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Physico-Chemical and Functional Properties, Nutritional Value and Acceptability of Purple Yam (*Dioscorea alata*)-Based Jam (Halaya) Using Purple Sweet Potato (*Ipomoea batatas*) and Purple Taro (*Colocasia esculenta* L (Schott)) as Extenders

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Abstract

The study was undertaken to determine the potentiality of yam-based jam with the most acceptable extenders. Commodity combination and levels were the two variables used in the study. Results showed that the variables did not significantly influence the adhesiveness and cohesiveness but greatly influenced the color, aroma, flavor and general acceptability of the product at 5% level of significance. Furthermore, purple sweet potato and purple taro can be used as an extender of yam in halaya processing due to its comparable physico-chemical properties, nutritional properties and functional properties.

Keywords: Sweet potato; Taro; Yam; Ube Jam; Nutritional value; Acceptability extenders

Introduction

A study was conducted to develop a jam using purple-sweet potato and purple taro flour as an extender of yam. Most Filipinos love to eat sweets and desserts. One of these Filipino-desserts is the ube jam [1].

Halaya an ube jam, a traditional Filipino dessert is prepared by cooking. The mixture is composed of mashed or powdered yam, water, milk, margarine, wheat flour and sugar under moderate heat [2]. Ube/yam is the primary source of ingredient in halaya processing [3]. Ube/Yam among Filipino is an old plant but is only recently that its commercial potential is being recognized. Exports of ube jam/halaya and powder are fast becoming a profitable industry.

However, it has always been considered as a minor crop due to its relatively small volume of production and its contribution to national income. Ube/Yams during the dry season are in a state of dormancy [4]. Therefore, ube/yam is seasonal. On the other hand; the purple sweet potato and taro corms are widely available in all seasons in the Philippines [5]. According to Lohachoompol [6] sweet potato and taro flours prepared by steaming and dehydration are ingredients used in formulated foods. According to Yang et al. [7], steaming and dehydration increased the percentage of polymeric anthocyanins in purple sweet potato powders than in pure freeze-dried powder. Processed foods have higher nutrient than fresh most likely due to the heat-induced release of some nutrients from its cellular matrix [8]. Boiling, baking, cooking and frying are the most common methods of preparation [9].

The availability throughout the season of purple sweet potato and taro makes a potential extender. Furthermore, these root crops are cheaper than yam. Yam/Ube, sweet potatoes and taro are highly perishable and not immediately used up after harvesting. Therefore, conversion into flour can preserve and use that possible ingredient in halaya. Moreover, yam/ube halaya contains pigments that give violet color that can be linked to nutritional and antioxidant properties.

Method

Product formulation

Yam/Ube flour processing: The tubers were washed thoroughly in running water and cut into 2 in (5 cm) thick. Sliced tubers were cooked for 20 to 25 min or until soft. The cooked slices were peeled and mashed the pulp. Spread out thinly, about 75 in (2 cm) thick and dried for 12 h at 70°C following the standard procedure of Department of Food Science and Technology as cited by Mrs. Teodora de Villa. The dried product was finely grounded and sifted before packing in polyethene plastics.

Purple sweet potato flour processing: Sweet potatoes soaked in water for a few min to soften the dirt clinging to the tubers [10]. The tubers were cleaned and washed thoroughly until they are free of mud and dirt and after cleaning. The clean, sweet potatoes were peeled and sliced to facilitate rate of drying and milling operation. The sliced tubers blanched at 60°C for 15 min in order to inactivate enzymes that may cause browning reaction. After blanching, the chips were uniformly spread on a stainless steel perforated tray and dried in a cabinet dryer at 70°C for 12 h.

Taro flour processing

The taro corms were sorted correctly washed with clean water and peeled. The peeled taro corms were sliced 2 in (thick) and soaked in water for 12 hours to remove the oxalates partially. These sliced corms blanched in boiling water for 4-5 min and dried 70°C for 12 h and milled [11].

