Nutrient Composition, Physicochemical Properties and Sensory Evaluation of Protein Rich Mixed Fruit Juice Beverages Enriched with Soy Protein Powder

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ABSTRACT

Background: *Soy protein powder (SPP) has poor consumer acceptability and minimal use in value added drinks principally because of the "beany flavor". The use of flavoring, sweeteners, fruit pulps and other extracts is a technologically viable option for industries to mask the undesirable taste.*

Objective: *This study determined the nutrient composition, physicochemical properties and sensory evaluation of protein rich mixed fruit juice beverages enriched with soy protein powder.*

Methods: Pineapple, orange and watermelon fruits were weighed and juiced together at varying proportions, and mixed with different proportions of soy protein isolate (SPI). The samples were tagged A-E, and centrifuged. The centrifuged samples were tagged G-K. Sample F served as the control and did not contain SPI. The samples were analysed for nutrient, physicochemical, and sensory properties using standard methods.

Results: *The moisture content of the control and the SPI enriched samples ranged from 83.26-92.56%, while the centrifuged samples recorded moisture contents ranging from 87.46-90.98%. The crude protein content of the control and SPI enriched samples ranged from 1.28-11.28%, and the centrifuged samples recorded crude protein content ranging from 2.00-5.72. The pH of the control and the SPI enriched samples ranged from 3.83-4.94, and increased further (4.49-5.13) after centrifuging. Overall acceptability score of the sample showed that sample F (7.70) was ranked best.*

Conclusion: The study has showed that inclusion of soy isolates improved the protein content of mixed fruit juice, however the sensory evaluation result showed that panelists preferred the sample without soy ***protein isolates****.*

Keywords: Mixed fruit juice, Soy protein isolate, Sensory evaluation, Centrifuge, Protein

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INTRODUCTION

Beverages are foods consumed in liquid form, which can either be alcoholic or non-alcoholic. Non-alcoholic beverages are regarded as after meal drinks or refreshing drinks, however, most of these beverages are made up of about 90% water, sugar, flavouring agents and sometimes preservatives. Although most commercially available non-alcoholic beverages in developing countries are less nutritious, some of them such as soy milk, fruit juices etc., are nutritious and of medicinal value (1, 2). Beverage as a functional food can be produced from varieties of fruits, dairy and plant sources or a combination of them all for improved nutritional value.

Fruit juice is a popular drink as it contains antioxidants, vitamins and minerals that are essential for human beings (3, 4). The high potassium and low sodium contents of most juices help to maintain a healthy blood pressure (4). Fresh juice consumption is increasing globally due to consumer's perception of freshness, high vitamin content, low calorie value and ability to reduce risk of many diseases (5). They could prevent occurrence of several diseases, such as; heart diseases, cancer and diabetes (5, 6). Vitamin C, naturally present in fruit juices is important for the formation of body collagen, cartilage, muscle and blood vessels (6). In the beverages segment, the fruit processing Industries are developing differentiated products composed of two or more fruits, and this market is expanding increasingly (7, 8, 9, 10).

Fruit juice blends can be produced from various fruits in order to combine all the basic nutrients present in these different fruits. This usually gives a better-quality juice nutritionally and organoleptically. Recent studies show that the practice of mixing different exotic fruits positively improve the flavor and taste of the fruit and fruit products (11, 12). Much research has been carried out earlier in this context to determine the effects of different processing techniques on the nutritional components and consumers' acceptability of such beverages. Akusu *et al*. (13) have successfully reported on the quality characteristics of a fruit juice from blends of orange and pineapple fruits. Most fruit drinks contain negligible amount of protein as nutritional component. Fortification of fruit drinks with protein is a challenge due to protein stability in acidic and ionic environment. However, there have been limited information on mixing plant-based protein in the fruit juice blends. A number of fruits, vegetables and in some cases, soybean have become useful raw materials in the production of natural drinks. Moreover, one could think of developing a new product through the blends of pineapple, orange and watermelon enriched with soy protein powder in the form of a natural health drink which may also serve as a meal or an after-meal dessert. It could be considered a functional drink due to its health-promoting properties and could have anti-inflammatory, anti-atherosclerotic, antioxidants among others and help prevent malnutrition (14, 15). According to Ebabhamiegbebho *et al*. (16) incorporation of pineapple into soymilk improved the nutritional quality of the milk. It is therefore expected that incorporation of soy protein powder into pineapple, watermelon and orange juice will enhance the quality and sensory attributes of the beverage. The present study is designed to bridge the gap identified in previous research by enriching pineapple, orange and watermelon fruit juice blends with soy protein powder with focus on assessing consumer acceptability.

