DEVELOPMENT OF FUNCTIONAL WEANIMIX USING SWEET POTATOES FORTIFIED WITH CARROTS

ABSTRACT

Functional weanimix was developed using sweet potatoes , soyabean and carrot.to see the best formulation and nutritional content. The consumer acceptability and the proximate composition of the product were determined. The product was prepared into porridge using three different formulations PSC100(sweet potato flour 60%, soya beans flour 30%, carrot flour 10%), PSC200(sweet potato flour 50%, soya beans flour 30%, carrot flour 20%) and PSC300(sweet potato flour 40%, soya beans flour 40%, carrot flour 20%). Thirty panellist assessed the products using the appearance, aroma, taste, mouthfeel, aftertaste, overall acceptability using point hedonic scale. Results of the study revealed that the PSC 300 was preferred in terms of appearance (4.37), aroma (4.33), after-taste (4.20), and general acceptability (4.53). PSC 100 competed fairly with PSC 300 with ratings of 4.3 (appearance), 4.13 (aroma), 4.0 (after taste), and 4.23 in general acceptability. PSC 300 was the most preferred formulation. The level of nutrients (ash-1.66, fat-17.64, fibre-6.86, protein -18.32, and carbohydrate- 52.91) in the most preferred formulation (PSC 300) met the FAO standards and that of the Codex Alimentarius Commission Guidelines for complementary foods for infants and young children.

Keywords: Weanimix, sweet potatoes, functional food, malnutrition, Vitamin A

1.0 Introduction

Nutritional deficiencies have been connected to the generational transfer of poverty in low-income countries. These deficiencies ultimately lead to a halt in growth and/or mortality, preventing individuals from realizing their full potential as adults. (Amagloh, 2012; Tacoli, 2017). Chronic micronutrient deficiencies, such as those caused by a lack of vitamin A, zinc, or iron in young children, can impair cognitive development and raise a child's risk of infections, stunted growth, or blindness with vitamin A deficiency shown to have the highest illness loads (Lam & Lawlis 2017). Due to their high phytate content and lack of pro-vitamin A/beta-carotene content, cereal-legume combinations frequently used as supplemental diets in low-income countries contributes to nutritional inadequacies. (Gibbs et al., 2011). Because human intestinal phytase activity is modest, phytate can form insoluble complexes with various micronutrients. These complexes can only partially hydrolyze to liberate the bound minerals (Elliott et al., 2022).

It has been suggested that one way to combat childhood malnutrition in underdeveloped nations is to improve the food of newborns (Obiri-Asamoah & Fraikue, 2018). As awareness in the role that food plays in promoting health and well-being as well as preventing disease has grown, the concept of "functional foods" has emerged. Regular or everyday meals that are included in a person's regular diet are known as functional foods (Reis et al., 2017). Functional foods when ingested consistently at effective amounts offer health benefits that go beyond simple nourishment (Granato et al., 2020). Today's consumers want foods that are safe, fresh, natural, and high in nutrients, as well as those that are processed and produced responsibly (Putnik et al., 2017)

The absence of nutrient-dense supplemental meals is one of the main causes of malnutrition in Ghanaian babies and children, which is why the Ministry of Health in Ghana developed weanimix with assistance from UNICEF (Omari, & Anyebuno, 2020).

Weanimix is a flour product made from a blend of one part legume (such as groundnuts and cowpeas) and four parts cereal (such as rice, millet, and maize) (Omari & Anyebuno, 2020) In Ghana, cereals are a major constituent of weanimix with little attention given to root tubers such as sweet potatoes. It has been determined that sweet potatoes, when used as a supplemental food, are a feasible product for improving the crop's usage as well as meeting the nutritional needs of newborns in underdeveloped nations (Laryea et al., 2018). As sources of carbohydrates, starchy root and tuber crops are only second in significance to cereals and they contribute significantly to the global food (Chandrasekara, & Kumar, 2016).
An increasing number of root vegetables have received attention due to the presence of bioactive compounds in them. Root vegetables such as carrots are high in dietary fiber, vitamins, minerals, and β-carotene is a precursor to vitamin A and can thus help prevent vitamin A deficiency (Laryea et al., 2018; Kambabazi et al., 2021; Siddiqui et al, 2022). The most prevalent deficiencies are those in iron, zinc, and vitamin A, which have detrimental consequences on growth and development (Adetola et al.,2020). Therefore the creation of a fresh strain of weanimix that is high in macro- and micronutrients to aid in the fight against undernutrition in young children is essential. Hence, the major objective of this study was to develop functional weanimix using sweet potatoes fortified with carrots.

2. Materials and methods

2.1 Sources of Raw Materials

The white Bonita variety of Sweet potato was purchased from Agormanya Market in the Eastern Region of Ghana. The soybean were purchased from Somanya market in Eastern Region of Ghana. The carrot was also purchased from Bantama market in the Asante Region of Ghana

2.2 Flours

2.2.1 Preparation of Sweet Potato Flour

The sweet potatoes were sorted by selecting the good ones from the unwanted ones. Sweet potatoes weighing 5.2 kg were washed, peeled, washed, sliced into 3mm thicknesses, and soaked in lemon solution for 5 minutes to prevent discoloration.

Sweet potatoes was then dried with a clean cloth and arranged in a dehydrator tray to dry at 125F/52^{o}C for 11 hours. The sweet potatoes were arranged in a baking sheet, while the oven was pre-heated to a temperature of 100℃ for the baking of sweet potatoes, Sweet potatoes slices were put in the oven for 40 minutes to get the product very dry. The dried sweet potatoes were ground to fine powder using (model SC-1589 Silver Crest) blender sieved with a 0.150 μ sieve and packaged in an air airtight zip lock bag for further use.

