

## TARO “*Colocasia esculenta*”: It’s Utilization in Food Products in Ghana

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### Abstract

**Background:** The study developed Taro “*Colocasia esculenta*” products and sensorily assessed acceptability and promotion in the diets of Ghanaians to help address the increasing persistent malnutrition among Ghanaians and provide employment through agro-processing.

**Materials and methods:** Composite flours were produced from taro, soybeans, rice and maize and analyzed proximately. Ten panelists, 5 males and 5 females were purposively sampled from the VOTEC Department of University of Cape Coast and interviewed. A self developed questionnaire was administered to panelists to evaluate the sensory properties of baby food and pastries prepared from the composite flours. Panelists’ scores were subjected to ANOVA and Duncan’s multiple test at  $\alpha \leq 0.05$ . Babies of the 5 females were fed samples of the baby food and observations made in relation to how well they ate the food were compared to the scores provided by the panelists.

**Results:** Results showed taro flour ash content of 4.01%, protein 3.43%, carbohydrates 0.74%, dry matter 85.32%, and fat 0.18%. Sensory analyzed samples had high mean scores for characteristics considered. Appearance and color of baby food ( $S_1 - S_4$ ) were not significantly different at  $\alpha \leq 0.05$  whilst taste, flavor and overall acceptability differed. The taste of  $S_1$  and  $S_3$  were not significantly different but were significantly different for  $S_2$  and  $S_4$ . The texture of  $S_1$  and  $S_3$  were not significantly different but  $S_4$  was different. All samples of baby food were not significantly different for overall acceptability. For the taro cake ( $T_1 - T_3$ ) most of the sensory characteristics were not significantly different.  $T_2$  was evaluated as the best product followed by  $T_3$ ,  $T_1$  whilst  $T_6$  came out as the best product followed by  $T_5$  and  $T_4$  respectively.

**Conclusions:** Panelists acknowledged acceptability of taro products recommending its promotion in the diets of Ghanaians and the possibility to process taro at the rural level to provide jobs for the rural poor.

**Keywords:** *Colocasia esculenta* (Taro); Baby food; Food processing; Malnutrition

### Introduction

In the past, only about 10% of the World population used root crops as the major staple, [1] but presently the diet of most Ghanaians is based on roots and tubers, and on processed cereal grains. The common roots and tubers utilized in Ghana are mostly cassava, yam and cocoyam. Cereals such as rice, maize and sorghum are also greatly patronized. However, there are other important roots and tubers like sweet potatoes and taro which although have high nutritional value, are not often eaten by Ghanaians. Taro can also be stored for a longer time than all other root crops, without much change in quality and taste. Roots and tubers generally serve as a major source of carbohydrate or energy and provide minor amounts of proteins, fats and oils, minerals and vitamins [2]. For example, there is a myth that the consumption of taro leads to weakness in male sexuality. Others complain of an awkward taste in boiled taro. However, with persistent problem of malnutrition and population increase in Ghana, addition of taro to the already existing common roots and tubers eaten will go a long way to help address the aforementioned problems. Thus, there is the need to exploit new and unconventional low cost and high quality energy foods like taro. In recent past, as a policy of the government of Ghana to improve the nutritional levels of the population, it put in place crop improvement programmes centered on local staple crops such as maize and rice with some emphasis on some root crops to promote some of Ghana’s lesser known root crops such as sweet potatoes and taro due to high nutritive value and ease of cultivation.

In addition to promoting the consumption of Taro among other roots and tubers in Ghana, it is essential to encourage people in post-

harvest management and agro-processing as a way of obtaining the most benefits from crop production outputs in general by reducing losses and maintaining product quality and nutritional value. Coming up with recipes that are accepted and liked by people could help rural-based agro-processing industries emerge and provide a source of income for the rural population, thereby reducing poverty as well.

There have been reports of the use of taro flour for infant formulas and as part of canned baby food in the United States of America. Taro foods are useful to persons allergic to cereals and can be consumed by infants/children who are sensitive to milk. Studies conducted in Asia in the past have reported that babies who were fed poi-a type of baby food prepared from taro were found to suffer less from health conditions such as diarrhea, pneumonia, enteritis and beriberi than babies fed with rice and bread [3]. Recently, [4] highlighted the nutritive value of poi as being hypoallergenic, rich in calcium, potassium, phosphorus, magnesium, B vitamins, vitamin A and C, high in fiber and serves as a slow release energy food source. Apart from the vast uses of taro for food, it can also be used as an additive to render plastics biodegradable.

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In the recent past, taro products found in most large supermarkets around the world included taro chips, taro bread, vegetable taro burger and baby food due to its high digestibility [5]. Since food is part of a people's culture and thus changes in cultural practices regarding food preparation and consumption patterns can easily alter research results, it is important to iterate that recent trends in people working for long hours and having less available time to cook has led to increases in the consumption of processed foods such as taro products listed earlier.

Taro has a small starch grain about a tenth of that of potato (1-6.5 micrometers) making it more digestible. With a digestibility of about 98.8%, taro is appropriate for use in infant food, food for the elderly and the sick. People who are often allergic to cereals and babies or infants who are intolerant to milk can easily consume foods made of taro without any problems [3] reported the high value of taro in the diet of the people of Hawaii. In addition, he reported on a survey of tooth decay conducted among Melanesian inhabitants of the Manus Islands. Children who were fed on taro had better dental arches as compared to those fed on sago (*Metroxylon spp.*). In addition to that there was lower incidence of acute infection of the gum. This observation can be explained based on the fact that taro contains higher vitamin content than sago. Taro has higher content of proteins and amino acids than many other tropical root crops [6].