MATERIALS AND METHODS

Sample collection

Five Fully mature, ripe and fresh pineapple (Queen variety), fiften orange fruits (Parson Brown variety), two big watermelon (Crimson sweet variety) fruits and 1 kg soybean seeds were purchased from Mile 3 market, Port Harcourt, Rivers State, Nigeria.

Preparation of mixed juice

The fruits were selected washed, peeled and diced with a sterile stainless knife. The diced fruits were then weighed and transferred into a juicer (Pyramid, PM-J675) to extract the juice. Extracted juice was filtered using sterile muslin cloth. The filtered juice was packaged in air tight screw cap sterilized bottles then refrigerated at 4°C prior to use.

Production of soybean flour

This was done using the modified method described by Aminat *et al.* (17). The soy bean seeds were sorted manually to remove stones, damaged and immature seeds. The clean soy bean seeds were soaked in a volume of water four (4) times its weight (1:4 at 26ºC) for four (4) hours, after which it was boiled at 100ºC for 30 min. The seed coats were removed, washed and the water drained out. It was dried in an oven for 12 hours at 65ºC, after which it was milled and sifted through a 150 μm mesh screen.

Production of soy protein isolate (SPI)

SPI was prepared as described by Kondjoyan *et al.* (18). Soybean flours were degreased three times with n-hexane 1:6 (w/v) in a 37 °C water bath. Defatted soy flours were mixed with deionized water at a ratio of 1:10 (w/v) with the pH adjusted to 8.0 (2 mol/L NaOH). The mixture was stirred continuously for 30 min at room temperature. Afterward, the solution was centrifuged at 10,000 rpm for 30min at 4°C. After centrifugation, the pH of supernatant was adjusted to 4.5 using 2 mol/L HCl, and centrifuged at 6500 rpm for 30 min at 4 °C. The precipitate was washed with deionized water for 48 hours at 4°C and neutralized to pH 7.0 using 2 mol/L NaOH, followed by dialysis, and freeze-drying. The final product was a fine white powder of SPI. All steps were performed at room temperature.

Formulation of pineapple, orange and watermelon fruit juice blends enriched with SPI

Table 1 shows the formulation of mixed fruit juice with soy protein isolate using Pearson square (Food ratio formulation) as described by Wagner and

Stanton (19). They were mixed for 3 minutes using a blender to produce five homogeneous samples of protein rich mixed fruit juice beverages after which the five samples (A to E) were divided into two (2) and each of them centrifuged at 2500 rpm for 10 minutes to get a clear mixed fruit juice beverage sample (G to K). 100% mixed fruit juice (sample F) was used as the reference sample. The beverages formulated were separately packaged in airtight sterilized bottles, labelled and preserved in a refrigerator at 4°C until needed for analysis.

Table1:Formulation of mixed fruit juice with soy protein isolate

Sample Code	Pineapple (g)	Orange (g)	Watermelon (g)	Soy Protein Isolate (g)
	22.47	40.44	26.96	10.13
B	20.89	37.59	25.06	16.46
C	19.31	34.75	23.17	22.78
D	17.72	31.90	21.27	29.11
E	16.14	29.05	19.37	35.44
F (control)	33.33	33.33	33.33	-