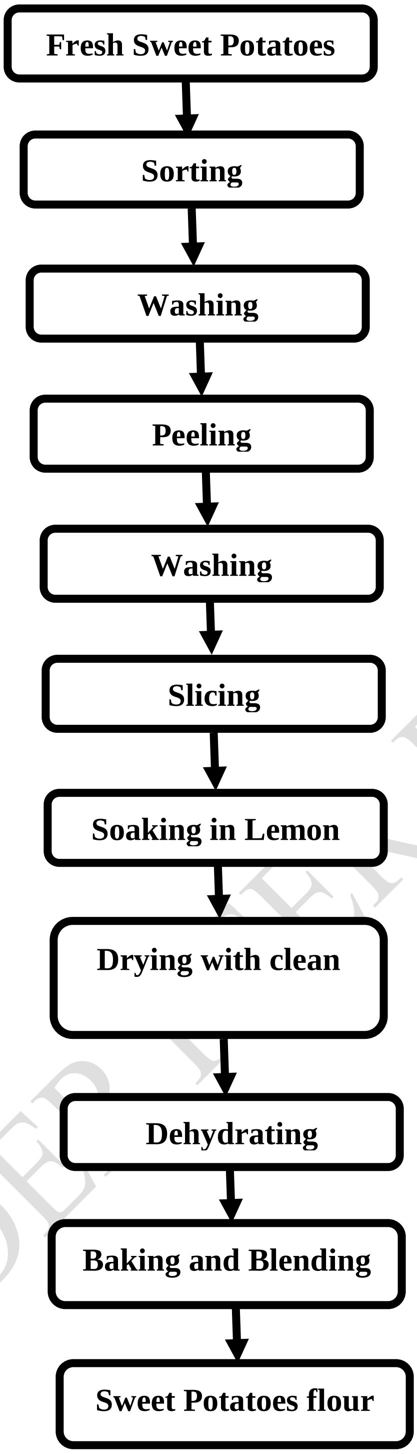

Figure 1: Process flow diagram for Sweet Potatoes flour

2.2.2 Preparation of Carrot flour

The method described by Phebean et al. (2017), was used in the preparation of carrot powder The carrot fruits were washed in portable water, peeled, and sliced into 56mm length and 2mm thickness; the sliced carrots were blanched for 3 minutes in hot water containing sodium metabisulphite to prevent browning and discoloration. According to Gamboa-Santos et al (2012), the dehydration of carrots was to extend their shelf-life for distribution and storage. Prior to these processes, carrots are usually blanched in hot water or steam for air removal, stabilization of colour, hydrolysis and solubilization of protopectin and inactivation of microorganisms and enzymes. The sliced and blanched carrot were then Place on dehydrator tray to dry at 125F/52°C for 6-10 hours. When the carrot were dried few pieces were then picked to test from different trays, it was then allowed to cool for about five minutes, carrots become dry when their surfaces are leathery, and they break easily.. The dried fruit was ground to fine powder (model SC-1589 Silver Crest) blender and sieved with a 0.150 µ sieve and was packaged in an air airtight transparent container for further uses.

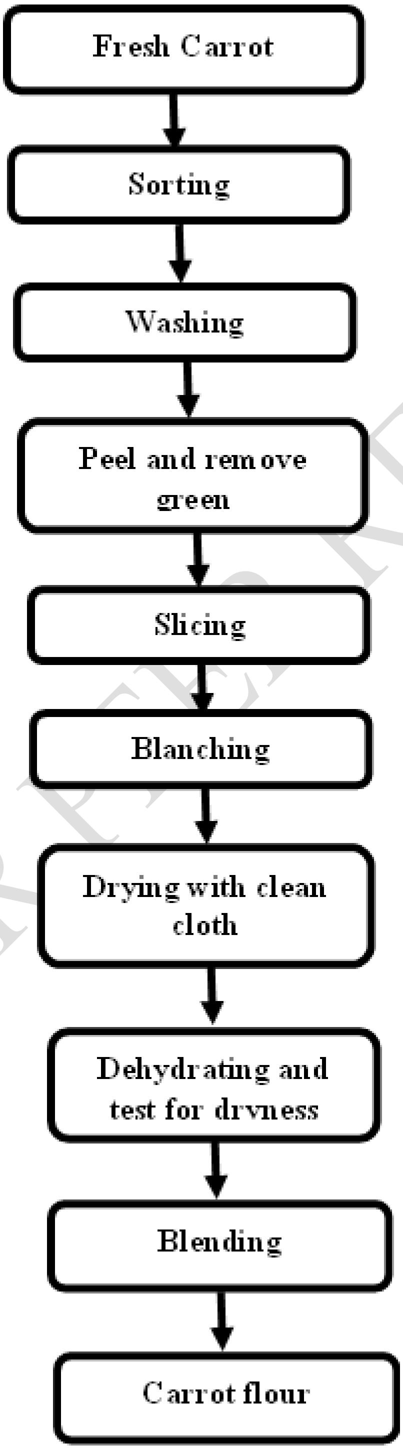

Figure 2: Process flow diagram for carrot flour

2.2.3 Preparation of Soya beans flour

Fresh soya beans were sorted by selecting the good ones from the unwanted ones. Soya bean weighing 2 Kg were put into a baking sheet, Pre-heat the oven to a temperature of 100℃ for 10minute for the baking of soya beans. Bake the soya beans at a temperature of 200℃ for 20 minute.

NOTE: Allow baked product to cool after baking. Blend the soya beans into fine powder (model SC-1589 Silver Crest) blender and was allow to cool and sieved with a 0.150 μ sieve. Package them into airtight containers and store at room temperature.

