Analysis of the Effects of Pasteurization on Proximate, Atwater Factor and Acceptability of Smoothie from Banana, Carrot and Soymilk Blends

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ABSTRACT

***Background:** Single fruit consumption results in loss of appetite and consumption due to monotony of flavor thereby results in lack of functional nutrient inherent in fruits and vegetables. These functional nutrients prevent such chronic diseases like cancer, stroke among others alongside same health benefits. Conversely, combination of different fruits improves flavour and consumption thereby enhances phytonutrient consumption with reduced risk of chronic disease.*

***Objective**: As smoothies are pasteurized before short time storage in fridge by some people, this research understudied the effect of pasteurization on the proximate, Atwater factor and acceptability of smoothie from the blend of ripe banana, carrot and soymilk.*

***Methods**: Banana, carrot slices and soymilk were blended with variable speed kitchen blender in varying proportions to produce four samples of pasteurized and unpasteurized smoothie samples. The smoothie samples were subjected to proximate and acceptability using standard analytical methods. Energy values were by calculation using the Atwater factor.*

***Results**: Proximate composition of both pasteurized and unpasteurized smoothie samples showed that moisture ranged from 88.33 to 90.42%, ash 0.75 to 0.88%, crude protein 3.74 to 3.91%, crude fibre 0.14 to1.17%, fat 2.65 to 3.15% and, carbohydrate 2.82 to 3.90%. Energy values ranged from 154.02 to 211.470 Kj/100g.Sensory scores for taste ranged from 4 to 7, appearance 5 to 7, consistency 5 to 6 and general acceptability 5 to 7.*

***Conclusion**: The study revealed that pasteurization affected the proximate composition, energy values and acceptability of all the smoothie blends and therefore should be a matter of choice*

Keywords: Smoothie, Pasteurization, Banana; Carrot, Soymilk

INTRODUCTION

Smoothie is a thick consistent fruit mixes normally consumed fresh or preserved for short period (1-3weeks) in the refrigerator after pasteurization [1]. They provide a better convenient way of consuming fruits and vegetables. When yoghurt or milk is included, smoothie contributes to dairy intake [2]. Current dietary guideline promotes the consumption of more portions of fruit and vegetable per day. The healthfulness of a smoothie depends on its ingredients. Fruits are excellent sources of the phytochemical which are essential for human health and relished by consumer all year round. Fruits high in acidity content and astringency have limited scope for table consumption despite their rich functional ingredient content [1].

Monotony of single fruit consumption has made many people to lose appetite in consuming fruit because of too much familiarity with the flavor of such fruit. This had led to recent increase in such chronic diseases like heart attack, stroke among others due to inadequate intake of those functional nutrients inherent in the fruits especially in developing countries. Combination

of two or more fruits results in novel flavour and taste which helps to improve consumption [1]. Fruit blending is an excellent method of improving the nutritional quality of juice [3]. However, consumption of smoothie from ripe banana, carrot and soymilk blends will reduce the diseases associated with deficiency of functional nutrients lacking in the body.

Soymilk is an off-white emulsion/suspension aqueous extract of soybeans endowed with both functional and nutritional ingredients comparable to cow's milk. It is a good candidate for economic breast milk substitute from vegetable origin [4, 5]. Pioneer reports have recognized soymilk as an economic source of protein for infants and adults of both genders and ages [4, 6].Soybean sprouting improves the nutrient, soymilk yield, acceptability [7], digestibility by decreasing anti-nutrients and/or by increasing the susceptibility of the degraded nutrients to enzyme attack [8]and protein efficiency ratio [9].

Banana (*Musa sapientum)* possesses desirable qualities such as high fibre content which helps to restore normal bowl action, stimulates the production of hemoglobin in the blood. When banana is consumed along with other fruits and vegetable, can offer some reduced risk of various cancers such as renal cell carcinoma. Banana is rich in potassium and low in salt, hence its lowering effect on blood pressure and stroke. Banana consumption along with other fruits and vegetables can reduce renal cell carcinoma among other cancers [10]. Potassium is the most abundant mineral in banana followed by magnesium, calcium and phosphorous. It contains vitamins C, D and E as well as saponin, tannin, oxalate, phytate and cyanide [11].