•A= 22.47% PJ, 40.44% OJ, 26.96% WJ, 10.13% SPI
•B= 20.89% PJ, 37.59% OJ, 25.06% WJ, 16.46% SPI
•C= 19.31% PJ, 34.75% OJ, 23.17% WJ, 22.78% SPI
•D= 17.72% PJ, 31.90% OJ, 21.27% WJ, 29.11% SPI
•E= 16.14% PJ, 29.05% OJ, 19.37% WJ, 35.44% SPI
•F= 33.33% PJ, 33.33% OJ, 33.33% WJ, 0.00%SPI
•PJ= Pineapple juice
•OJ= Orange juice
•WJ= Watermelon juice
•SPI= Soy protein Isolate

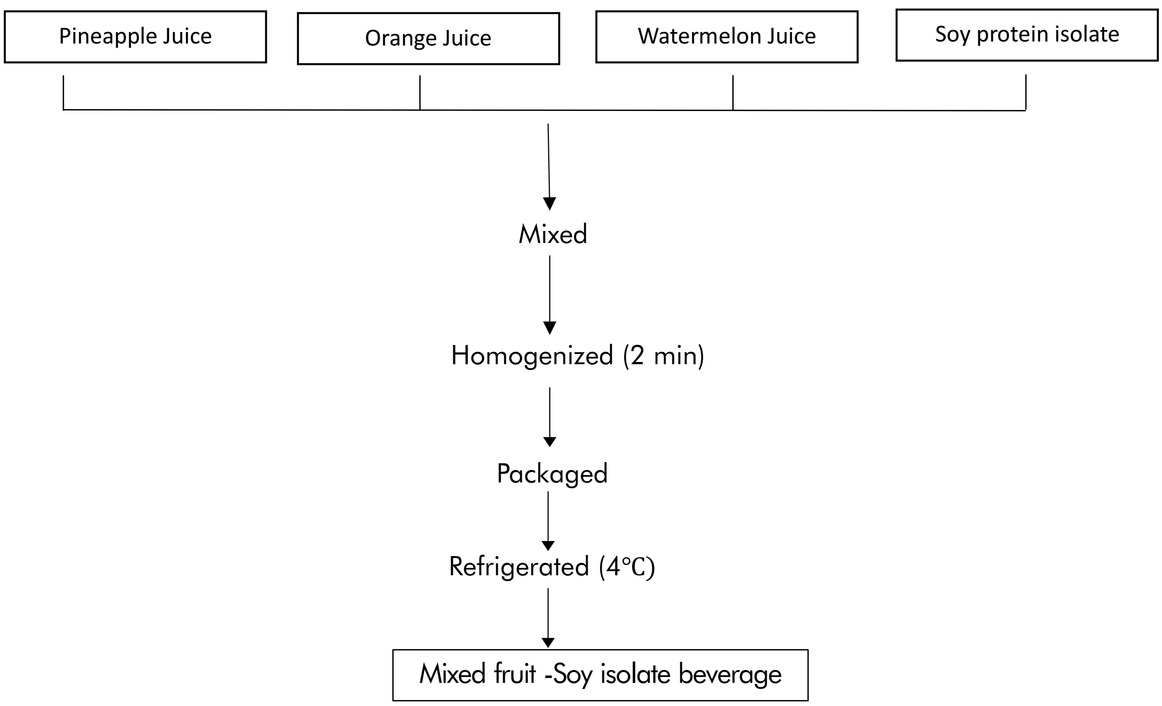

Fig. 1: Flowchart for the formulation of a protein rich mixed fruit juice beverage

Physicochemical properties determination
The pH, total soluble solids (°Brix) and total titratable acid (TTA) was determine using standard method described by Association of Official Analytical Chemists (AOAC) (20).

pH Determination
The pH of the juice was determined using a digital pH meter (pHs-2F, Harris, England). Exactly 50 ml of the juice was transferred into a beaker and the pH was determined after the meter was calibrated using standard buffer solutions of pH 4.0 and 7.0. Sufficient time was allowed for equilibration before readings were taken.