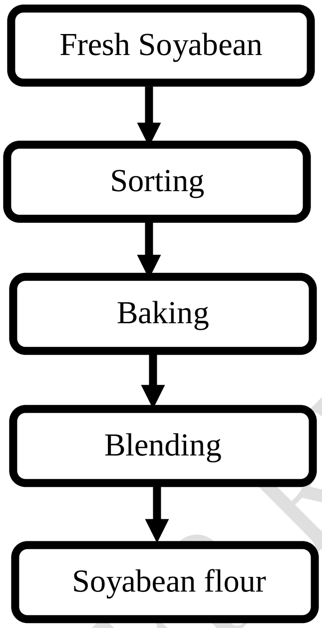

Figure 3: Process flow diagram for soyabean flour

2.3 Preparation of Composited Mixture

Preparation of composite samples mixtures composes sweet potatoes, soya beans, and carrot flour was mixed with 750ml of water into puree for porridge was carried out base on the formulation as shown in table 1 as follows: Product A (PSC 100) was prepared by using 60% (60g) sweet potatoes flour, 30%(30g) soya beans flour, 10%(10g) carrot flour, and some ingredients such as salt and sugar was added to enrich it. Product B (PSC 200) was prepared by using 50%(50g) sweet potatoes flour, 30%(30g) soya beans flour, 20%(20g) carrot flour, and some ingredients such as salt and sugar was added to enrich it. The last sample product C (PSC 300) was prepared by using 40%(40g) sweet potato flour, 40%(40g) soya beans, 20%(20g)carrot flour, and some ingredients such as salt and sugar was added to enrich it. It was prepared by using boiling method at 100℃ for 10 minutes.

Table 1 Flour of Sweet potato, Carrot, Soya beans for Porridge Production and some added Ingredients.

Product Samples	**Water (ml)**	**Sweet Potato Flour (%)**	**Soya beans Flour (%)**	**Carrot Flour (%)**	**Salt (g)**	**Sugar (g)**
PSC 100	**750**	**60**	**30**	**10**	**2**	10
PSC 200	**750**	**50**	**30**	**20**	**2**	10
PSC 300	**750**	**40**	**40**	**20**	**2**	10

The various flour blends from sweet potato, carrot, and soya beans was done as shown in Table 1. Each sample was measured to get a unified composite mix.

2.4 Porridge Making Procedure

About 334g of flour (sweet potatoes, soya beans, and carrot), salt and 300ml water was mixed together by stirring with a wooden spoon. About 450ml of water was poured into a saucepan, placed on fire to heat for about 5 minutes. The mixed puree was then poured in the heated water and immediately stirred by moving the wooden spoon to one direction until it became thick and add sugar. The porridge was left to boil at 100°C for 5minutes on fire. It was later taken from the fire and poured into a flask to maintain its hot temperature. Porridge were packed in a disposable cup and labeled according to formulations with codes prior to sensory evaluation.

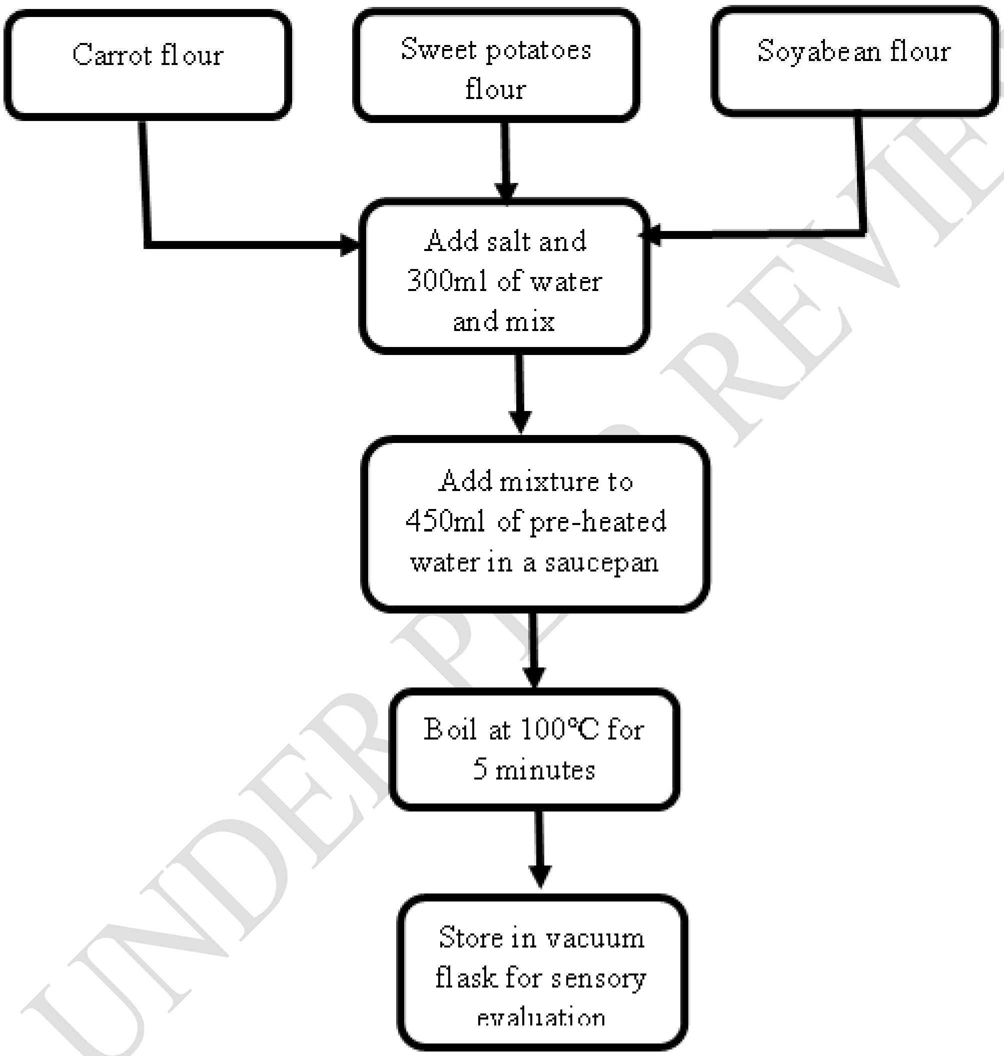

Figure 4. Process flow of Porridge preparation

2.5 Sensory Evaluation

Open and close-ended questionnaires concerning 'functional weanimix using root tuber fortified with carrot' was carried out in the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development – Kumasi Campus in the Ashanti Region of Ghana.