Although taro is often known to be acrid because it contains anti-nutritive factors such as calcium oxalate crystals in high levels (120,000/cm), cooking and fermentation destroy the acidity and make it suitable for consumption. Taro is known to be a good source of carbohydrate, fiber, minerals especially potassium and vitamins (especially B-complex) which is more than that found in whole milk and vitamin A and C. It is rather low in ascorbic acid and carotene with the amount of carotene being the same level as that found in cabbage and twice that found in potato [1]. Large servings of taro foods are a significant source of dietary protein, calcium, phosphorus and are often effective when taken more than once a day. Taro supplies approximately 95 calories per adult serving. Raw corm shavings mixed with other plants can be used to treat indigestion and constipation.

With all these characteristics, taro would pass for good food but one cannot look only at the nutritional value without looking at consumer acceptance. Thus the purpose of this study was to promote the use of Taro in food product development.

To achieve this, the following objectives were considered:

1. To develop food products from Taro
2. Use sensory analysis to assess the acceptability of the food products

## Materials and Methods

### Production of composite flours (Taro, Soybeans, Rice and Corn/Maize)

Taro, soybeans, rice and corn/maize were purchased from the Kotokuraba market in Cape Coast for the preparation of individual and composite flours. To prepare the taro flour, taro was washed, peeled, re-washed, chipped using a mechanical chipper and spread evenly on a metallic solar drier for 3 days to dry. A portion of the chipped and dried taro pieces was partly roasted for 15-20 minutes and ground into flour using a Kenwood blender, sieved using a sieve of diameter from 180-500 $\mu$ m and packed into clean dry plastic containers. The soybeans, rice and corn/maize were sorted, washed, dried, partially pot roasted at constant heat for 15-20 minutes and milled into flour using a Kenwood

blender/mill. The flour was packed into clean plastic containers for use in producing composite flour for making baby food and pastries.

Three hundred (300) grams of the powdered products were weighed using a measuring scale

Taro (300g) and 100g roasted and milled corn/maize formed sample S<sub>1</sub>, 300g taro and 100g rice formed sample S<sub>2</sub>, 300g taro and 100g soybean formed sample S<sub>3</sub> and finally 100g of all the cereals were mixed with 100g of taro flour to form sample S<sub>4</sub>. S<sub>1</sub> to S<sub>4</sub> formed the baby food. Baby foods were produced from a combination of the taro flour with soybean, rice, corn/maize and the pastries from a combination of taro and wheat flour. The baby foods were evaluated for its' sensory properties using 5 babies, 5 male and 5 female adults and the pastries by only the 10 adults.

### Recipe for preparation of baby food for sensory analysis

Fifty (50) grams of each sample S<sub>1</sub>-S<sub>4</sub> was weighed, 4 tablespoons sucrose/sugar, a pinch of salt to taste and 3 cups of water was added to the products and mixed in different labeled saucepans. The amount of sucrose/sugar added to each sample was constant or the same to help prevent the situation where the sweetness of the product will differ and influence babies' preference. The mixtures were brought to boil and allowed to cook for 8 minutes under moderate heat and left to simmer for an additional 2 minutes. Samples were poured into well labeled containers for sensory analysis. The mothers whose babies were used for evaluating the baby food products were purposively selected from a group of University of Cape Coast (UCC) students and invited to the Vocational and Technical Education Department's food laboratory and schooled on how to evaluate cooked and served to the babies. The mothers were given instructions as to how to determine which of the different samples is liked most by their babies for scoring purposes. Mothers fed babies with one samples at a time and gave the babies some water to rinse down each sample taken before the next. As babies it was difficult scoring for individual sensory characteristics but scores were provided for overall product acceptability based on which product the babies ate with the most enthusiasm. The baby food was also given to the 5 male and 5 female panelists to evaluate. Recipes for preparing taro cakes and chips are shown in table 1 and 2.

### Preparation of taro cake and chips (Pastries)

To make 1 pound of the taro cake, 450 g of margarine was weighed using a kitchen scale and added to 400 g of white refined sugar. The two ingredients were creamed together using a Kenwood cake mixer until the mixture became light and fluffy in texture. The 10 eggs were cracked separately, put together after cracking, flavored with 2 teaspoons of the pineapple flavoring and whisked until foamy. The whisked eggs were added in bits to the fat mixture. One tablespoon (3 teaspoons) baking powder and 3 large size nutmegs were grated and added to the flour. The batter was divided into three and 200 g each of the flour samples T<sub>1</sub> - T<sub>3</sub> were added to each and baked at a temperature of 180 degree Celsius for 45 minutes until it had an even brown color.