Total soluble solids (°Brix)
The hand-held sugar refractometer was used. The prism of the refractometer was cleaned and a drop of the juice was placed on the prism and closed. The total sugar content (°Brix) was read off the scale of the refractometer when held close to the eye.

Total titratable acid (TTA)
The titratable acidity was determined by titration with 0.1N sodium hydroxide (NaOH). Exactly 10 ml of the juice was pipetted into a conical flask and 25 ml of distilled water was added. Three drops of phenolphthalein indicator were added and titrated against 0.1N NaOH till a pink coloration was observed and the corresponding burette reading taken. The titratable acidity was calculated using the following formula;

$$\text{TTA (\%)} = \frac{\text{Average titre} \times \text{Dilution factor} \times 100}{\text{Weight of sample}}$$

Determination of nutrient composition
The moisture, protein, fat and ash contents of samples were analysed using the standard analytical method described by AOAC (20). Moisture was obtained gravimetrically after drying to a constant weight at 70°C in a hot air oven (DHG 9140A). Fat was determined using soxhlet extraction method with petroleum benzene. Kjeldahl method and a nitrogen conversion factor of 6.25 was used for crude protein determination. Ash content was determined gravimetrically after the incineration of the samples in a muffle Furnace (Model SXL) at 550°C for 2 h. The total carbohydrate content of the samples was determined using the Clegg Anthrone method as described by Okonwu *et al*. (21). Vitamin C content was determined using the spectrophotometric method as described by Rahman *et* al. (22). The methods described by Singh *et al*. (23) and Bolarinwa *et al*. (24) was used to determine the β-carotene content of the juice samples using an atomic absorption spectrophotometer (Buck scientific, model 210).

Sensory evaluation
The sensory evaluation was carried out using a twenty-member semi-trained panelist consisting of students of Food Science and Technology Department, Rivers State University, Port Harcourt, Rivers State, Nigeria. The organoleptic qualities evaluated were: taste, aftertaste, colour, flavour, consistency and overall acceptability. The prepared drinks were served with clean glasses to individual panelist. The order of presentation of samples to the panel was randomized. Portable water was provided to rinse the mouth between evaluations. Each sensory attribute was on a 9 – point Hedonic Scale with 1 = disliked extremely while 9 = liked extremely as described by Iwe (25).

Statistical analysis
All the analysis were carried out in duplicate. Statistical analysis was performed using Statistical Package for Service Solution (SPSS), version 26. Data obtained were subjected to Analysis of Variance (ANOVA) and difference between means were compared using Turkey's Multiple comparison tests with 95% confidence level.

RESULTS
Physicochemical properties of mixed fruit juice enriched with soy protein isolate
The physicochemical properties of mixed fruit juice enriched with soy protein isolates are shown in Table 2 below.

The pH of the samples ranged from 3.83-5.13 with samples F & K had the lowest and highest pH, respectively.

The TTA of the samples ranged from 0.47% (sample F) to 1.04% (sample E), while the TSS of the samples ranged from 9.00-13.00 ^{0}Brix, with sample A, F and G recording the lowest value while sample E had the highest TSS.

Table 2: Physicochemical properties of mixed fruit juice enriched with soy protein isolate

Sample	pH	TTA (%)	TSS (^{O}Brix)
A	$4.23^{g}\pm0.03$	$0.59^{de}\pm0.03$	$9.00^{e}\pm0.00$
B	$4.48^{f}\pm0.01$	$0.64^{d}\pm0.00$	$10.00^{d}\pm0.00$
C	$4.59^{e}\pm0.14$	$0.80^{c}\pm0.04$	$11.00^{c}\pm0.00$
D	$4.76^{c}\pm0.01$	$0.98^{b}\pm0.02$	$12.00^{b}\pm0.00$
E	$4.94^{b}\pm0.01$	$1.04^{a}\pm0.03$	$13.00^{a}\pm0.00$
F	$3.83^{h}\pm0.01$	$0.47^{f}\pm0.02$	$9.00^{e}\pm0.00$
G	$4.49^{f}\pm0.04$	$0.49^{f}\pm0.01$	$9.00^{e}\pm0.00$
H	$4.67^{d}\pm0.00$	$0.53^{ef}\pm0.02$	$10.00^{d}\pm0.00$
I	$4.76^{c}\pm0.01$	$0.53^{ef}\pm0.01$	$10.50^{d}\pm0.00$
J	$4.95^{b}\pm0.01$	$0.63^{d}\pm0.02$	$11.50^{b}\pm0.00$
K	$5.13^{a}\pm0.01$	$0.66^{d}\pm0.01$	$12.00^{b}\pm0.00$