The three samples obtained from the different fractions of the flour (sweet potatoes, soya beans, and carrot) mixed and made into porridge were subjected to sensory evaluation.

The following attributes namely appearance, aroma, taste, mouthfeel, aftertaste and overall acceptability were assessed on the porridge samples using 5-point hedonic scale was 1= dislike very much, 2=dislike slightly, 3=neither like nor dislike, 4= like slightly, 5= like very much. 30 panelists who were neither sick nor allergic to porridge products were involved in the assessment. The panelists were instruction to rinse their mouth water after tasting each sample.

2.6 Proximate Analysis

2.6.1 Moisture Content and Total Solids: Oven Drying Method

About 5g of the sample was transferred to the previously dried and weighed dish. The dish was placed in an oven which was thermostatically controlled at 105 degrees for 5 hours. The dish was then removed and placed in a desiccator to cool to room temperature and weighed. The sample was dried gain for 30 minutes, cooled down, and weighed. The drying, cooling and weighing process were repeated until a constant weight was reached. (Alternatively, dry sample in a thermostatically controlled oven for at least 8 hours where a constant weight would be achieved) (AOAC.METHODS.1.1990).

NB. The determination was duplicated and the average found.

Calculations

$$\%\text{moisture (wt/wt)} = \frac{\text{wt } H_2O \text{ in sample}}{\text{Wt of wet sample}} \times 100$$

$$\%\text{moisture (wt/wt)} = \frac{\text{wt of wet sample-wtof dry sample}}{\text{Wt of wet sample}} \times 100$$

$$\%\text{total solids (wt/wt)} = \frac{\text{wt of dried sample}}{\text{Wt of wet sample}} \times 100$$

2.6.2 Ash Content:

About 5g of the sample was weighed into a tarred crucible. The sample was pre- dried to remove moist.

The crucibles were then placed in cool muffle furnace. Tongs, gloves and protective eyewear were used when the muffle furnace was warm. The muffle furnace was Ignited for 2 hours at about 600 degrees. The muffle furnace was turned off and waited until the temperature was dropped to 250 degrees and lower before it was opened. The door was carefully opened to avoid losing ash that may be fluffy. Safety tongs was used to, quickly transfer crucibles to a desiccator with a porcelain plate and desiccant. The desiccator was then Closed and the crucibles were allowed to cool prior to weighing (AOAC.METHODS.1.1990).

Calculations;

$$\%\text{Ash} = \frac{\text{wt of ash}}{\text{Wt of sample}} \times 100$$

$$\%\text{Ash} = \frac{\text{(wt of crucible+ ash)} - \text{wt of empty crucible}}{\text{(wt of crucible+ sample)} - \text{wt of empty crucible}} \times 100$$

2.6.3 Fat Content: Soxhlet Extraction

Previously dried (air oven at 100°C) 250 ml round bottom flask was Weighed accurately. About 5.0g of dried sample was weighed to 22 ×80mm paper thimble or a folded filter paper. A small of cotton or glass wool was placed into the thimble to prevent loss of the sample. About 150ml of petroleum spirit B.P 40-60°C was added to the round bottom flask and the apparatus was assembled. condenser was connected to the soxhlet extractor and refluxed for 4 - 6 hours on the heating mantle. After extraction the thimble was, removed and the solvent was recovered by distillation. the flask and fat/oil were heated in the oven at about 103°C to evaporate the solvent. The flask and contents were Cooled to room temperature in a desiccator. The flask was then weighed and the weight of fat/oil collected were also determined (AOAC.METHODS.1.1990).

$$\% \text{ FAT (dry basis)} = \frac{\text{fat/oil collected} \times 100}{\text{Weight of sample}}$$

$$\% \text{ FAT (dry basis)} = \frac{(\text{wt of flask + oil}) - \text{wt. of flask} \times 100}{\text{Weight of sample}}$$

2.6.4 Crude Fiber Determination

about 2.g of the sample from crude fat determination was Weighed into a 750ml Erlenmeyer flask. 200ml of 1.25% H_2SO_4 was added and immediately a flask was set on a hot plate and connected to a condenser. The contents boiled within 1 minute when it came into contact with the solution. At the end of 30 minutes, the flask was removed and immediately filtered through a linen cloth in a funnel and washed with a large volume of water. The filtrate was Washed (containing sample from acid hydrolysis) back into the flask with 200ml 1.25% NaOH solutions. The flask condenser was connected and boiled for exactly 30 minutes. It was then Filtered through Fischer's crucible and washed thoroughly with water and 15ml 96% alcohol was added. Crucible and contents were dried for 2 hours at 105 °C, cooled in desiccator and weighed. crucible was Ignited in a furnace for 30 minutes, cooled and reweighed (AOAC.METHODS.1.1990).

$$\% \text{ Crude fibre} = \frac{\text{weight of crude fibre} \times 100}{\text{Weight of sample}}$$

$$\% \text{ Crude fibre} = \frac{\text{wt of crucible + sample(before – after) ashing} \times 100}{\text{Weight of sample}}$$

2.6.5 Protein Determination

2.6.5.1 Digestion

To the digestion flask, 2g of the sample and a half of selenium –based catalyst tablets and a few anti-bumping agents were added. Add 25ml of concentrated H_2SO_4 was added and the flask was shook so that the entire sample is thoroughly wet. Flask was then placed on digestion burner and heated slowly until boiling ceased and the resulting solution was clear. Cooled to room temperature, the digested sample solution was transfered into a 100ml volumetric flask and made up to the mark (AOAC.METHODS.1.1990).