For the preparation of chips, 300 grams margarine and 1 tablespoon adobo seasoning (salt free) were used to produce 1 pound of chips and flour divided into three samples, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>. Three tablespoons of water was added to each sample to form dough. The dough was rolled into a size of about 0.4 cm in thickness and cut out into straw chips. Chips were arranged on lightly greased baking sheet and baked at a temperature of 180°C for 12 to 15 minutes to golden brown.

| Sample         | Ingredients/Action |           |                  |              |                           |                     |                 |                |
|----------------|--------------------|-----------|------------------|--------------|---------------------------|---------------------|-----------------|----------------|
|                | Margarine (g)      | Sugar (g) | Eggs medium size | Nutmeg (Tsp) | Flavoring Pineapple (tsp) | Baking Powder (tsp) | Wheat flour (g) | Taro flour (g) |
| T <sub>1</sub> | 450 mix            | 400       | 10 mix           | 1 mix        | 2 mix                     | 3 mix               | 100             | 100            |
| T <sub>2</sub> | 450 mix            | 400       | 10 mix           | 1 mix        | 2 mix                     | 3 mix               | 50              | 150            |
| T <sub>3</sub> | 450 mix            | 400       | 10 mix           | 1 mix        | 2 mix                     | 3 mix               | 150             | 50             |

\*\*Ingredients are listed on the left most columns followed by the actions. The further right an ingredient and action are listed, the later in time that action should take place

Table 1: Recipe for preparing taro cake.

| Sample         | Ingredients/Action |                                 |                 |                |
|----------------|--------------------|---------------------------------|-----------------|----------------|
|                | Margarine (g)      | Adobo salt free seasoning (tsp) | Wheat flour (g) | Taro flour (g) |
| T <sub>4</sub> | 300 mix            | 1 mix                           | 150             | 50             |
| T <sub>5</sub> | 300 mix            | 1 mix                           | 100             | 100            |
| T <sub>6</sub> | 300 mix            | 1 mix                           | 50              | 150            |

\*\*Ingredients are listed on the left most columns followed by the actions. The further right an ingredient and action are listed, the later in time that action should take place. Add salt to taste

Table 2: Recipe for preparing taro chips.

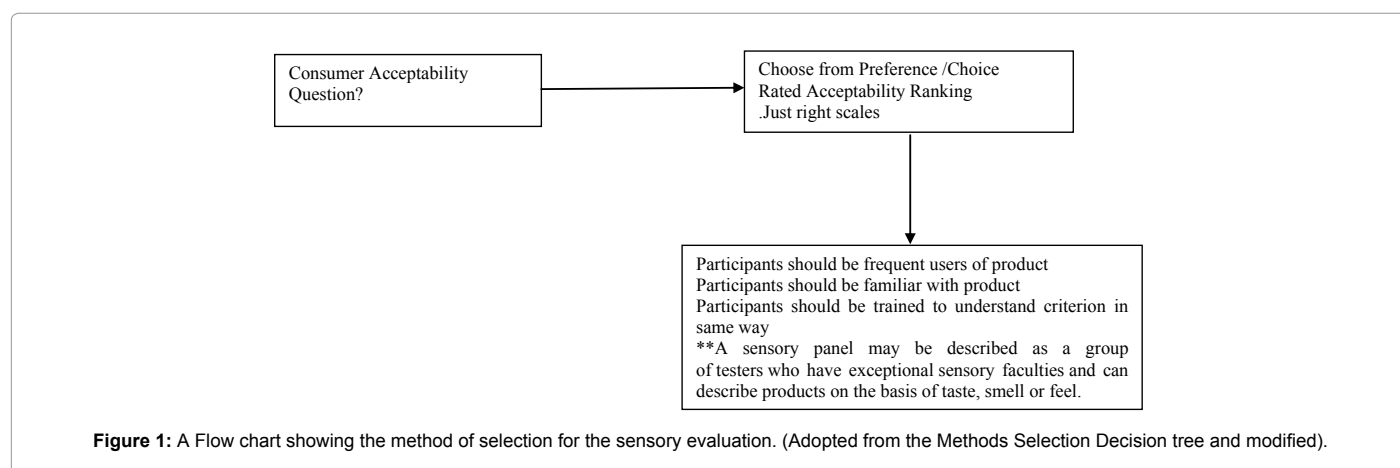


Figure 1: A Flow chart showing the method of selection for the sensory evaluation. (Adopted from the Methods Selection Decision tree and modified).

### Sensory evaluation of the taro cake and chips (pastries)

The method of selection was adopted from the Methods Selection Decision tree and modified (Figure 1).

**Sensory evaluation method (s) used:** The Affective method was used to determine consumer acceptance of the products.

#### Panel:

- Hedonic test (5-point hedonic scale-5- excellent; 4- very good; 3-good; 2- fair; and 1- poor was used); the attribute rating was based on appearance, taste, color, texture, flavor and overall acceptability.
- 5 males and 5 females totaling 10 panel members were used.
- The purposive sampling technique was used to select panel members and an informed consent statement provided to them.

**Test conditions:** Test area for the sensory evaluation was the Vocational and Technical Education Department's food laboratory.

**Sample description:** Sensory evaluation of two (2) taro food products- baby food and pastries (plain cake and straw chips) were coded as S<sub>1</sub> - S<sub>4</sub> and T<sub>1</sub> - T<sub>4</sub> respectively.

**Sample preparation:** Samples were prepared, blind labeled using random codes with minimum conceptual information. For the baby

food, 4 samples were tested at one session and for the taro cake and chips, 2 sessions were organized with 3 samples at each session.

**Analysis:** Analysis of variance (ANOVA) was used.

**i. Selection criteria:** To participate, the individual has to be either an employee or nonemployee specifically a staff or student of the University of Cape Coast (UCC).

**ii. Demographics:** Participants had to be at least 18 years of age or more and equal numbers of males and females were selected to help bring out differences in taste and smell characteristics of these two groups of people, for example men are known to tolerate more bitter taste than females. Participants should be familiar with product and be able to know what organoleptic characteristics to expect of taro products. They should be frequent users/eaters of the product as well.