Halaya processing

The formulation of halaya adopted the prescribed by Department of Science and Technology (DOST) [12]. Four hundred twenty (420) gm of powdered ube mixed with water were prepared. The ingredients blended together were two hundred fifty (250) ml of evaporated milk, fifteen (15) gm of margarine and sixty (60) gm of wheat flour and three

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hundred sixty (360) gm of sugar. Then the mixture was cooked at low heat about 25 min. The mixture made by continuous stirring until noticed a very thick consistency. Lemon rind added lastly. Then the halaya was cooled and refrigerated before serving.

Experimental Design

For this study, the following treatments were presented using the Randomized Complete Block Design (RCBD) as shown in Table 1.

Statistical analysis

The design employed a quasi-experimental design with nine (9) treatments and three (3) replications. The tabulated results were tested across different treatments using the analysis of variance.

Sensory evaluation

The samples labeled appropriately and used general procedures for a sensory test. The samples were numbered using random numbers. Each judge served with samples of the yam/ube-sweet potato and ube-taro halaya with different percentage of formulation. A cup of water was served with the score sheet to achieve unbiased result. Twenty (20) panelists were chosen to evaluate the sensory qualities of the product as to which were include color, aroma, flavor and the general acceptability. A 7-point hedonic scale was used to determine the degree of acceptability of each sensory attributes.

Physico-chemical determination

The physico-chemical analyses determined the pH, total soluble solids, total anthocyanin and total phenols of the finished product.

The pH of the sample determined using pH pen calibrated with standard buffer pH 4.0 and counter checked with pH 7.0 buffer. The samples were poured in a small beaker and the pH pen dipped. After which, recorded the readings.

Hydrogen ion concentration of pH is a symbol that indicates acidity and alkalinity in units that can be measured [13]. The pH is of importance as a measure of the active acidity which influences the flavor and palatability of the product. It has of significant impact in the color, taste and on the redox potential.

Total soluble solids

Total Soluble Solids or TSS expressed in °Brix measured by placing 2-3 drops of the sample in the prism on the hand refractometer.

Total Soluble Solids is the amount of the soluble compounds present in the aqueous solution of the food. TSS also measures of the sweetness of the sample. The TSS is a measure of soluble sugars. Other soluble solids in foods are the organic acids, alcohol, inorganic salts.

Variables		
Treatments	**Root crop combination**	**Levels**
T_1	UBE: PSP	100:0
T_2		75:25
T_3		50:50
T_4		25:75
T_5		0:100
T_6	UBE: TARO	75:25
T_7		50:50
T_8		25:75
T_9		0:100
Note: PSP: Purple Sweet Potato		

Table 1: The treatments for the root crop combination and percentage levels of yam/ube-based halaya.

Nutritional analyses and functional analyses

The nutritional and functional properties analyses were determined by following the [14] procedure.

Physico-chemical determination

pH, total soluble solids, total anthocyanin and total phenols of the finished product were being determined.

Chemical analysis

Anthocyanin analysis:

Preparation of anthocyanin extract for spectrometric analysis: The anthocyanin extract from the halaya, 5 grams, 20 ml citric acid was mixed in a 50 ml beaker. The resulting mixture removed from the beaker and the supernatant was decanted and filtered using Whatman no.1 paper. The residue rinsed on the filter paper rinsed with appropriate citric acid solution. The filtrate containing the anthocyanin pigments were transferred to 25 ml volumetric flask and diluted to proper volume. Pigment present in the medium was prepared separately by measuring 10 ml of liquor and diluting it to 25 ml. The anthocyanin extract was subjected to UV Spectrophotometer [7].

Total anthocyanin determination: For anthocyanin extraction, 5 gm of sample was weighed and placed in 125 ml Erlenmeyer flask and 50 ml of 1% HCl in methanol. The sample was used for extraction overnight in the refrigerator at 4°C. Using a Whatman no.1 filter paper, in a Buchner funnel filtered the extract and 10 ml of distilled water added to the anthocyanin extract. The mixture was shaken using Vortex mixer for about a minute and the absorbance read at 530 nm. The absorbance of the samples was measured based on the vis-max of cyaniding-3-glucoside. The total monomeric anthocyanin pigment concentration of the sample calculated used by Wrolstand [15].

