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# Development of Crispy Sweet Potato Chips Utilizing Vacuum Fryer

**Arthur G. Ibañez, Denis V. Policar**

***Abstract : Objectives:*** *The study aimed to (1) develop a shelf-stable and acceptable vacuum fried sweet potato chips, (2) establish process schedule to conduct material balance, (3) evaluate the sensory characteristics of the chips and (4) determine its nutrient composition. Methodology: Sweet potato (Ipomoea batatas) was utilized and vacuum fried. The production of the crispy sweet potato chips comprised of selecting quality and newly harvested sweet potato, washing the selected sweet potato with 50ppm chlorinated water peeling and slicing the sweet potato with 2mm thickness cooking the sliced sweet potato for 10minutes, freezing the cooked sweet potato overnight, vacuum frying the frozen sweet psotato, cooling the vacuum fried sweet potato to room temperature and weighing and packing on an 89µm thickness laminated stand – up pouch. Then, material balance was evaluated accounting to wastage and moisture loss. Finally, the quality of the product was tested through sensory evaluation. There were three mass treatments used: Treatment A with 1.0kg; Treatment B with 3.0kg; and, Treatment C with 50kg. Each treatment had three (3) replicates and were fried at 100°C. Findings: Vacuum fried sweet potatoes for The three treatments recorded average bubble end – points of 42.33 (A), 47.67(B), and 52.67 (C) minutes. This shows that the weight to be processed per batch is directly proportional with the bubble end-point as temperature and pressure were held constant. Applications: Sweet Potatoes can be developed as crispy chips utilizing vacuum fryer.*

***Keywords: sweet potato, chips, vacuum fryer***

## I. INTRODUCTION

Vacuum frying is a promising technology for the production of snacks such as fruit and vegetable crisps that achieves the desired quality and responds to the new health trends. This technique of frying food at a low temperature and pressure makes the nutritional quality of the food maintained and the quality of the used oil not quickly declined to become saturated oils which are harmful for human health. Significantly, this technique produces chips that have physical, chemical, and sensorial properties generally better than thosse produced by conventional deep-fat frying methods. Presently, vacuum frying is already being employed commercially by neighboring countries of thePhilippines for the manufacture of non-traditional fried foods and snacks. Vacuum fried fruits sold commercially include apple, pears, pineapple, jackfruit, mango, durian, while fried vegetables include string beans, carrots, taro, sweet potato, okra, and squash.

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## II. MATERIALS AND METHOD

Raw material specificationsare as follows:

| Commodity | Parameters | | | |
|---|---|---|---|---|
| | Variety | Color | Size | Maturity/ Ripeness |
| Sweet potato | Orange-flesh sweet potato varieties | orange | 4-6 cm, dia. 10-15 cm long | 110-130 days harvest-fit |

The process flow diagram for the development of crispy sweet potato chips is presented in Figure 1.