2.6.5.2 Distillation

To flush out the apparatus before use, the distilled water was boiled in a steam generator of the distillation apparatus with the connections arranged to circulate through the condenser, for at least 10 minutes. The tip of the condenser was beneath the surface of the distillate, and the receiving flask was lowered and continued to heat for 30 seconds in order to carry over all liquid in the condenser.

25 ml of 2% boric acid was pipetted and 2 drops of mixed indicator was added to 250ml conical flask.

The conical flask and its contents were placed under the condenser in such a position that the tip of the condenser was completely immersed in the solution. 10ml of the digested sample solution was measured into the decomposition flask of the Kejdahl unit, it was then fixed and excess of 40% NaOH (about 15-20ml) was added to it. The ammonia produced was distilled into the collection flask with the condenser tip immersed in the receiving flask till a volume of about 150ml– 200ml was collected. The apparatus was then flushed as in step 1 above, before another sample was distilled and on completion of all distillations, Steam need to be passed only until 5ml of distillate is obtained (AOAC.METHODS.1.1990).

2.6.5.3 Titration

Titrate the distillated solution with 0.1N HCL solution. The acid was then added until the solution was colorless. If additional acid was added the solution would have become pink. The nitrogen content was Determine, at least in duplicate, a blank determination was run using the same amount of all reagents as it was used for the sample. The blank was to correct the traces of nitrogen in the reagents and should include digestion as well as distillation (AOAC.METHODS.1.1990).

Calculation:

$$\% \text{ total nitrogen} = \frac{100 \times (Va-Vb) \times NA \times 0.01401 \times 100}{W \times 10}$$

Va- volume in ml of standard acid used in titration
Vb- volume in ml of standard acid used in blank
NA- normality of acid
W- Weight of sample taken

2.7 Carbohydrate

Calculation
Carbohydrate (%) = % crude fibre + % NFE
OR
Carbohydrate (%) =100 - (% moisture +% fat +% protein +% ash)
x. Calculation for dry basis = $\frac{(100-\% \text{ moisture}) \times \text{wet basis}}{100}$

Energy (Kcal/100g) is by Atwater method.

2.8 Statistical Analysis

The data obtained from the sensory tests were coded and inputted into the Statistical Package for Social Science (SPSS version 21) for further statistical analyses. Also, descriptive statistics were conducted and this encompassed means, standard deviation, coefficient of variations as well as significant difference. The Analysis of Variance (ANOVA) was conducted by use of Turkey at a confidence level of 95%.

3. Results and discussions

3.1 Consumer Acceptability of Functional Weanimix

The consumer acceptability survey findings of the functional weanimix included input from about 30 panelists. The consumer acceptability of the samples (PSC 100, PSC 200, and PSC 300) was evaluated using a 5-point hedonic scale, where 1 represents dislike very much and 5 represents a like very much. The evaluation criteria included appearance, aroma, taste, mouthfeel, aftertaste and overall acceptability According to the results, sample PSC 300 was scored 4.30 for its appearance, which corresponds to like slightly on the hedonic scale. This was followed by samples PSC 100 (4.30) and PSC 200 (4.10), which also correspond to like slightly on the hedonic scale. This results is similar to work than Kweku Amagloh et al., (2013) which showed all of the three formulations of sweet potato-based complementary foods were judged to be acceptable on all of the indicators. Again, Hagan et al., 2018 reported that, the appearance of mushroom cereal blend product was liked whereas the appearance of mushroom orange flesh sweet potatoes was neither liked nor disliked. This could be as a result of different ingredients used as well as different formulations used.

All of the samples aromas were slightly liked with ratings 4.13,4.03 and 4.33 for PSC 100, PSC 200 and PSC 300 respectively (Table 2). This was similar to that reported by Adetola et al., (2020) who reported the flavor of sweet potato-based complementary foods (OFSP-CF1: OFSP 64.57%, soybean 34.76%, carrot 0.68%) was liked slightly.

Samples PSC 100, PSC 200 and PSC 300 were each given a taste rating of 4.27, 4.17, and 4.23 on the hedonic scale, respectively, representing like slightly, with sample PSC 100 slightly preferred, which is consistent with that reported by Adetola et al., (2020) who reported the tatse of sweet potato-based complementary foods (OFSP-CF1: OFSP 64.57%, soybean 34.76%, carrot 0.68%) was liked slightly. The sample's aftertaste was liked slightly with rating 4.00, 4.17 and 4.20 for PSC 100, PSC 200 and PSC 300 respectively.

Sample PSC 200 had the highest mouthfeel rating of 3.90, followed by sample PSC 100 (3.86). and sample PSC 300 (3.77). All the samples mouthfeel were liked slightly with no statistical significant difference between them.

All of the samples received a generally favourable rating PSC 100 (4.23), PSC 200(4.00) and PSC 300 (4.53) for acceptance, with PSC 300 being preferred over the other two with rating like very much on the hedonic scale (Table 2) which aligns with the results of Kweku Amagloh et al., (2013) and Adetola et al.,2020 which showed all of the three formulations of sweet potato-based complementary foods were judged to be acceptable on all of the indicators.