Values are means ± Standard Deviation of duplicate determinations. Means in the same column with different superscript are significantly different at $p<0.05$
A =22.47% PJ, 40.44% OJ, 26.96% WJ, 10.13% SPI
B= 20.89% PJ, 37.59% OJ, 25.06% WJ, 16.46% SPI
C= 19.31% PJ, 34.75% OJ, 23.17% WJ, 22.78% SPI
D= 17.72% PJ, 31.90% OJ, 21.27% WJ, 29.11% SPI
E= 16.14% PJ, 29.05% OJ, 19.37% WJ, 35.44% SPI
F= 33.33% PJ, 33.33% OJ, 33.33% WJ
G= Centrifuged sample A
H= Centrifuged sample B
I= Centrifuged sample C
J= Centrifuged sample D
K= Centrifuged sample E
PJ= Pineapple juice
OJ= Orange juice
WJ= Watermelon juice
SPI= Soy protein Isolate

Nutrient composition of mixed fruit juice enriched with soy protein isolate

Table 3 shows the nutrient composition of mixed fruit juice enriched with protein isolate.

The moisture contents of the mixed fruits ranged from 83.26-92.56% with sample E (16.14% PJ, 29.05% OJ, 19.37% WJ, 35.44% SPI) having the least moisture content while sample F (33.33% PJ, 33.33% OJ, 33.33% WJ) had the highest moisture content.

Ash content of the sample ranged from 0.30-0.60%, with samples F (33.33% PJ, 33.33% OJ, 33.33% WJ) and E, recording the lowest and highest ash content, respectively.

Sample F recorded the lowest crude protein content (1.28%), while sample E (16.14% PJ, 29.05% OJ, 19.37% WJ, 35.44% SPI) recorded the highest crude protein content of 11.28%.

The fat content of the samples ranged from 0.34% in sample G (centrifuged sample A) to 0.81% in sample E.

Carbohydrate content of the samples ranged from 4.13-7.56%, with sample K (centrifuged sample E) and sample A recording the highest and lowest, carbohydrate content.

The vitamin C content of the samples ranged from 7.23-7.69 mg/100g with sample I (centrifuged sample C) having the lowest, while the highest vitamin C content was observed in sample H.

The least β-Carotene content was recorded in sample E (1.46 μg/ml), while sample F (4.08 μg/ml) recorded the highest.

Table 3Nutrient composition of mixed fruit juice enriched with soy protein isolate