Total phenol analysis: The samples were diluted to about 1000 ug/ml in methanol-standard solutions. Samples prepared with known concentrations of 0, 20, 40, 80 and 100 ug/ml Gallic acid in methanol. About 0.25 ml of diluted samples of standard solutions was added to 3.5 ml distilled water in test tubes. About 0.5 ml of 50% Folin-Ciocalteau reagent was added and after three times, 1 ml 20% sodium carbonate was added. The solutions were mixed and incubated in boiling water for one-minute absorbance was read. The total phenolics of the samples were calculated based on the standard curve. The calculation of total phenolics expressed as ug Gallic acid equivalent (GAE) per gram fresh samples (FB) [16].

Proximate analysis: Standard methods of the Association of Official Analytical Chemists (1980) were used to determine the moisture, crude protein, crude fat, total ash and crude fiber contents of each sample. Moisture content was determined by heating 2.0 g of each fresh sample to a constant weight in crucible placed in an oven maintained at 105°C. In the determination of the other parameters used the dry matter. Crude protein (% total nitrogen x 6.25) was determined by Kjeldahl method, using 2.0 g samples. The crude fat was obtained by exhaustively extracting 5.0 g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 40°C-60°C) as the extractant. As was determined by the incineration of 10.0 g samples placed in a muffle furnace, maintained at 550°C for 5 h. Crude fiber was obtained by digesting 2.0 g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace kept at 550°C for 5 h. Moisture sample

to a constant weight in a crucible placed in an oven maintained at 105°C. Each analysis was carried out in triplicate. The determination was carried out using standard procedures. During the determination, the sample was first ashed and dissolved in a solvent and the result and solution aspirated into an air-acetylene flame. The mineral element determined were Zinc (Zn), Lead (Pb), Manganese (Mn), Copper (Cu), Potassium (K), Sodium (Na), Iron (Fe), Cadmium (Cd), Phosphorus (P) and calcium (Ca). Spectrophotometric methods using flame emission, spectrophotometer for Sodium (Na) and Potassium (K) and atomic absorption spectrophotometer for others were the methods used in Proximate analysis. Before determining the concentration of any element in the sample, a calibration curve of the element in the sample was prepared using prepared standard stock solutions.

Antinutrients analysis: Determinations of Phytic Acid and Oxalic Acid were determined using the AOAC (1980) method. Samples subjected to spectrophotometer for Phytic and Oxalic acid analysis.

Results and Discussion

Table 2 shows sensory evaluation for the different attributes in color, aroma, flavor, adhesiveness, cohesiveness and general acceptability of ube-based halaya using purple sweet potato and purple taro as extenders.

Sensory evaluation

The commodity combination and the levels of the formulation did not significantly influence the adhesiveness and cohesiveness of the product. The result was caused by the amylose content. The amylose contents of ube, taro and sweet potato are in close values that resulted to no difference in texture. Amylose is also an important thickener, water binder, emulsion stabilizer and gelling agent in both industrial and food-based contexts [17].

However, the color, aroma, flavor and general acceptability were significantly influenced by the variables at 5% level of significance. Total soluble solids were perhaps responsible for the effect. Starch-sugar proportion depends on the root crop [11]. Moreover, according to [18], inclusion of sugar was observed to improve the color of the jam.

The most acceptable product was subjected to further analyses. Treatment 3, (50% ube and 50% purple sweet potato) was subjected to physicochemical and nutritional analyses as shown in Table 2.

pH

Based on Table 3; the pH of jam usually falls <3.5 to minimize microorganisms. Furthermore, the TSS of processed root crops was higher compared to the raw root crops since sugar and milk added to jam. The report supports the study of Vidhya and Narain [19] that the increase in TSS and sugars would be attributed to the conversion of starch and other insoluble carbohydrates into sugars.

Total anthocyanin and total phenol

Total anthocyanins lowered as compared to the new root crop because of the processing involvement. The decrease is attributed to the fact that anthocyanins are water-soluble pigments [20]. Moreover, from the cooking procedure, the tubers were cut into smaller sizes that increased the surface area in contact with water. Total phenols increased due to the heat obtained. De Wanto [21] stated that thermal processing resulted to the breakdown of cellular constituents and as a consequence, releases the bound phenolics. The total phenol and anthocyanin were higher in 100% ube jam. The result is possible because the initial content in fresh ube is higher than of sweet potato.