**iii.** Panelists were instructed to wash their mouths after each sample tasted and swallowed. They were also asked to wait a few minutes after each tasting before the next and asked to avoid any form of communication with each other to prevent any possible influence from each other. For scoring of taro products based on the sensory characteristics, a structured questionnaire in the form of a tabular scoring sheet was designed in a way that required panelists to score products presented to them independently. The score sheet was verbally explained to panelists before they were handed over to them.

### Proximate analysis of taro flour

The different constituents of the prepared taro flour were determined using proximate analysis. For determining the dry matter content of the taro flour, 1g of the sample (taro flour) was weighed after drying the taro flour in an oven at 105°C for 24 hours according to [7]. The total nitrogen content of the taro flour which is an indication of the protein content was determined using the Kjeldahl digestion and distillation method. The Soxhlet ether method of extraction was used to determine the lipid and fat content of the flour. The Anthrone method was used for determining Carbohydrates and the dietary fiber content was obtained using the acid fiber method; and ash and moisture were determined using the physical method [7].

### Results and Discussion

Table 3 shows the proximate composition of the taro flour. The dry matter content of the taro flour was 85.32%. In a study to promote taro for food production in Nigeria, all dried samples of taro analyzed were rich in dry matter (94.33 to 96.30%), which proves the efficiency of sun drying to allow a long term preservation of the taro flour. This makes taro processing and preservation more effective. Although the dry content in this case was lower, 85.32% is quite high for good preservation and storage. The high percentage of dry matter in taro (85.32%) enhances digestibility due to high fiber and hence using taro in infant formula helps in intestinal and bowel health.

In a comparison study of Taiwan paddy- and upland-cultivated taro, [8] reports show that fresh taro corms have 1.75% - 2.57% crude protein which is lower than that obtained for the taro flour prepared in this study (3.43%). On the contrary, other authors, [9] show that the protein content of processed taro generally varies between 3% and 6%. The amount of protein in taro may probably be dependent on the type of cultivar and the handling and processing of the corm. Comparing a protein content of 1.75%-2.7% in fresh taro to about 3% to 6% in processed taro suggests that drying taro and milling it into flour among other treatments could improve or increase the protein content of taro.

As often recorded in most tubers, potassium constitutes the most abundant mineral in taro and sodium the least abundant. The same study [8] also reports reasonably high contents of potassium and magnesium ranging from 2251-4143 and 118-219 mg/100 g dry matter (DM), respectively for the paddy and upland taro. Although the individual minerals in the taro flour for this study were not determined because of lack of appropriate equipment, an ash content of 4.01% representing the level of all minerals present in the taro flour is remarkable and worth commenting on. The ash content was also higher than that of some macronutrients such as protein (3.43%) and carbohydrate (0.73%) [10]. Study on the effects of traditional soaking on the nutritional profile of taro flour in Chad reports the amount of potassium to be 10.2 g/kg DM for the control and sodium is the least abundant macro-element (0.45 g/kg DM for the control). In earlier studies, [11] results show that potassium constitutes the most abundant macro-element in taro and sodium the least abundant [12]. Some studies however publish slightly lower sodium values from 0.28 to 0.35 g/kg DM for taro tubers grown in Ghana.

A high starch content of 21.1%-26.2% is revealed by [8] compared to that reported in this study (0.74% carbohydrates). Probably, during the drying process, some of the starches were lost together with the moisture thus reducing the amount available in the flour [2]. A study reports that taro corm is an excellent source of energy, required by the body for activity and also provides fiber for the intestines and

other parts of the digestive system to perform properly. It has been documented that regular consumption of taro provides a good source of calcium and iron. These minerals are known to help make bones and teeth strong as well as keep blood healthy thus making taro an essential component of baby food [13]. It has also been recommended as an excellent food product for people with digestion problems and allergies such as lactose intolerance. The protein in taro is relatively high (3.43%) as compared to other root tubers such as potatoes thus providing better growth in infants when used in baby food.

### Sensory analysis

Sensory evaluation scores were subjected to analysis of variance (ANOVA) and Duncan's Multiple tests to determine any significant difference at 5% significance level. The mean scores for quality and overall acceptability as produced from ANOVA results for the male panelists are presented in table 4. Generally, all the samples produced high mean scores for all the qualities considered in the sensory analysis. Appearance and color of all products S<sub>1</sub>-S<sub>4</sub> were not significantly different whilst taste, flavor and overall acceptability differed. The taste of S<sub>1</sub> and S<sub>3</sub> were not significantly different but were significantly different from S<sub>2</sub> and S<sub>4</sub>. For texture, samples S<sub>1</sub> and S<sub>2</sub> had no significant difference whereas S<sub>4</sub> had a significant difference (Table 4). The figures reported in table 4 represent the mean scores provided by the panelists in evaluating the quality characteristics of the taro products presented to them for evaluation. There was no significant difference within the sensory characteristics of products S<sub>1</sub> and S<sub>3</sub> but there were some significant differences within the sensory characteristics of products S<sub>2</sub> and S<sub>4</sub> at 5% significance level respectively. Also, between products evaluated, there was no significant difference in the appearance and color of all products at 5% significance level. There was no significant difference in the taste and flavor of S<sub>1</sub> and S<sub>3</sub> but these were significantly different from the taste and flavor of S<sub>2</sub> and S<sub>4</sub> which were similar in taste and flavor at 5% significance level. The texture of S<sub>1</sub>, S<sub>2</sub> and S<sub>3</sub> was not significantly different but was different from that of S<sub>4</sub> at 5% significance level. For overall acceptability, S<sub>1</sub> was not significantly different from all the other three products S<sub>2</sub>, S<sub>3</sub> and S<sub>4</sub> but S<sub>2</sub> and S<sub>4</sub> were significantly different from S<sub>3</sub> at 5% significance level.