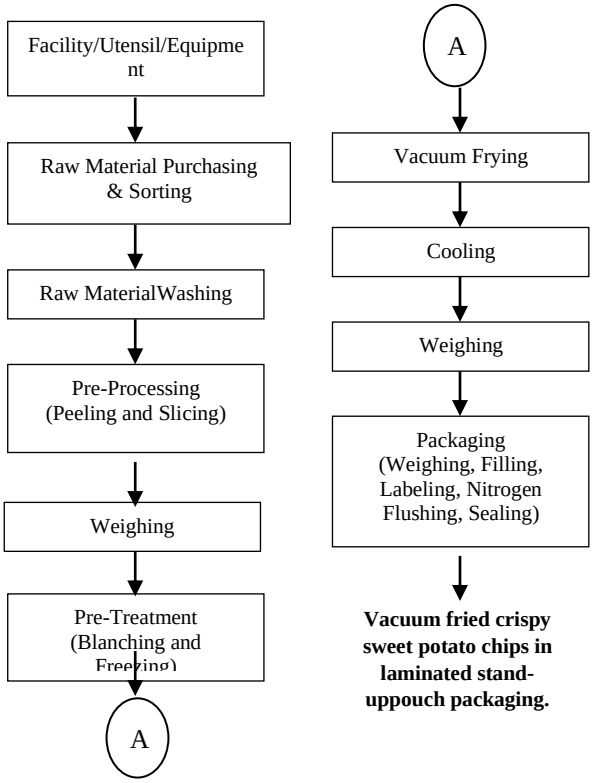


**Figure 1: Process Flow of Vacuum Fried Sweet Potato Chips Development**

### *Sensory Evaluation*

The sensory characteristics of the vacuum fried sweet potato were evaluated based on color, appearance, texture, flavor, and aroma as well as on general acceptabilityusing the 9-point Hedonic Scale.

The following criteria were used:

a) **Color** was evaluated from *Light* (1 as lowest) to *Bright* (9 as highest);

b) **Appearance** was evaluated from *Unappetizing* (1 as lowest) to *Appetizing* (9 as highest);
c) **Texture** was evaluated from *Soft* (1 as lowest) to *Crispy* (9 as highest);
d) **Flavor** was evaluated from *Bland* (1 as lowest) to *Strong* (9 as highest);
e) **Aroma** was evaluated from *Weak* (1 as lowest) to *Strong* (9 as highest);
f) **General acceptability** was evaluated from *Disliked Extremely* (1 as lowest) to *Liked Extremely* (9 as highest).

## III. DISCUSSION OF RESULT

Bubble end-points for each treatment were determined during the vacuum frying process. Material balances were conducted to account for wastage and for food material moisture reduction.

Final product's sensory characteristics, through quality scoring and consumer acceptance, and nutritional content were also determined.

### *3.1 Bubble End-Points Determination*

In the vacuum frying process, temperature was set to 100℃ and vessel pressure was held constant at 76cmHg vacuum. Bubble end-points, as indicator of the end of the frying process, for the three treatments are shown in **Table 1**. The results show that the span of time to reach bubble end-point is directly proportional to the amount of food material being fried. Treatment 1 achieved bubble end-point at anaverageof 42. 33 minutes, Treatment 2 at 47.67 minutes and Treatment 3 at 52.67 minutes.

**Table 1. Bubble end-points of vacuum fried samples at 100℃ and 76cmHg vacuum**

| Replicates | Mass (g) | Bubble End-Point (min) | Ave. Bubble End-Point (min) |
|---|---|---|---|
| A1 | 1,000 | 44 | 42.33 |
| A2 | | 42 | |
| A3 | | 41 | |
| B1 | 3,000 | 47 | 47.67 |
| B2 | | 48 | |
| B3 | | 48 | |
| C1 | 5,000 | 51 | 52.67 |
| C2 | | 54 | |
| C3 | | 53 | |

### *Material Balance*

The overall material balance of the process shows that a 30 kg of fresh sweet potatoes yielded to a 94% recovery (28.20 kg) of peeled and sliced food material and 6% (1.80 kg) wastage.

Out of the 28.20 kg, 27.0 kg was pre-treated and vacuum fried. Corresponding to moisture lossesof the food material for the three treatments, an average of 30% of the initial mass was recovered while 70% was lost during the operation.

### *Summary Evaluation*

For sensory evaluation, the mean score of the panelists' valuation for the three treatments for color, appearance, texture, flavor, and aroma are 8, 8, 8, 8 and 7, respectively.

The corresponding qualitative scale for a mean average of 8 of the quality attributes are as follows: (1) color is close to bright orange indicating product's retention of its natural color during the process; (2) appearance is close to appetizing indicating the product's wholesome aesthetic presentation; (3) texture corresponds that the product is near crispy; and (4) flavor is close to having strong appealing taste.

Only the aroma got a mean average of 7, scale in between strong and average, corresponding to the product's noticeable pleasant smell.

For the consumers' acceptability evaluation, the three (3) different treatments got an average of 8 which indicates "liked very much".