Proximate analysis

The results revealed that there was an increased and decreased on the values of as compared to the fresh commodities. The increase was due to the addition of milk, sugar and water. Moisture content of 35.75% is an IMF or intermediate moisture foods (15%-40%). Hence, this suggests that the product is in a range of protection against microorganisms.

Mineral analysis

The analysis detected the calcium content of 0.05%. The result suggests that the processing was not a factor to lower the calcium content of purple sweet potato and taro.

Anti-nutrient analysis

Processed root crops were found with fewer amounts of anti-nutrients specifically Phytate and Oxalate than unprocessed. Boiling and washing may cause considerable skin rupture and facilitate the leakage of soluble oxalate in the cooking water [22].

Samples	Attributes					
	Mean scores[1]					
	Color	Aroma	Flavor	Adhesiveness	Cohesiveness	General acceptability
T1	5.67ab	5.37^{ab}	5.30^{a}	5.10^{a}	5.40^{a}	5.73^{b}
T2	5.53^{ab}	5.57^{ab}	5.23^{a}	5.20^{a}	5.50^{a}	5.76^{b}
T3	5.93^{ab}	5.30^{ab}	5.33^{a}	5.27^{a}	5.57^{a}	6.67^{a}
T4	5.73^{ab}	5.10^{ab}	5.00^{bc}	5.70^{a}	5.53^{a}	5.67^{b}
T5	5.67^{ab}	2.90^{d}	4.97^{bc}	5.33^{a}	5.43^{a}	5.37^{bc}
T6	5.47^{ab}	5.60^{ab}	5.37^{a}	5.35^{a}	5.47^{a}	5.77^{b}
T7	5.40^{ab}	5.67^{ab}	5.27^{a}	5.26^{a}	5.43^{a}	5.43^{bc}
T8	3.33^{c}	3.37^{c}	3.15^{c}	5.25^{a}	5.23^{a}	5.40^{bc}
T9	3.10^{c}	2.37^{e}	3.06^{d}	5.23^{a}	5.30^{a}	5.43^{bc}

Note: Means with the same letter are not significantly different from each other at 5% level of significance.
T1 – 100% ube
T2 – 75% ube+25% PSP
T3 – 50% ube+50% PSP
T4 – 25% ube+75% PSP
T6 – 75%ube+25% taro
T7 – 50% ube+50% taro
T8 – 25% ube+75% taro
T9 – 100% taro
T5 – 100% PSP
PSP – Purple Sweet potato

Table 2: Sensory evaluation for the different attributes in color, aroma, flavor, adhesiveness, cohesiveness and general acceptability of ube-based halaya using purple sweet potato and purple taro as extenders.

Analyses	T3 (50%ube+50%PSP)	Yam/Ube jam (100%)
Physico-chemical analysis		
pH	3.5	3.8
Total soluble solids (TSS)	45° B	36° B
Functional analysis		
Total anthocyanin	210.17 mg/100 g	260.52 mg/100 g
Total phenols	121.34 µg/g gallic acid	139.34 µg/g gallic acid
Proximate analysis		
Moisture content	35.75%	38.15%
Ash content	1.18%	1.57%
Crude fat	0.15%	0.25%
Crude fiber	1.07%	1.78%
Crude protein	1.04%	1.10%
Mineral analysis		
Phosphorus	non-detectable	non-detectable
Calcium	0.05%	0.04%
Iron	non-detectable	non-detectable
Anti-nutrient analysis		
Phytate	9.45 mg/100 g	11.36 mg/100 g
Oxalate	50.65 mg/100 g	60.12 mg/100 g

Table 3: Physico-chemical, functional, nutritional and anti-nutrient analyses of Ube-based jam.

Conclusion

From the result of the study, it can be concluded that purple sweet potato and purple taro have potential as an extender to yam/ube in halaya processing. Treatment 3 (50% PSP+50% ube) had the highest acceptability. Hence, the treatment was subjected to further physico-chemical, functional and nutritional properties. It also revealed that the functional and nutritional properties of the product are capable comparable with 100% ube. The use of rootcrop flours in ube processing lessens more the anti-nutrients than in fresh rootcrops.

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