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Acceptability of Vacuum-fried Squash (*Cucurbita maxima*) Using Three Process Schedules

Elvi C. Escarez, Ronie F. Magsino, Mario A. De Castro Jr.*

Mindoro State College of Agriculture and Technology – Calapan City Campus, Masipit, Calapan City, Oriental Mindoro, Philippines
*Corresponding author: mcc.research01@gmail.com

Abstract A healthy alternative way of reducing the oil content while retaining the nutritional content of the food could be achieved through vacuum frying. This study aimed to develop a value-added product to squash through the adoption of the vacuum frying technology introduced by the DOST. This specifically determined the acceptability of the quality attributes of vacuum fried young squash and its hypothesized differences in terms of color, taste, texture, and general acceptability by employing the three process schedules. Three batches of thinly sliced frozen squash were fried under vacuum at 80°C for 20 minutes; 90°C for 15 minutes; and 100°C for 10 minutes. The vacuum fried squash were subjected to sensory evaluation of its quality attributes in terms of color, taste, texture and general acceptability using the 9-point Hedonic Scale by the selected panelists (n=30) who were considered as potential customers. Results of the sensory evaluation showed that the quality attributes of the vacuum fried squash were liked very much by the panelists however, significant differences existed in terms of the color and general acceptability of the product. The panelists considered vacuum fried squash which were subjected to the first and second process schedules acceptable.

Keywords: *vacuum frying, squash, department of science and technology*

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1. Introduction

Vacuum frying of vegetables is a healthy alternative way of reducing the oil content while retaining the nutritional content of the food. It offers natural taste while enjoying the crunchy bite of the product. Processed vacuum fried products may vary from fruits, vegetables, fish or even meat. It was found out that the higher the frying temperature, the shorter is the frying time [1]. These two are inversely proportional to each other. The vacuum frying time is shortened if the temperature is increased and vice versa. To produce chips with lower oil content and with good color and texture, vacuum frying could be considered as a feasible alternative [2]. Vacuum frying at 84.53°C temperature and 40 mbar pressure for 18 minutes might produce pumpkin chips with acceptable quality. Among the quality attributes being considered are the color, taste, crispiness and general acceptability of the product. Mehrjardi, Tarzi, & Bassiri [3] found that 60% of water content was exited from pumpkin slices during vacuum frying and around 20% of oil was absorbed by fried slices. Moisture content needs to be lowered to lengthen the shelf life of the vacuum fried products. In addition, if 80% of the oil is being recovered through the use of vacuum fryer spinner, this will ensure that the products will really contain less oil in it.

Delightful snacks may or may not always be healthy. Normally, fried snacks are tasteful but not ideal for human consumption due to its high fat content [4]. As a general rule in dealing with lipids, it is recommended to make the intake of low density lipoproteins (LDL) low while high density lipoproteins (HDL) high. The HDL serves as good cholesterol in our body while the LDL serves as bad cholesterol which can cause constriction of the blood vessels.

Cucurbita maxima or squash is a chief source of vitamin A. Squash fruits contain some nutritional compounds for human feeding such as moderate quantity of mineral salts like Potassium (K), Phosphorus (P), Magnesium (Mg), Iron (Fe) and Selenium (Se), while the seeds contain unsaturated fatty acids and some minerals. Pumpkin fruits are rich sources of vitamins C, E, B_6, K, thiamine, riboflavin, and niacin. With such a rich chemical composition, pumpkin offers a valuable component of a human diet, showing not only antioxidant and anti-cancer effects but also hypoglycemic and anti-inflammatory properties [5]. Filipinos commonly regard squash as chief source of anti-night blindness vitamin. It is eaten cooked as an immature fruit which is rich in fibers and vitamins. Some find it more nutritious to include the squash skin specifically when the fruit is still young. Winter squash fruit flesh also contains a large amount of free sugars (glucose, fructose, sucrose) and polysaccharides (starch: amylose and amylopectin, cellulose, hemicelluloses) and provides a valuable source of dietary fibre. The presence of these free sugars causes the change in color when the fruit is vacuum fried. In addition, the mature seeds of the squash rich in oil and protein [6] are one of the many healthy seed snacks produced in the country.

The climate variability has been harsh on crop productivity and fisheries. Studies show that if this persists, there is a considerable consequence to food security [7]. In order to meet the need for food security, the Batangan tau-buid and the Buhid Mangyan in Baco, Oriental Mindoro grow crops of corn and sweet potato near their huts. They also plant cassava, rice, bananas, papayas, avocados, squash, beans, taro, and other vegetables as supplements to their staple food [8]. Other plants cultivated by the Tau-buid in Pinamalayan, Oriental Mindoro include sugarcane (tamis/ngawe), squash (badu), bottle gourd (baringan), cucumber (unduy), eggplant (talung), pigeon pea (adius), cow pea (lumabing) and lima beans (taptu) [9]. The Department of Agrarian Reform (DAR) recently signed an agreement with the City government of Calapan for the construction of a squash processing center to help increase the income of Agrarian Reform Beneficiaries (ARBs) involved in squash farming. Under the agreement, the DAR will shoulder P480,000.00 while the city government of Calapan will shoulder P120,000.00.The squash-canton production project in the said barangay will employ 40 women members of Guinobatan ARC Cooperative (Garcco) who are directly involved in squash-canton processing, and 25 squash and malunggay ARB-growers [10]. With this, the city government of Calapan is trying to increase the aquash production and at the same time sustain the livelihood project initiated by DAR.