As presented in table 5, there was no significant difference between the appearance, color, texture, flavor and overall acceptability of products S<sub>1</sub> - S<sub>4</sub>. However, the taste of S<sub>2</sub> was significantly different from

| Parameter    | Percentage (%) |
|--------------|----------------|
| Dry matter   | 85.32          |
| Moisture     | 14.68          |
| Ash          | 4.01           |
| Protein      | 3.43           |
| Carbohydrate | 0.74           |
| Fat          | 0.18           |

\*Figures are based on dry matter content

Table 3: Proximate composition of Taro flour.

| Product        | Appearance       | Taste            | Color            | Texture          | Flavor           | Overall Acceptability |
|----------------|------------------|------------------|------------------|------------------|------------------|-----------------------|
| S <sub>1</sub> | 4.0 <sup>a</sup> | 4.2 <sup>a</sup> | 3.8 <sup>a</sup> | 4.2 <sup>a</sup> | 4.2 <sup>a</sup> | 4.2 <sup>ab</sup>     |
| S <sub>2</sub> | 3.8 <sup>a</sup> | 3.2 <sup>b</sup> | 3.6 <sup>a</sup> | 4.2 <sup>a</sup> | 3.2 <sup>b</sup> | 3.6 <sup>b</sup>      |
| S <sub>3</sub> | 4.0 <sup>a</sup> | 4.8 <sup>a</sup> | 3.8 <sup>a</sup> | 4.2 <sup>a</sup> | 4.4 <sup>a</sup> | 4.6 <sup>a</sup>      |
| S <sub>4</sub> | 4.4 <sup>a</sup> | 3.0 <sup>b</sup> | 3.8 <sup>a</sup> | 3.4 <sup>b</sup> | 3.0 <sup>b</sup> | 3.6 <sup>b</sup>      |

α ≤ 0.05 Values are means of 5 scores from male panelists on each characteristic. Means with similar letter(s) in the same column or row are not significantly different at 5% significance level

Table 4: Male panelists ANOVA results for evaluating baby food.

| Product        | Appearance       | Taste            | Color            | Texture          | Flavor           | Overall Acceptability |
|----------------|------------------|------------------|------------------|------------------|------------------|-----------------------|
| S <sub>1</sub> | 3.8 <sup>a</sup> | 3.8 <sup>a</sup> | 3.8 <sup>a</sup> | 4.0 <sup>a</sup> | 3.4 <sup>a</sup> | 4.0 <sup>a</sup>      |
| S <sub>2</sub> | 3.4 <sup>a</sup> | 3.6 <sup>b</sup> | 3.4 <sup>a</sup> | 3.8 <sup>a</sup> | 3.6 <sup>a</sup> | 3.6 <sup>a</sup>      |
| S <sub>3</sub> | 4.0 <sup>a</sup> | 4.0 <sup>a</sup> | 3.8 <sup>a</sup> | 4.2 <sup>a</sup> | 3.8 <sup>a</sup> | 3.8 <sup>a</sup>      |
| S <sub>4</sub> | 3.6 <sup>a</sup> | 3.6 <sup>a</sup> | 3.8 <sup>a</sup> | 3.8 <sup>a</sup> | 4.0 <sup>a</sup> | 4.0 <sup>a</sup>      |

$\alpha \leq 0.05$  Values are means of 5 scores from female panelists on each characteristic. Means with similar letter(s) in the same column or rows are not significantly different at 5% significance level

**Table 5:** Female panelists ANOVA results for evaluating baby food.

all the other samples S<sub>1</sub>, S<sub>3</sub> and S<sub>4</sub> at 5% significance level. There was no significant difference within all the sensory qualities of S<sub>1</sub>, S<sub>3</sub> and S<sub>4</sub> at 5% significance level except for the taste of S<sub>2</sub> which was significantly different from the other sensory qualities of S<sub>2</sub>.

The ANOVA results presented in table 6 show that there was no significant difference between the scores for appearance, color, and flavor of all products S<sub>1</sub>- S<sub>4</sub> by males and females at 5% significance level. However, the taste of S<sub>1</sub> was not significantly different from that of S<sub>2</sub>, S<sub>3</sub>, and S<sub>4</sub> but although the taste of S<sub>2</sub> was the same as S<sub>4</sub>, it was significantly different from that of S<sub>3</sub> at 5% significance level. For S<sub>2</sub> and S<sub>4</sub> taste was significantly different from appearance, color, and flavor at 5% significance level and similar to texture and overall acceptability.

Although males are normally known to be color blind, their scores for color (Table 4) were expected to be different from that of the females (Table 5). However, the results on color rather did not show any significant difference. In the case of taste, scores for both males and females were significantly different (Table 8). This may have resulted from the fact that males are known to have taste buds which are more sensitive to bitter taste than females who are more sensitive to sweet taste.