Carrot (*Daucuscarota*) is a crispy textured root vegetable when fresh, from the family *Apiaceae*. It is usually orange in colour as well as purple, red, white and yellow varieties. The taproots are the most commonly eaten part for human nutrition, but the green parts are edible too. A steady increase in carrot juice consumption has been reported. It is regarded as healthy food item because of its high vitamin and fibre content [12]. The perishable nature of the fruits and vegetables results inpost-harvest losses most especially in developing countries where there are inadequate fruit processing factories, storage and good distribution facilities. Production of smoothie will help to preserve and extend their storage stability from post-harvest losses.

Pasteurization is a short time low (<100^{0}C) heat treatment that conserves the nutrients as well as destroys the enzymes, anti-nutrients and some microorganisms thereby helps to preserve the smoothie from spoilage. This work thereby aimed at studying the effect of pasteurization on proximate, Atwater factor and acceptability of the smoothie blends of banana, carrots and soymilk.

MATERIALS AND METHODS

Procurements of raw materials

While banana and carrot were procured from Urbani main market Umuahia, soybeans were procured from Ndioru, market in Ikwuano Local Government Area all in Abia State, Nigeria. The procured materials were transported to Food Processing Laboratory of Food Science and Technology Department of Michaell Okpara University of Agriculture Umudike for production and analysis. All chemicals used for the analysis were purchased from credible scientific chemical suppliers and were of analytical grade.

Material preparation

Banana fingers were washed with clean water to get rid of germs and extraneous materials, peeled, sliced with stainless steel knife into smaller slices and weighed. The carrot roots were sorted to remove damaged and rotten ones as well as contaminants present, washed, scraped off skin, rewashed ,sliced with stainless steel knife into smaller slices and weighed. Soymilk was prepared with cleaned, sorted and weighed soybean samples. The beans were soaked in tap water for 12 h, drained, spread on a clean jute sack on the floor and covered with black polythene. The beans were allowed to sprout for 72 h at room temperature. Beans' surface was sprinkled with water regularly as soon as they get dried during sprouting. The sprouts were washed and boiled in 0.5% $NaHCO_3$ solution for 20 min, drained, and hand-dehulled. The hulls and shoot were removed by water floatation to leave cleaned soybean cotyledons. The cotyledons were milled into slurry with variable speed kitchen blender (Qasa blender) with hot water (93%) in a ratio of 2.7 L part hot water to 1 kg part cotyledons (v/w). Soymilk was extracted by screening the slurry through a double layered muslin cloth [13].

Banana and carrot slices as well as soymilk produced were blended (Table 1), milled, bottled and marked (Figure 1). Half of the bottled smoothie samples were analyzes unpasteurized as control samples (Plates 1a, 1c, 1e and 1g) while the rest samples were pasteurized at 75^{0}C for 15 min and stored after cooling for analysis (Plates 1b, 1d, 1f and 1h).