With the Department of Science and Technology-High Impact Technology Solutions (DOST-HITS), localized food processing equipment, various native and popular food products are processed and come in new form and flavor, and appropriate packages for longer shelf life. The processing is done in the established FICs in selected regions of the country, where the DOST - developed food processing equipment (FPE) are installed [11]. Region IV-B MIMAROPA Food Innovation Center located at Mindoro State College of Agriculture and Technology-Calapan City Campus assists the needs of people in the region in terms of processing and product development.

2. Objectives of the Study

The study aimed to develop a value-added product to squash through the adoption of the vacuum-frying technology introduced by the DOST. Specifically, it aimed to determine the acceptability of the quality attributes of vacuum-fried young squash in terms of color, taste, texture and general acceptability using three process schedules and determine the degree of variation among the quality attributes of vacuum-fried squash.

3. Materials and Methods

3.1. Materials

Squash were purchased directly from the farmers in Naujan, Oriental Mindoro. Palm oil was purchased in the different Malls in Calapan City. Freshly-thin cut squash were weighed and packed in polyethylene (PE) bags and stored at zero degree Celsius (0°C) prior to use.

3.2. Preparation of Squash

Washed and disinfected young squash were cut thinly using a kitchen knife. Freshly-cut squash were packed and refrigerated for two days until it became frozen at -30°C.

3.3. Vacuum-frying

About 68 kg of palm oil were placed into a vacuum fryer (DOST-HITS). Three batches of 1 kilogram of frozen young squash were fried under vacuum at various temperatures for various time intervals. The first process schedule was set at 800C for 20 minutes; second at 900C for 15 minutes; and third at 1000C for 10 minutes. After frying, the fried squash were centrifuged using vacuum fryer spinner for 20 minutes to remove excess frying oil in the squash. Vacuum fried squash were packed and stored at room temperature before analysis.

3.4. Sensory Evaluation

The vacuum fried squash were subjected to sensory evaluation by selected panelists (n=30) who were potential customers of the product. Numerical score sheets were provided to rate the color, taste, texture and general acceptability of vacuum fried squash using the 9-point Hedonic Scale.

3.5. Statistical Analysis

The data collected were treated and analyzed using descriptive statistics. Analysis of Variance (ANOVA) was used to test the degree of variance among the quality attributes across the three process schedules.

4. Results and Discussion

4.1. Quality attributes of Vacuum Fried Squash

As shown in Table 1, using process schedule 1 (800C for 20 minutes), the vacuum fried squash in terms of color was very appealing as this was rated liked very much as revealed by the mean score of 7.97. The finding supports the study of Garayo & Moreira [2] which pointed out that vacuum frying could be a feasible alternative to produce chips with lower oil content and with good color and texture. However, the taste, texture, and general acceptability were rated moderately appealing as shown by their mean scores 7.07, 7.40 and 7.47 respectively. It has an overall mean score of 7.48 described as liked moderately. This means that the vacuum fried squash set at 80°C for 20 minutes were moderately acceptable to the potential customers of the product.

Table 1. Acceptability Attributes of Vacuum Fried Squash Using Process Schedule 1

Quality Attributes	Weighted Mean	Description
Color	7.97	Liked Very Much
Taste	7.07	Liked Moderately
Texture	7.40	Liked Moderately
General Acceptability	7.47	Liked Moderately

Overall Mean: 7.48 Description: Liked Moderately.

As indicated in Table 2, the quality attributes of vacuum fried squash were very appealing in terms of the color and texture as revealed by the mean scores of 7.50, and 7.53 respectively. This means that the process schedule 2 (900C for 15 minutes) had an effect on the texture and color of vacuum fried squash. The higher the frying temperature for a shorter period of time [1], the crispier and darker the vacuum fried squash would be. However, the taste and general acceptability of vacuum fried squash were moderately appealing as shown by the mean scores of 7.20 and 7.40 respectively. The overall mean score of 7.41 described as liked moderately means that the second treatment could also produce product which was also moderately acceptable to the potential customers.

Table 2. Acceptability Attributes of Vacuum Fried Squash Using Process Schedule 2

Quality Attributes	Weighted Mean	Description
Color	7.50	Liked Very Much
Taste	7.20	Liked Moderately
Texture	7.53	Liked Very Much
General Acceptability	7.40	Liked Moderately

Overall Mean: 7.41 Description: Liked Moderately.