There was no significant difference in the scores on appearance, color and flavor for both males and females. Rather, there was a slight significant difference for taste and texture for the combined scores for both males and females. For overall acceptability of S<sub>1</sub>-S<sub>4</sub>, both males and females selected S<sub>3</sub> (Taro+Soybean) as the best product (Table 4) followed by S<sub>1</sub> (Taro+Maize/Corn), S<sub>4</sub> (Taro+Rice+Maize+Soybean) and the least being S<sub>2</sub> (Taro+Rice). S<sub>2</sub> had the least mean score with a significant difference in the rest of the products. Interestingly, when the mothers fed the babies with the cooked S<sub>1</sub>-S<sub>4</sub> samples in the order of feeding S<sub>1</sub> first through S<sub>4</sub>, babies were observed to have enjoyed eating S<sub>3</sub> best followed by S<sub>1</sub>, S<sub>4</sub> and S<sub>2</sub> as the least eaten. S<sub>1</sub> was the best baby food eaten probably because it contained both taro (carbohydrate) and soybean (protein) and thus more nutritious than the least eaten baby food S<sub>2</sub> which consists of taro flour and rice flour, both carbohydrates.

Although the ideal situation would have been for the babies to score if that was possible, the results of the panel members is still a good measure for acceptability of the product by babies since there was some similarities in the products that were eaten well and that selected by the panelists as best. The texture of S<sub>3</sub> (300g roasted milled taro + 100g roasted milled soybeans) giving a ratio of 3:1 was rated best probably because taro is known to be an excellent source of fiber and protein and is low in carbohydrate accounting for the consistency in texture which probably makes it more acceptable as baby food.

Between samples T<sub>1</sub>-T<sub>3</sub> (Table 7), texture and overall acceptability had no significant difference at 5% significance level. The appearance for samples T<sub>1</sub> and T<sub>3</sub> were not significantly different as well as the taste and color of T<sub>2</sub> and T<sub>3</sub>. The flavor of T<sub>1</sub> and T<sub>3</sub> were not significantly different at 5% significance level as shown in table 7 below. Within

sample T<sub>4</sub>, there was no significant difference in the sensory qualities at 5% significance level. The overall acceptability and texture within T<sub>5</sub> were similar but significantly different from appearance, taste, color and flavor at 5% significance level. For T<sub>3</sub>, there was no significant difference in all the sensory qualities within at 5% significance level.

There was no significant difference between T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> in terms of texture, color and overall acceptability for all products at 5% significance level as shown in table 8 below. The appearance, taste and flavor for T<sub>4</sub>-T<sub>6</sub> were not significantly different either. There was significant difference in appearance, color, texture and overall acceptability within sample T<sub>6</sub> at 5% significance level as well as for texture and overall acceptability for T<sub>5</sub> at 5% significance level.

There was no significant difference in texture, color and overall acceptability for products T<sub>4</sub>-T<sub>6</sub> as represented in table 8. The texture and overall acceptability of T<sub>5</sub> were different while the appearance, taste, color and flavor did not show any significant difference at 5% level. This trend was observed for T<sub>6</sub> as well but between T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>, there were no significant differences in the sensory qualities at 5% significance level.

For all samples in table 9, there was no significant difference in appearance, texture and flavor. However, the taste, color and overall acceptability of the products in table 9 were significantly different.

| Product        | Appearance       | Taste             | Color            | Texture           | Flavor           | Overall Acceptability |
|----------------|------------------|-------------------|------------------|-------------------|------------------|-----------------------|
| S <sub>1</sub> | 3.9 <sup>a</sup> | 4.0 <sup>ab</sup> | 3.8 <sup>a</sup> | 4.1 <sup>a</sup>  | 3.8 <sup>a</sup> | 4.1 <sup>ab</sup>     |
| S <sub>2</sub> | 3.6 <sup>a</sup> | 3.3 <sup>b</sup>  | 3.5 <sup>a</sup> | 4.0 <sup>ab</sup> | 3.3 <sup>a</sup> | 3.6 <sup>b</sup>      |
| S <sub>3</sub> | 4.0 <sup>a</sup> | 4.4 <sup>a</sup>  | 3.8 <sup>a</sup> | 4.2 <sup>a</sup>  | 4.1 <sup>a</sup> | 4.2 <sup>a</sup>      |
| S <sub>4</sub> | 4.0 <sup>a</sup> | 3.3 <sup>b</sup>  | 3.8 <sup>a</sup> | 3.6 <sup>a</sup>  | 3.5 <sup>a</sup> | 3.8 <sup>ab</sup>     |

$\alpha \leq 0.05$  Values are means of 10 scores from both male and female panelists on each characteristic. Means with similar letter(s) in the same column and row are not significantly different at 5% significance level

**Table 6:** Male and female panelists ANOVA results for evaluating baby food.

| Product        | Appearance        | Taste             | Color             | Texture          | Flavor            | Overall Acceptability |
|----------------|-------------------|-------------------|-------------------|------------------|-------------------|-----------------------|
| T <sub>1</sub> | 4.0 <sup>a</sup>  | 3.2 <sup>ab</sup> | 4.0 <sup>a</sup>  | 3.4 <sup>a</sup> | 3.6 <sup>ab</sup> | 3.6 <sup>a</sup>      |
| T <sub>2</sub> | 3.8 <sup>ab</sup> | 3.8 <sup>a</sup>  | 3.2 <sup>ab</sup> | 3.6 <sup>a</sup> | 4.2 <sup>a</sup>  | 3.8 <sup>a</sup>      |
| T <sub>3</sub> | 4.0 <sup>a</sup>  | 3.6 <sup>a</sup>  | 3.8 <sup>ab</sup> | 3.6 <sup>a</sup> | 3.4 <sup>ab</sup> | 3.8 <sup>a</sup>      |