Table 2. Consumer Acceptability of Functional Weanimix

Attributes		**Samples**	
	PSC 100	PSC 200	**PSC 300**
Appearance	4.30±0.65	4.10±0.92	**4.37±0.56**
Aroma	4.13±0.86	4.03±0.93	**4.33±0.92**
Taste	4.27±0.74	4.17±0.83	**4.23±0.77**
Mouthfeel	3.86±0.97	3.90±0.92	**3.77±1.00**
Aftertaste	4.00±0.83	4.17±0.79	**4.2±1.03**
Overall acceptability	4.23±0.72	4.00±0.83	**4.53±0.73**

-Data is represented as mean ± standard deviation

-Scale; 1- Dislike very much, 2-Dislike slightly, 3-Neither like nor dislike, 4-Like slightly, 5-Like Very much

PSC-100 (60% Sweet potato flour: 30% Soybean flour : 10% carrot flour)
PSC-200 (50% Sweet potato flour: 30% Soybean flour : 20% carrot flour)
PSC-300 (40% Sweet potato flour: 40% Soybean flour : 20% carrot flour)

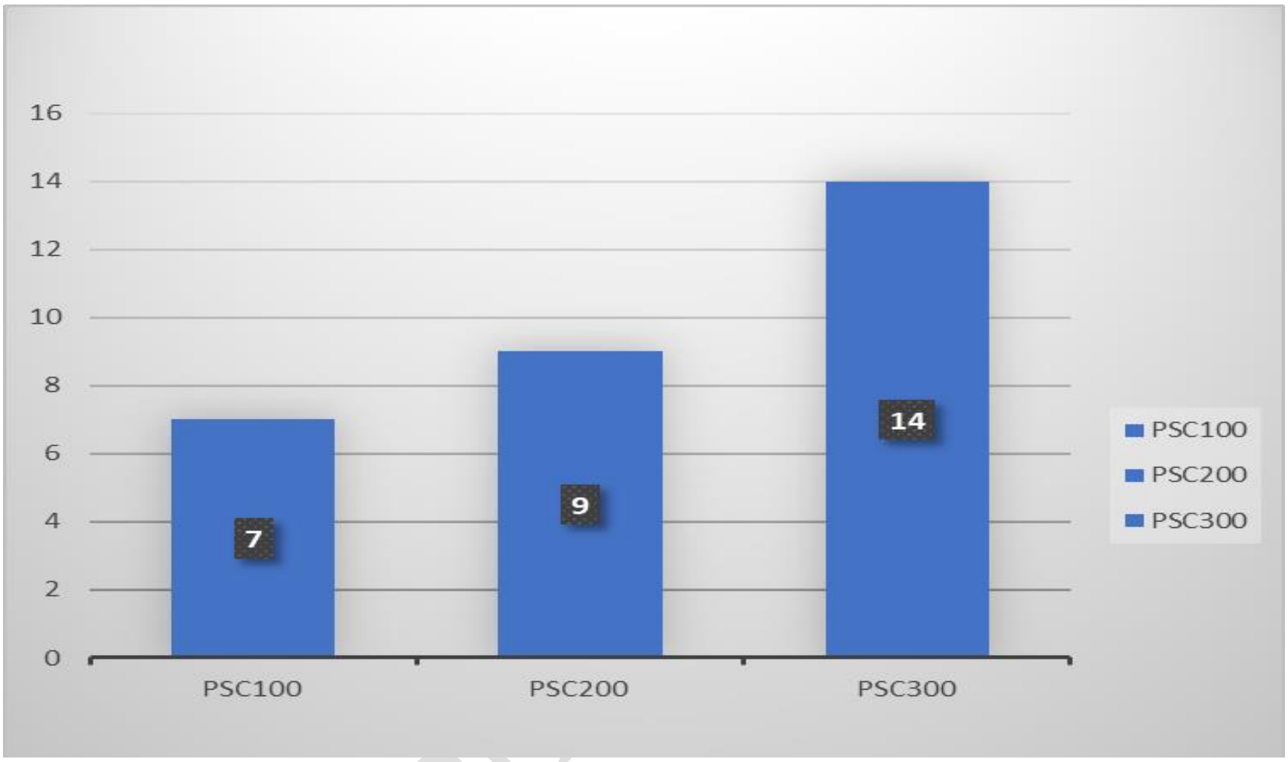

Figure 5: Commercially Availability

3.2 Commercial Availability of Functional Weanimix

Figure 5 indicates that 14 respondents representing 47% are willing to buy product PSC300 if it is commercially available whilst 9 respondents representing 30% are willing to buy product PSC200 if it is commercially available and 7 respondents representing 23% are willing to buy product PSC100 if it was commercially available. It can then be concluded that the product PSC300 which is rated highest will be bought by the majority of the respondents if it was commercially available followed by the product PSC200 and lastly the product PSC100.

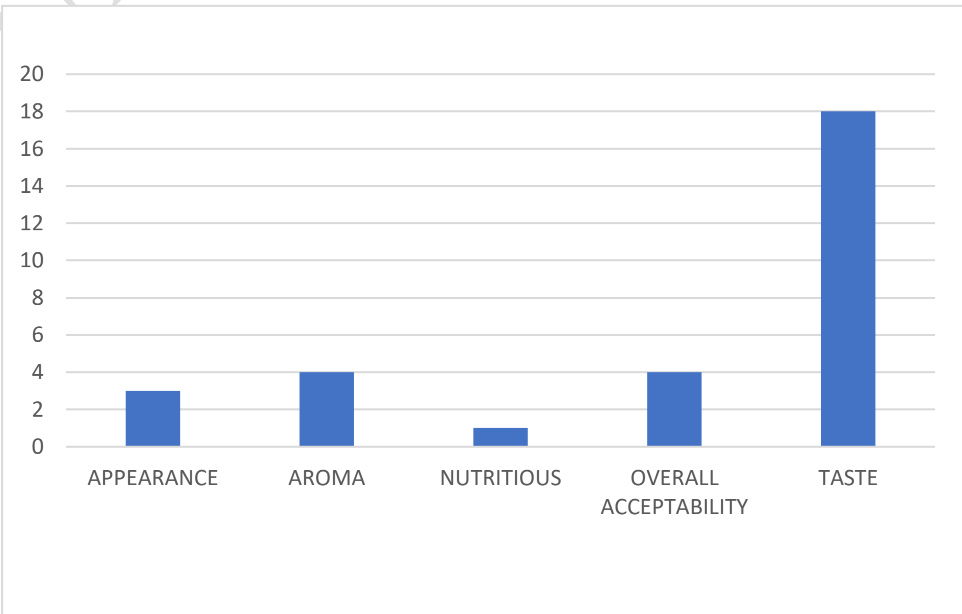

Figure 6: Reasons for Choice

3.3 Reasons for Choice of the Functional Weanimix

Again, when respondents were asked in the questionnaire to give their reasons why they would buy the product if it was commercially available, it was recorded that 3 respondents representing 10% would buy the product because of its appearance, 4 respondents representing 13% would buy the product because of the aroma, 1 respondent representing 3% will buy the product because the product is nutritious, 4 respondents representing 13% will buy the product because of the overall acceptability and 18 respondents representing 60% will buy the product because of the taste. This is shown in Figure 6