As specified in Table 3, the vacuum fried squash in terms of color, taste and general acceptability were moderately appealing as indicated by their mean scores of 6.50, 6.53, 7.03 and 6.70 respectively. The overall mean score of 6.69, described as liked moderately means that the product was discreetly acceptable to the potential customers.

Table 3. Acceptability Attributes of Vacuum-Fried Squash Using Process Schedule 3

Quality Attributes	Weighted Mean	Description
Color	6.50	Liked Moderately
Taste	6.53	Liked Moderately
Texture	7.03	Liked Moderately
General Acceptability	6.70	Liked Moderately

Overall Mean: 6.69 Description: Liked Moderately.

As shown in Table 4, significant difference exists in terms of color of the vacuum fried squash across the three process schedules since the computed F-value of 13.5733 exceeded the critical F-value of 3.1012957. This is due to the variation in the frying time and temperature of the vacuum fryer. The color of the vacuum fried squash in the first process schedule got the highest acceptability. The product has light yellow color which was deemed appealing to the potential customers. This is in consonance with the findings of Garayo & Moreira [2] that vacuum frying could produce chips having lower oil content and with good color.

Since the computed F-value of 0.254945 failed to exceed the critical F-value of 4.006873 as indicated in Table 5, no significant difference on the quality attribute of vacuum fried squash in terms of taste exist across the three process schedules. This means that the product contains the same amount of nutrients even if they are subjected to variation in the frying time and temperature. Vacuum fried squash is a rich source of nutrients like Magnesium, Manganese and Potassium as well as vitamins A, E, and C. The product is also an excellent storage of fibers [3].

As revealed in Table 6, no significant difference in the texture of vacuum fried squash exists since the computed F-value of 1.66358 failed to exceed the critical F-value of 3.101296. The textures of vacuum fried squash using the three process schedules were perceived to be the same by the panelists. The products were able to sustain its crispiness even if they were subjected to varying frying temperatures. This finding is contrary to the study conducted by Satriana & Supandan [12] which revealed that frying temperature significantly affected the moisture content. This means that the higher the temperature, the lower is the moisture content. Lower moisture content is a factor in retaining the crispiness of the product. Diamante, et. al. [1] pointed out that crispiness and rancidity were the two important qualities that dictate the shelf life of vacuum fried products. The crispier the vacuum fried squash chips, the more desirable it would be to the potential customers.

Table 4. ANOVA Summary Table on the Quality Attributes of Vacuum Fried Squash in terms of Color

Source of Variation	SS	df	MS	F	P-value	F crit	Result
Between Groups	33.68888889	2	16.84444	13.57333	7.4E-06	3.10129576	Significant
Within Groups	107.9666667	87	1.240996				
Total	141.6555556	89					

Table 5. ANOVA Summary Table on the Differences on the Quality Attributes of Vacuum Fried Squash in terms of Taste

Source of Variation	SS	df	MS	F	P-value	F crit	Result
Between Groups	0.266667	1	0.266667	0.254945	0.615528	4.006873	Not Significant
Within Groups	60.66667	58	1.045977				
Total	60.93333	59					

Table 6. ANOVA Summary Table on the Differences on the Quality Attributes of Vacuum Fried Squash in Terms of Texture

Source of Variation	SS	df	MS	F	P-value	F crit	Result
Between Groups	4.022222	2	2.011111	1.656358	0.19673	3.101296	Not Significant
Within Groups	105.6333	87	1.214176				
Total	109.6556	89					

Table 7. ANOVA Summary Table on the Differences on the Quality Attributes of Vacuum Fried Squash in terms of General Acceptability

Source of Variation	SS	df	MS	F	P-value	F crit	Result
Between Groups	10.82222	2	5.411111	5.06382	0.00831	3.101296	Significant
Within Groups	92.96667	87	1.068582				
Total	103.7889	89					

As indicated in Table 7, the computed F-value of 5.06382 exceeded the critical F-value of 3.101296. The results of the Analysis of Variance (ANOVA) for the general acceptability of the product showed a significant difference between the panelists' evaluation. The general acceptability provides an indication of the magnitude of acceptability of vacuum fried squash based on considering all aspects.

5. Conclusions and Recommendations

Three batches of vacuum fried squash of varying time and temperature were successfully prepared. Results of sensory evaluation revealed acceptable quality attributes in terms of color, taste, texture and general acceptability using treatments 1 and 2. The product which was subjected to the third process schedule was evaluated discreetly acceptable in terms of the color, taste and general acceptability. On the other hand, results of the sensory evaluation revealed that the potential customers liked very much its texture due to its brittleness which made it more appealing. The vacuum fried squash is a nutritious snack that offers natural taste while enjoying the crunchy bite.

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