### *Nutritional Content of Sweet Potato*

Result of nutritional content analysis of the product is as follows: 2.10% moisture, 2.67% crude protein, 36.71% total fat, and 57.76% carbohydrates.

### *Production Cost of the Developed Food Product*

The production cost of vacuum fried sweet potato for every 50 g, without packaging and label, is 18.719 Php.

## IV. CONCLUSIONS AND RECOMMENDATIONS

### A. Conclusions

Peeled and sliced sweet potatoes were vacuum fried according to the following weight: 1.0 kg (Treatment A), 3.0 kg (Treatment B), and 5.0 kg (Treatment C) in triplicates with recorded average bubble end-points of 42.33, 47.67, and 52.67 minutes, respectively. This shows that the weight to be processed per batch is directly proportional with the bubble end-point as temperature and pressure were held constant. During the process, an average of 30% of the initial mass was recovered while 70% was lost during the operation which is associated with moisture loss of the food material. The output of this study was shelf-stable and acceptable vacuum fried sweet potato chips. The developed food product was evaluated in terms of color (8), appearance (8), texture (8), flavor (8), and aroma (7) as well as its general acceptability (8). The corresponding scores showed that the developed product has high quality attributes and is "highly acceptable". The product nutritional content are 2.10% moisture, 2.67% crude protein, and 36.71% total fat and 57.75% carbohydrates.

### B. Recommendations

The hereinresearchers recommend: (1)the use of other variety of sweet potato locally abundant in the region, (2) the use of coconut oil instead of palm oil, (3) there is a need to test the product in different temperatures and pressures, and (4) the promotion of the product for mass production.

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1986 – 1988 - Master of Science in Civil Engineering (Structural)
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**IMPORTANT STUDIES/RESEARCHES /PAPERS WRITTEN**

Factors Influencing Irrigated Rice Productivity in Region O2: The Case of Cagayan Province
Rajabat Agriculture Journal – Vol 14, No. 2
July-December 2015
Factors Influencing Irrigated Rice Productivity in Rain fed Areas of Cagayan
Rajabat Agriculture Journal – Vol 14, No. 2
July-December 2015
Implementation of Infrastructure Development Programs of SUCs in Region O2
CSU Carig Research Local – Vol 1, No. 1 – ISSN: 2244-6575
May 2013-June 2018
Poverty Alleviation through Food Product Processes
1st National Conference on Poverty & Sustainable Development PovCon 2017
Development of Dilis Bagoong Powder
Vol. 1, No. 2 (2017):2nd SIMP-AAG Joint Multidisciplinary Research Conference Proceeding Abstracts
2017
Establishing Earthquake Risks: The use of RAPID Earthquake Damage Assessment System (REDAS) in the Province of Cagayan, Philippines
ILS Research Journal Vol. 1, No.1
December 2014
Cagayan Valley's Innovation & Product Development
3rd International Research Conference on Innovation in Engineering, Science &Technology
3rd IRCIEST Conference Proceeding
September 27-29, 2017

**UTILITY MODELS**

Registration No. 103
Process of Producing Powdered Food Seasoning
Registration No. 108
Composition of Powdered Food Seasoning
Registration No. 107
Composition of Powdered Beverages
Registration No. 106
Composition of Crispy Snack Food made from Mixed Vegetables
Registration No. 109
A Process of Producing Crispy Snack Food from Squash
Registration No. 104
A Process of Producing Crispy Snack Food made from Mixed Vegetables

**AWARD/S RECEIVED**

DOST Outstanding Service & Support to the Establishment on the Food Innovation Center
Department of Science and Technology
February 2, 2016
PUGAD LAWIN – Presidential Service Award
PugadLawin Philippines Inc.
2015-2016
DOST – Significant Contribution in the Establishment of the Food Innovation Center
Department of Science and Technology
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DOST – Invaluable Assistance in Promoting S & T Activities
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UNDP Senior Quality Assurance Supervisor for LGU Projects (RO2 and Abra)
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*"Upgrading of Metal and Stainless Fabrication Process"*
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*"Upgrading of CJ's Motor Parts and Accessories"*
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