Sample	Moisture (%)	Ash (%)	Crude Protein (%)	Fat (%)	Carbohydrate (%)	Vitamin C (mg/100g)	β-Carotene (μg/ml)
A	$91.17^{ab}\pm0.81$	$0.35^{bc}\pm0.07$	$1.75^{f}\pm0.00$	$0.56^{c}\pm0.00$	$7.56^{a}\pm0.44$	$7.43^{cde}\pm0.09$	$3.33^{b}\pm0.23$
B	$87.87^{cd}\pm0.84$	$0.45^{abc}\pm0.07$	$3.06^{d}\pm0.00$	$0.61^{c}\pm0.01$	$6.58^{abc}\pm0.07$	$7.48^{bcd}\pm0.03$	$1.98^{de}\pm0.00$
C	$85.80^{de}\pm0.24$	$0.45^{abc}\pm0.05$	$5.75^{c}\pm0.08$	$0.65^{bc}\pm0.01$	$5.82^{bcde}\pm0.29$	$7.64^{ab}\pm0.03$	$1.78^{ef}\pm0.05$
D	$84.26^{e}\pm0.38$	$0.55^{ab}\pm0.07$	$9.09^{b}\pm0.13$	$0.74^{ab}\pm0.02$	$5.72^{bcde}\pm0.29$	$7.64^{ab}\pm0.03$	$2.35^{cd}\pm0.01$
E	$83.26^{e}\pm0.13$	$0.60^{a}\pm0.00$	$11.28^{a}\pm0.75$	$0.81^{a}\pm0.04$	$5.20^{def}\pm0.00$	$7.55^{abc}\pm0.02$	$1.46^{f}\pm0.01$
F	$92.56^{a}\pm1.63$	$0.30^{c}\pm0.00$	$1.28^{f}\pm0.04$	$0.40^{ef}\pm0.06$	$6.94^{ab}\pm0.84$	$7.68^{a}\pm0.08$	$4.08^{a}\pm0.00$
G	$90.98^{ab}\pm0.67$	$0.35^{bc}\pm0.07$	$2.00^{ef}\pm0.00$	$0.34^{f}\pm0.03$	$6.23^{abcd}\pm0.16$	$7.53^{abc}\pm0.01$	$3.20^{b}\pm0.16$
H	$89.81^{abc}\pm0.69$	$0.40^{abc}\pm0.00$	$2.30^{def}\pm0.15$	$0.36^{ef}\pm0.00$	$5.82^{bcde}\pm0.29$	$7.69^{a}\pm0.03$	$3.12^{b}\pm0.23$
I	$89.12^{bc}\pm0.47$	$0.40^{abc}\pm0.00$	$2.97^{de}\pm0.13$	$0.43^{ef}\pm0.01$	$5.46^{cdef}\pm0.07$	$7.23^{f}\pm0.05$	$3.10^{b}\pm0.02$
J	$89.56^{bc}\pm0.30$	$0.40^{abc}\pm0.00$	$5.20^{c}\pm0.08$	$0.45^{de}\pm0.01$	$4.75^{ef}\pm0.36$	$7.25^{ef}\pm0.05$	$2.61^{c}\pm0.06$
K	$87.46^{cd}\pm0.13$	$0.40^{abc}\pm0.07$	$5.72^{c}\pm0.31$	$0.55^{cd}\pm0.01$	$4.13^{f}\pm0.07$	$7.33^{def}\pm0.06$	$2.54^{c}\pm0.03$

Values are means ± Standard Deviation of duplicate determinations. Means in the same column with different superscript are significantly different at $p<0.05$

Sensory evaluation of mixed fruit juice enriched with soy protein isolate

The sensory evaluation of mixed fruit juice enriched with soy protein isolates is shown in Table 4. Sample E was ranked the lowest (5.05) in aftertaste while sample F (7.80) was rated the highest. Sample E (4.85) was scored the lowest, while sample F (7.90) scored the highest in taste. The flavour scores of the samples ranged from 5.30 (sample C and D) to 7.60 (sample F), while the colour score ranged from 5.61-7.87. Sample E scored the least in flavour while sample F scored the highest.The samples were rated from 4.60-7.40 in consistency with sample E having the lowest, while sample F scored the highest.The overall acceptability of the samples was ranked from 5.03-7.70. Sample E was liked the least, while sample F was liked best in overall acceptability.

DISCUSSION

Effect of soy protein isolate on the physicochemical properties of mix fruit juice

The pH of the control (sample F) increased after addition of soy protein isolates and differed significantly ($p<0.05$) from the samples added isolates and centrifuged. The pH values (3.83-5.13) of mixed fruits of present study differed from 2.70-5.40 reported by Obasi & Ukpoju (26). Food with a pH below 4.6 is considered as a low acid food and is safe from bacterial or spore-forming pathogens growth (27), thus samples A, B, F and G can be considered as low acid food.