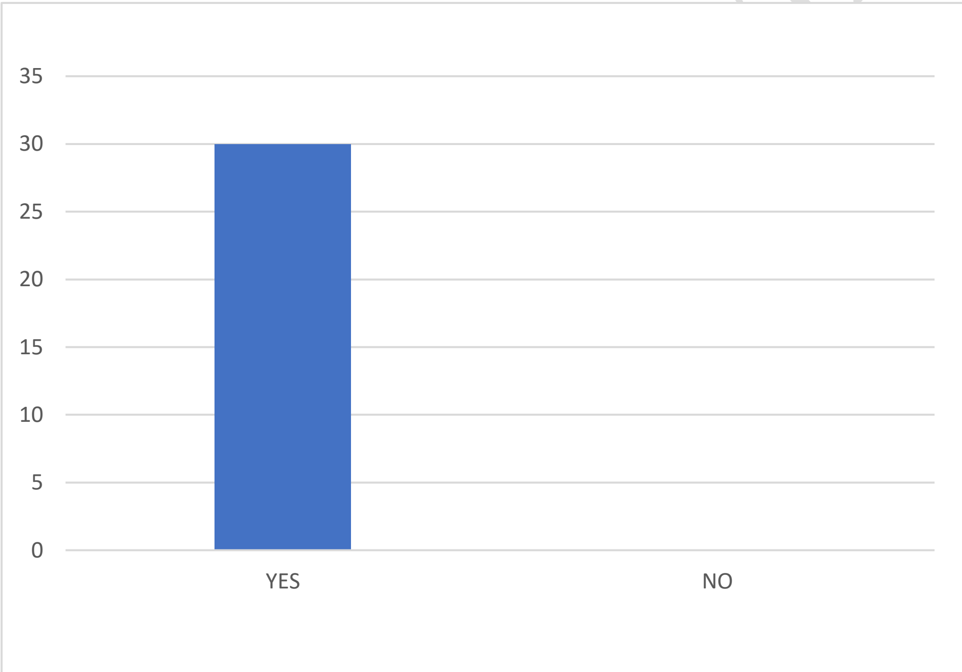

Figure 7. Recommendation of Product

3.4 Recommendation of Functional Weanimix to Others

Finally, respondents were asked to respond to whether they would recommend the product to consumers on a rating scale of YES or NO. From figure 7 it shows that 100% of the respondents (all the 30 respondents) responded yes to the products they have chosen but no respondent responded NO to the choice of the product he or she has made.

Table 3. Nutrient Composition of Functional Weanimix

Proximate Components	PSC 300
Moisture (%)	9.47±0.39
Ash (%)	1.66±0.03
Fat (%)	17.64±0.37
Fibre (%)	6.86±0.28
Protein (%)	18.32±3.02

Carbohydrate (%)	**52.91± 0.07**

-Values are averages of triplicate determinations
-Data is represented as mean ± standard deviation
-Most preferred sample ratio is represented as (PSC 300; 40% sweetpotato:40% soybean: 20% carrot)

4.6 Proximate Composition of Functional Weanimix

The nutritional composition of the most preferred formulation was investigated. The results showed that the moisture, ash, fat, fibre, protein and carbohydrate content were 9.47, 1.66, 17.64, 6.86, 18.32 and 52.91 respectively. The moisture content (9.47%) was higher than that reported by Adetola et al., 2020 (4.38%) and that of Laryea et al., 2018 (6.47%). The moisture content of foods is important to food manufacturers for a variety of reasons. Moisture is an important factor in food quality, preservation, and resistance to deterioration (Nielsen, 2010).

The presence of ash is an indication of minerals present in the sample (Owiredu et al., 2013). The ash falls within the range reported by Bonsi et al. (2014) (1.39–1.98%) but lower than that of Haque et al. (2013) (1.90–2.14%) in their orange-fleshed sweetpotato complementary foods. FAO (1990) reported that the ash content of a complementary food should be less than 5%. The most preferred sample therefore meets this standard.

The fat content of the most preferred sample was significantly higher (17.64%) than that reported by Laryea et al., 2018 (6. 20%).The higher fat content in weanimix could be attributed to the composition of the product; the product was soybean, carrot and sweet potatoe. The soybeans contributed to the fat content. The FAO (1990) reports that the fat content of complementary foods should be greater or equal to 12%. CAC/GL 08 (1999) also reports that the fat content should be at least 20%. Although the fat content of the functional Weanimix was above FAO standards, it met the standard of CAC/GL 08.

The fibre content of the PSC 300 was high (6.86) compared to that reported by Laryea et al., 2018 (1.70%) and is slightly above the criteria set by CAC/GL 08 (1999) and CAC (2011); which reports that fibre content should be less than5%. This is because the presence of high quantities of fibre makes the food bulky and induces flatulence CAC/GL 08 (1999); CAC (2011) which is an uncomfortable feeling in infants. Moreover, digestion of high fibre foods is a difficult task for infants, since their digestive system is not well developed at that stage.