$\alpha \leq 0.05$  Values are means of 5 scores from male panelists on each characteristic. Means with similar letter(s) in the same column or row are not significantly different at 5% significance level

**Table 7:** Sensory evaluation of Taro cake by male panelists.

| Product        | Appearance         | Taste              | Color             | Texture          | Flavor            | Overall Acceptability |
|----------------|--------------------|--------------------|-------------------|------------------|-------------------|-----------------------|
| T <sub>4</sub> | 3.4 <sup>abc</sup> | 2.2 <sup>c</sup>   | 3.0 <sup>b</sup>  | 3.2 <sup>a</sup> | 2.4 <sup>c</sup>  | 2.8 <sup>a</sup>      |
| T <sub>5</sub> | 3.2 <sup>bc</sup>  | 2.4 <sup>bc</sup>  | 3.2 <sup>ab</sup> | 3.4 <sup>a</sup> | 3.0 <sup>bc</sup> | 3.0 <sup>a</sup>      |
| T <sub>6</sub> | 3.0 <sup>c</sup>   | 3.0 <sup>abc</sup> | 3.2 <sup>ab</sup> | 3.4 <sup>a</sup> | 3.2 <sup>bc</sup> | 2.8 <sup>a</sup>      |

$\alpha \leq 0.05$  Values are means of 5 male panelists on each characteristic. Means with similar letter(s) in the same column or row are not significantly different at 5% significance level.

**Table 8:** Sensory evaluation of Taro chips by male panelists.

| Product        | Appearance       | Taste             | Color             | Texture          | Flavor           | Overall Acceptability |
|----------------|------------------|-------------------|-------------------|------------------|------------------|-----------------------|
| T <sub>1</sub> | 3.8 <sup>a</sup> | 3.8 <sup>ab</sup> | 4.0 <sup>ab</sup> | 4.4 <sup>a</sup> | 4.0 <sup>a</sup> | 4.4 <sup>a</sup>      |
| T <sub>2</sub> | 4.2 <sup>a</sup> | 4.0 <sup>a</sup>  | 4.0 <sup>a</sup>  | 4.4 <sup>a</sup> | 4.6 <sup>a</sup> | 4.2 <sup>ab</sup>     |
| T <sub>3</sub> | 4.2 <sup>a</sup> | 4.0 <sup>a</sup>  | 4.4 <sup>a</sup>  | 4.2 <sup>a</sup> | 4.0 <sup>a</sup> | 4.0 <sup>ab</sup>     |

$\alpha \leq 0.05$  Values are means of 5 scores from female panelists. Means with similar letter(s) in the same column or row are not significantly different at 5% significance level

**Table 9:** Sensory evaluation of Taro cake by female panelists.

There was not much difference between the sensory qualities of T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> but within T<sub>2</sub> and T<sub>3</sub> the overall acceptability was significantly different from the other sensory qualities at 5% significance level.

Female panelists did not find any significant difference between the appearance, texture and flavor of T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> but within T<sub>4</sub>, taste and overall acceptability were significantly different from appearance, texture and flavor at 5% significance level. On the other hand, the sensory qualities within T<sub>3</sub> and T<sub>5</sub> did not show any significant differences at 5% significance level (Table 10).

Differences between the appearance, texture and flavor of T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were not significantly different at 5% significance level (Table 11). Only the color and taste within T<sub>2</sub> showed significant difference at 5% significance level and within T<sub>3</sub>, taste and overall acceptability for T<sub>3</sub> showed significant difference at 5% significance level. T<sub>2</sub> was selected by panelists as the best product followed by T<sub>3</sub> and T<sub>1</sub> respectively. Probably sample T<sub>2</sub> was selected as the best product because it was the most spongy with high proportion of taro flour added (150g taro flour + 50g wheat flour) as compared to that of T<sub>1</sub> (100g taro flour + 100g wheat flour) and T<sub>3</sub> (50g taro flour + 150g wheat flour).

Between T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>, there was no significant difference in all the sensory qualities scored except for the overall acceptability at 5% significance level. This trend is the same within T<sub>5</sub> where only the overall acceptability showed significant difference at 5% significance level (Table 12).

T<sub>6</sub> (150g taro flour + 50g wheat flour) was selected as the best product followed by T<sub>5</sub> (100g taro flour + 100g wheat flour) and T<sub>4</sub> (50g taro flour + 150 wheat flour) respectively. This trend can be attributed to the different proportions of taro flour added to wheat flour in the various products.