The TTA of the control sample increased with increase in soy isolate proportion, and centrifuging. Ekanem and Ekanem (11) reported TTA of 2.47% for apple juice, while Obasi and Ukpoju (26) reported TTA of 0.07-1.28%. These values differed from 0.47-1.04% reported in the present study.

The TSS of the samples increased with increase in inclusion levels of soy protein isolate. Centrifuging also slightly reduced the TSS of samples I, J, and K. The values of TSS obtained in the present study (9.00-13.00) were higher than the 3.75-6.50 reported by Obasi and Okpoju [26] and 8.00-9.00 reported by Banigo *et al*. (28).

Effect of soy protein isolate on the chemical composition of mix fruit juice

Inclusion of soy protein isolate reduced the moisture

Table 4: Sensory evaluation of mixed fruit juice supplemented with soy protein isolate

Values are means ± Standard Deviation of duplicate determinations. Means in the same column with different

Sample	Aftertaste	Taste	Flavour	Colour	Consistency	Overall Acceptability
A	$6.80^{abc}\pm1.21$	$6.95^{abc}\pm1.63$	$6.20^{abc}\pm1.40$	$7.14^{a}\pm1.02$	$6.85^{ab}\pm0.03$	$6.77^{ab}\pm0.17$
B	$5.90^{bcd}\pm0.32$	$6.15^{bcd}\pm1.41$	$6.00^{bc}\pm1.30$	$6.23^{bc}\pm1.06$	$5.50^{c}\pm0.41$	$5.94^{cd}\pm0.06$
C	$5.60^{cd}\pm1.22$	$5.60^{bc}\pm1.02$	$5.30^{c}\pm1.56$	$5.74^{c}\pm0.20$	$4.80^{d}\pm0.62$	$5.45^{cd}\pm0.22$
D	$5.20^{c}\pm1.41$	$5.45^{bc}\pm0.65$	$5.30^{c}\pm1.72$	$5.74^{c}\pm0.33$	$4.80^{d}\pm0.35$	$5.23^{d}\pm0.36$
E	$5.05^{c}\pm0.09$	$4.85^{d}\pm0.87$	$5.55^{c}\pm1.73$	$5.61^{c}\pm0.57$	$4.60^{d}\pm0.17$	$5.03^{d}\pm0.44$
F	$7.80^{a}\pm0.32$	$7.90^{a}\pm1.00$	$7.60^{a}\pm0.94$	$7.87^{a}\pm0.26$	$7.40^{a}\pm0.55$	$7.70^{a}\pm0.18$
G	$7.10^{ab}\pm0.87$	$7.25^{ab}\pm0.15$	$7.35^{ab}\pm1.04$	$6.52^{b}\pm0.22$	$7.00^{a}\pm0.63$	$7.11^{a}\pm0.39$
H	$6.75^{abc}\pm1.68$	7.25ab±1.55	$7.20^{ab}\pm1.06$	$6.15^{b}\pm1.36$	$6.61^{b}\pm1.27$	$6.79^{ab}\pm1.02$
I	$6.70^{abc}\pm1.81$	$6.95^{abc}\pm1.54$	$6.50^{abc}\pm1.76$	$6.55^{b}\pm1.52$	$6.14^{b}\pm0.33$	$6.57^{bc}\pm1.14$
J	$6.35^{abcd}\pm0.55$	$6.50^{abc}\pm1.57$	$6.50^{abc}\pm1.28$	$6.80^{b}\pm0.18$	$6.55^{b}\pm0.17$	$6.88^{ab}\pm0.18$
K	$5.15^{c}\pm1.23$	$5.45^{bc}\pm2.14$	$5.60^{c}\pm1.57$	$5.70^{c}\pm2.00$	$5.65^{c}\pm0.63$	$5.55^{bc}\pm1.89$

superscript are significantly different at $p<0.05$

content of the samples, and significant difference ($p<0.05$) existed between the control (sample F, having no soy protein isolate) and other samples (apart from the centrifuged). However, sample A, containing 10.13% soy protein isolate (SPI) did not show significant difference ($p>0.05$) from sample F. The moisture content of mixed fruit juice obtained here (83.26-92.56%) differs from Obasi and Ukpoju (26) who reported moisture content of mixed fruit juices ranging from 37.30-51.00%. However, this agrees with Vicente *et al.* (29) who reported that the moisture content of juice falls at 90%.