Protein content of sample PSC 300 was significantly higher than that of complementary food reported by Laryea et al., 2018. It was able to meet the protein standard of FAO (1990) and CAC (2011) standards.

Carbohydrate contributes a lot towards energy in complementary foods. Its content could be high but must be digestible enough for infants and young children to obtain the energy required or needed CAC/GL 08 (1999); CAC (2011). The carbohydrate content obtained (52.91%) compared with Laryea et al., 2018 (65.95%) was lower. Carbohydrate content of the complementary foods were able to meet FAO (1990), CAC/GL 08 (1999) and CAC (2011) standards for carbohydrate. The carbohydrate content was also comparable with what was reported by Bonsi et al. (2014) and Haque et al. (2013) (42.30–54.5%).

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Three formulations were used in the production of functional weanimix using root tubers fortified with carrots. The formulation PSC 300 was the most preferred (PSC 300; 40% sweet potato: 40% soybean: 20% carrot).PSC 300 was preferred in terms of appearance (4.37), aroma (4.33), after-taste (4.20), and general acceptability (4.53). PSC 100 competed fairly with PSC 300 with ratings of 4.3 (appearance), 4.13 (aroma), 4.0 (after taste), and 4.23 in general acceptability.The level of nutrients (ash-1.66, fat-17.64, fibre-6.86, protein -18.32, and carbohydrate- 52.91) in the most preferred formulation (PSC 300) met the FAO standards and that of the Codex Alimentarius Commission Guidelines for complementary foods for infants and young children. This product is a very innovative and nutritious dish for all ages, and it will provide variety and support for the use of sweet potatoes; soyabean and carrots in complementary food which can help control protein-energy malnutrition and Vitamin A deficiency in children.

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APPENDIX A

AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

FACULTY OF VOCATIONAL EDUCATION

DEPARTMENT OF HOSPITALITY AND TOURISM EDUCATION

SENSORY EVALUATION OF FUNCTIONAL WEANIMIX USING ROOT TUBERS FORTIFIED WITH CARROT

PARTICIPANTS CONSENT FORM

I am conducting a study on the "functional weanimix using root tubers fortified with carrot". This study will provide an alternative source of food for with improved nutritional benefits to consumers. You are hereby invited to volunteer in participating in this sensory evaluation process by responding to the questionnaire herein. The following are the ingredients for the preparation of the weanimix:

- Sweet potatoes flour, carrot flour, soybean flour, sugar and salt

You are kindly reminded that should you be allergic to any of the above ingredients, do not hesitate to withdraw your participation in this study.

You are assured that any information provided by you in this regard would be treated with the utmost confidentiality.

Instructions:

1. Answer all the questions in the various sections
2. You are requested to rinse your mouth with water provided after assessing each sample
3. You have been provided with weanimix samples, kindly examine and give your degree of likeness using the scale below.
   1- Dislike very much
   2- Dislike slightly
   3- Neither like nor dislike
   4- Like slightly
   5- Like Very much

DEMOGRAPHICS

1. Gender: (a) Male (b) Female
2. Age: (a) Less than 20 years (b) 20-25 years (c) 26-30 years d) above 30 years
3. Level: (a) Level 100 (b) Level 200 (c) Level 300 (d) Level 400

Scale

1- Dislike very much
2- Dislike slightly
3- Neither like nor dislike
4- Like slightly
5- Like Very much

Attributes	Samples		
	PSC100	PSC200	PSC300
Appearance			
Aroma			
Taste			
Mouthfeel			
Aftertaste			
Overall acceptability			

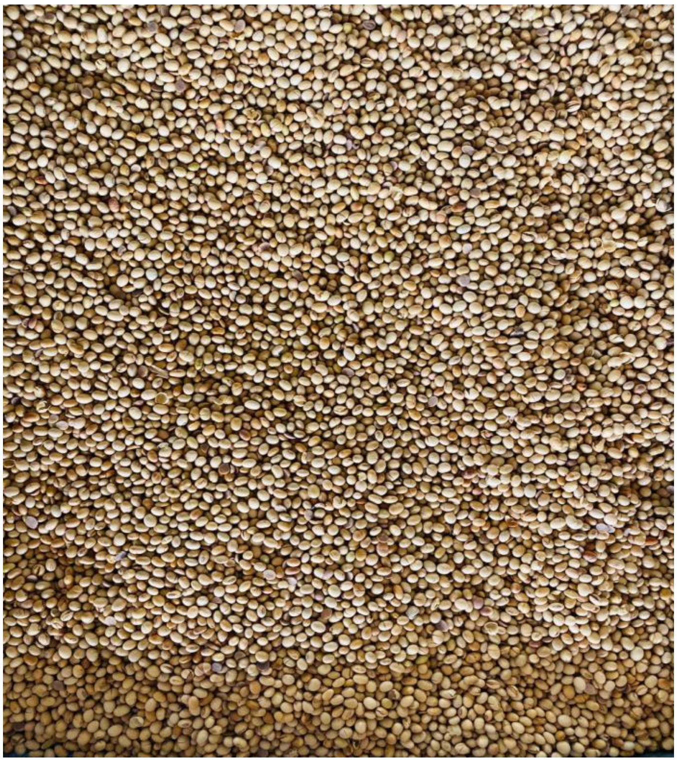
4. Which product will you buy if it was commercially available?
   (a) PSC100 b) PSC200 c) PSC300
5. What is the reason of your choice above (Q4.)?
6. Would you recommend this product to a nursing mother?
   a) Yes b) No c) Not sure

Thank you for completing this form

APPENDIX B

Sweet Potato

Freshly Cut Sweet Potato



Fresh Soya beans

Baked Soya beans

Fresh Carrot **Sliced Carrot**

Sliced Dried Carrot **Carrot Flour**

PSC 100 **PSC 200**

PSC 300 **Sweet potato carrot mix (sweet potato,**