezing step and the mechanism during vacuum frying (Saguy and Pinthus, 1995). The freezing

led to cell membrane breakage (Chassagne-Berces et al., 2009), it, consequently, decreased hardness value toward the strong freezing level. During the frying, the heat transfer was induced the water to more evaporate out from the product, to reduce water content, but increased the porosity, crispness characteristic and oil up take on vacuum fried okra (Krokida et al., 2000). The result was conformed to Galetto et al. (2010) that was the application of calcium chloride combined with freezing providing significant benefit in maintaining firmness of strawberries. By the way, the result also showed the brightness value were decreased, but the redness and the yellowness values increased with increasing the temperatures and periods of frozen ($p \leq 0.05$) as shown in fig. 2. This could be reasoned that the ice crystal increased the liquid concentration in cell tissue. This phenomen on induced to increase the browning reaction during vacuum frying (Leszkowial et al., 1990). The sensory analysis showed that effect of freezing was no significant effect on vacuum fried okra quality ($p>0.05$), but the crispness and overall appearance had highest hedonic scoring with freezing at the condition of -30°C and freezing about 4 h.

Table2. Comparison among hardness value, moisture and fat content of the vacuum fried okra after freezing in different temperatures and times. The data was recorded from 600 g okra per replication.

Treatment	Hardness (N)		Moisture content (% wet basis)		Fat content (% wet basis)	
	4 hrs	6 hrs	4 hrs	6 hrs	4 hrs	6 hrs
-20 ºC	19.51^{aA} ±0.30	17.03^{bA} ±0.22	10.87^{aA} ±0.28	9.97^{bA} ±0.09	29.33^{bC} ±1.03	31.32^{aC} ±0.72
-25 ºC	16.69^{aB} ±0.49	15.20^{bB} ±0.40	9.69^{aB} ±0.59	8.43^{bB} ±0.11	31.62^{bB} ±0.59	32.32^{aB} ±1.40
-30 ºC	13.80^{aC} ±0.44	12.60^{bC} ±0.54	8.24^{aC} ±0.09	6.17^{bC} ±0.28	33.64^{bA} ±1.25	35.82^{aA} ±1.34

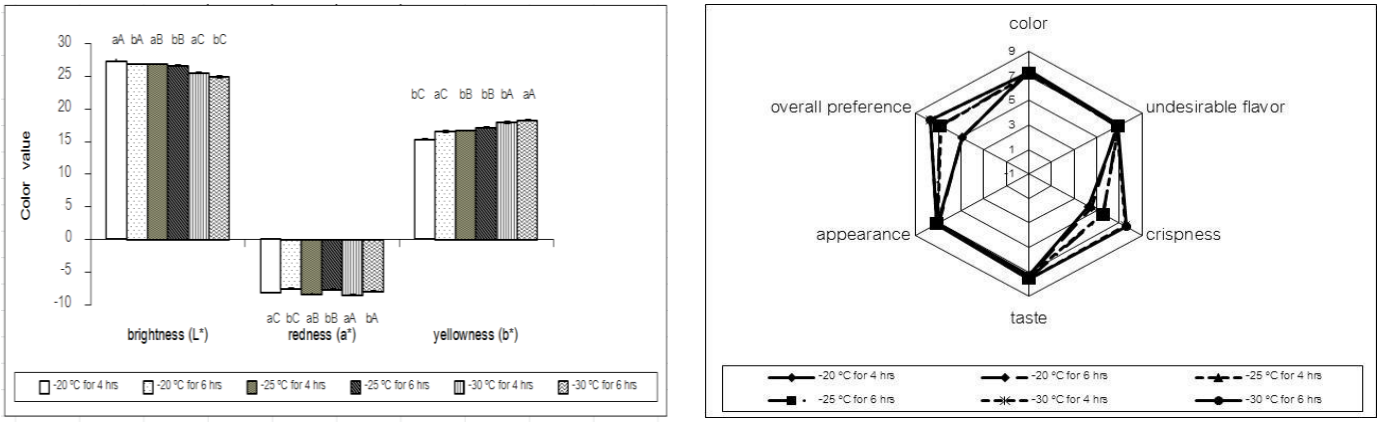


Figure 2. Changes in color and sensory qualities of the vacuum fried okra as affected by freezing in different temperatures and times. The different superscript (a,b,c..) and (A,B,C..) in row and column mean the average values from hour and temperature parameters, respectively, were significant difference at 95%.The data was recorded from 600 g okra per replication.

4. Conclusion

The high calcium concentration and strong freezing level could improve the vacuum fried okra quality especially in points of crispness and sensorial attributes. The effective treatment of improving the vacuum fried okra quality was done by the condition of the blanching okra with calcium chloride at 0.5 % (w/v) for 90 s, freezing the product at -30 °C for 4 h and frying treated okra with vacuum frying machine at 80 °C for 2 h. However, the future research should study in details of interaction between perceived texture and microstructure.

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