Addition of soy protein isolate increased the ash content of the mixed fruit juice. Sample E which has the highest percentage of soy isolate (35.44%) recorded the highest ash content (0.60%) among the samples. Centrifuging reduced the ash content of the sample. Only sample A with 10.13% remained the same (0.35%) after centrifuging (sample G). Obasi and Ukpoju (26) reported low ash content of 0.30-2.05%, which could be due to usage of long-stored fruit. Freshly harvested fruits have higher ash content which implies good source of minerals.

The crude protein content of the control was the lowest (1.28%) and it increased upon inclusion of soy isolate. Sample E which had the highest proportion (35.44%) of soy protein isolate recorded the highest protein content (11.28%). Centrifuging reduced the protein content of the samples with sample K (centrifuged sample E) having the highest protein content (5.72%). The crude protein content obtained here (1.28-11.28) differs from 1.65-2.05% of mixed fruit juice reported by Obasi and Ukpoju (26). Shamsudin *et al.* (30) reported low protein content of 0.80% for Thai seedless guava juice.

Fat content increased with addition of soy isolate, and reduced in samples G and H which contain 10.13% and 16.46% of soy isolates respectively before centrifuging. The fat contents of the samples (0.34-0.81%) was very low which is common for fruits. They were lower compared to the lipid content in Dragon Fruit (*Hylecereus polyhizus*) reported by Ruzainah *et al*. (31), which was 4.5% for freeze-dried sample and 5.5% for oven dried sample.

Centrifuging reduced the carbohydrate content of the samples, as well as addition of soy protein isolates. Folade and Akeem (32) reported reduction of carbohydrate content of flour on addition of protein isolate. The carbohydrate content (4.13-7.56%) disagrees with the values (38.40-54.85%) reported by Obasi and Ukpoju (26) for mixed fruit juice.

The vitamin C content of the sample decreased after the inclusion of soybean protein isolate. However, the vitamin C content increased after centrifugation. This implies that inclusion of soybean isolates reduce the vitamin C content of the juice. The vitamin C content (7.23-7.69 mg/100g) was lower than 22.15 mg/100g reported by Ekanem and Ekenam (11). This could be as a result of difference in fruits used. Obasi and Ukpoju (26) also reported higher vitamin C content (34.50-39.00 mg/100g) for mixed fruit juice.

The β-Carotene content of the samples also reduced on inclusion of soy protein isolate, and increased after centrifuging. The β-Carotene content (1.45-4.08 μg/ml) was higher than 0.014-0.023 μg/ml and 0.014-0.023 μg/ml for orange and apple juice, respectively as reported by Chiosa *et al.* (33).

Effect of soy protein isolate on the sensory quality of mix fruit juice

The control (sample F) was ranked best in all parameters tested (aftertaste, taste, flavour, appearance, consistency and overall acceptability). This was followed by centrifuged sample A (sample G) in aftertaste, taste, flavor and consistency. Taste score of 7.90 for mixed fruit juice reported by Obasi and Ukpoju (26) was similar to 7.90 observed for the control (sample F). Ekanem and Ekanem (11) recorded overall acceptability score of 7.6-8.4 for apple juice which was slightly higher than 5.03-7.70 observed.

CONCLUSION

The inclusion of soy protein isolate reduced the moisture content of the mixed fruit juice. Inclusion of soy protein isolates increased the pH of the samples, as well as the TTA and TSS. The vitamin C and β-Carotene content also reduced on addition of soy isolate. The β-Carotene however increased after centrifuging. Sensory evaluation showed that the control sample (sample F) was liked best in overall acceptability. Sample E, having the best protein content (11.28%) recorded the least score for all sensory parameters (aftertaste, flavour, taste, appearance, consistency and overall acceptability) determined.

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