According to a study, food flavor arises from a subtle interaction of taste and aroma which impacts a pleasing and displeasing smell of

| Product        | Appearance       | Taste             | Color             | Texture          | Flavor           | Overall Acceptability |
|----------------|------------------|-------------------|-------------------|------------------|------------------|-----------------------|
| T <sub>4</sub> | 3.8 <sup>a</sup> | 3.2 <sup>b</sup>  | 4.0 <sup>ab</sup> | 4.2 <sup>a</sup> | 3.8 <sup>a</sup> | 3.4 <sup>b</sup>      |
| T <sub>5</sub> | 3.6 <sup>a</sup> | 3.4 <sup>ab</sup> | 3.6 <sup>ab</sup> | 4.0 <sup>a</sup> | 3.4 <sup>a</sup> | 3.4 <sup>b</sup>      |
| T <sub>6</sub> | 3.6 <sup>a</sup> | 3.6 <sup>ab</sup> | 3.2 <sup>b</sup>  | 4.2 <sup>a</sup> | 3.6 <sup>a</sup> | 3.6 <sup>ab</sup>     |

α ≤ 0.05 Values are means of 5 scores from female panelists on each characteristic. Means with similar letter(s) in the same column or row are not significantly different at 5% significance level

Table 10: Sensory evaluation of Taro chips by female panelists.

| Product        | Appearance       | Taste             | Color              | Texture          | Flavor           | Overall Acceptability |
|----------------|------------------|-------------------|--------------------|------------------|------------------|-----------------------|
| T <sub>1</sub> | 3.9 <sup>a</sup> | 3.5 <sup>ab</sup> | 4.0 <sup>ab</sup>  | 3.7 <sup>a</sup> | 3.8 <sup>a</sup> | 4.0 <sup>abc</sup>    |
| T <sub>2</sub> | 4.0 <sup>a</sup> | 3.9 <sup>ab</sup> | 3.6 <sup>abc</sup> | 3.7 <sup>a</sup> | 3.7 <sup>a</sup> | 4.2 <sup>a</sup>      |
| T <sub>3</sub> | 4.1 <sup>a</sup> | 3.8 <sup>ab</sup> | 4.1 <sup>a</sup>   | 3.9 <sup>a</sup> | 3.7 <sup>a</sup> | 4.1 <sup>ab</sup>     |

α ≤ 0.05 Values are means of 10 scores of both male and female panelists. Means with similar letter(s) in the same column or row are not significantly different at 5% significance level

Table 11: Sensory evaluation of Taro cake by both males and female panelists.

| Product        | Appearance        | Taste             | Color              | Texture          | Flavor           | Overall Acceptability |
|----------------|-------------------|-------------------|--------------------|------------------|------------------|-----------------------|
| T <sub>4</sub> | 3.7 <sup>ab</sup> | 2.7 <sup>c</sup>  | 3.5 <sup>abc</sup> | 3.9 <sup>a</sup> | 3.1 <sup>a</sup> | 3.3 <sup>d</sup>      |
| T <sub>5</sub> | 3.3 <sup>b</sup>  | 2.9 <sup>cd</sup> | 3.4 <sup>b</sup>   | 3.5 <sup>a</sup> | 3.2 <sup>a</sup> | 3.5 <sup>cd</sup>     |
| T <sub>6</sub> | 3.3 <sup>b</sup>  | 3.3 <sup>cb</sup> | 3.2 <sup>c</sup>   | 3.6 <sup>a</sup> | 3.3 <sup>a</sup> | 3.6 <sup>bcd</sup>    |

α ≤ 0.05 Values are means of 10 scores of both male and female panelists on each characteristic. Means with similar letter(s) in the same column or row are not significantly different at 5% significant level

Table 12: Sensory evaluation of Taro chips by both males and female panelists.

a particular food product. Flavor, texture and appearance are perhaps the most important characteristics of food because they are attributes consumers really assess. The attribute color works together with flavor and texture to play an important role in food acceptability. Results also show that all the taro products presented to panelists had appreciable appearance, texture and flavor with appearance and texture been attributed to the fact that taro is light, soft, smooth and suitable for baby food and pastry production.

## Conclusion

Taste, flavor and overall acceptability of all the baby food products (S<sub>1</sub>-S<sub>4</sub>) differed with the taste and flavor of S<sub>1</sub> and S<sub>2</sub> being significantly different from that of S<sub>2</sub> and S<sub>4</sub>. The texture of S<sub>1</sub>, S<sub>2</sub> and S<sub>3</sub> were similar but significantly different from that of S<sub>4</sub>. Although gender usually has an effect on scores for color, in this study, there was no significant difference in the scores of males and females for color. However, gender did impact males and females scores showing a significant difference in taste. There was no significant difference in appearance, color and flavor of all the baby food products among males and females. For overall acceptability of S<sub>1</sub>-S<sub>4</sub>, both males and females selected S<sub>3</sub> (Taro + Soybean) as the best product, followed by S<sub>1</sub> (Taro + Maize/Corn), S<sub>4</sub> (Taro + Rice + Maize + Soybean), and the least being S<sub>2</sub> (Taro + Rice). S<sub>2</sub> had the least mean score with a significant difference in the rest of the products.

Between T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>, there was no significant difference in all the sensory qualities scored except for the overall acceptability at 5% significance level. T<sub>6</sub> (150g taro flour+50g wheat flour) was selected as the best product followed by T<sub>5</sub> (100g taro flour+100g wheat flour) and T<sub>4</sub> (50g taro flour+150 wheat flour) respectively. T<sub>2</sub> was selected by panelists as the best product followed by T<sub>3</sub> and T<sub>1</sub> respectively.

Panel members acknowledged the acceptance of the baby food, cake and chips prepared from a combination of taro flour and other cereals and grains such as maize/corn, rice and wheat. With the nutritive value of taro confirmed by the proximate analysis and the fact that taro is comparatively cheaper than other roots and tubers, promoting such taro food products is important and will help greatly in enhancing nutrition of the Ghanaian population especially the rural poor.

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