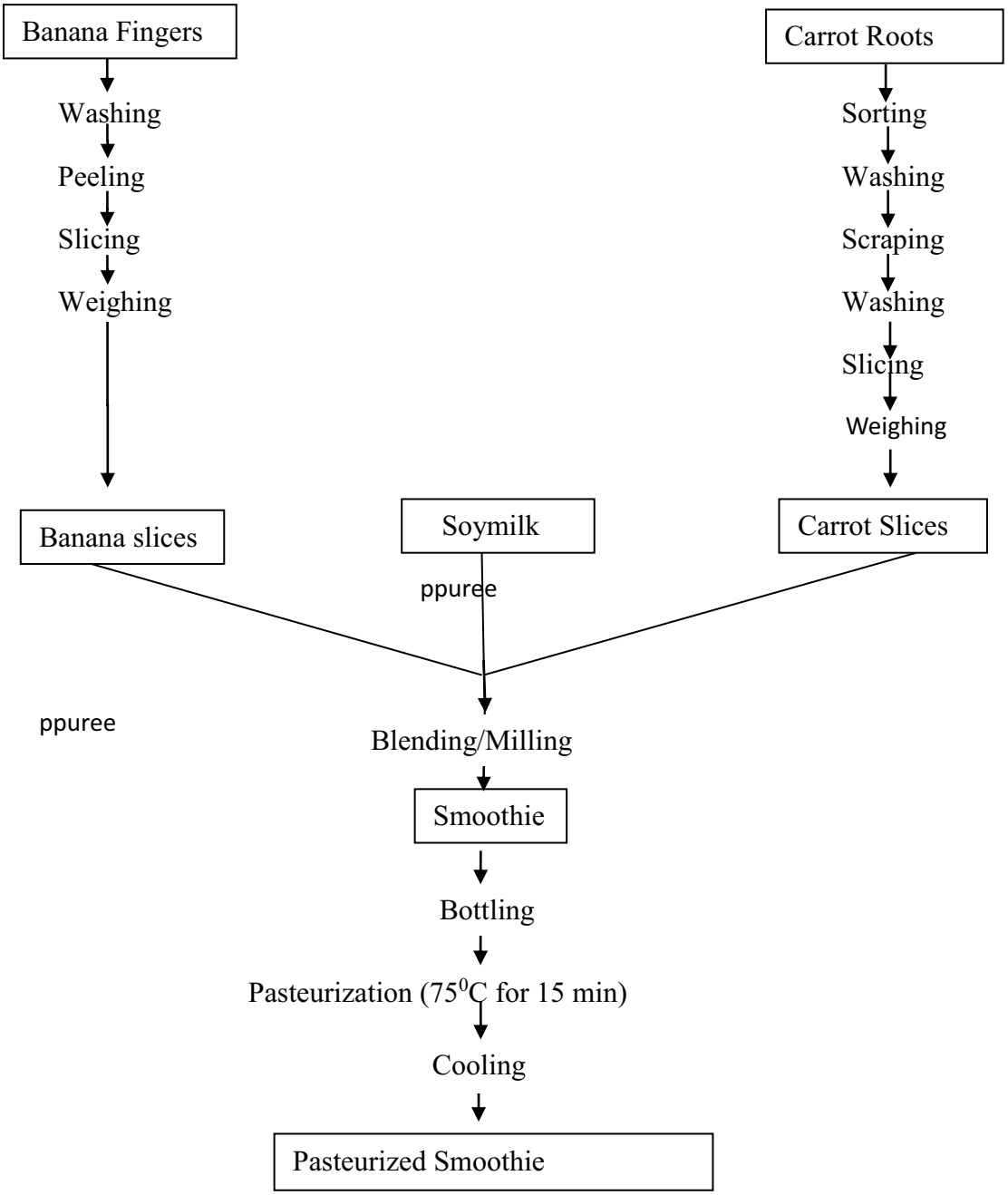

Figure1: Flow chart for preparation of smoothie

Table 1: Blending ratio of banana, carrot and soymilk for smoothie preparation (ml)

Samples	Banana puree	Carrot puree	Soymilk
201	33.5	33.5	33
312	60	20	20
423	20	60	20
544	20	20	60

Plate 1a: Sample 201 a unpasteurized smoothie

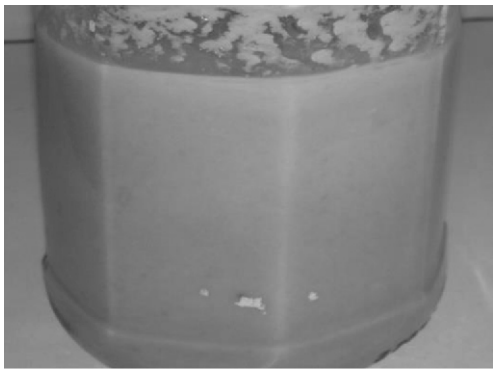

Plate 1b: Sample 201b Pasteurized smoothie

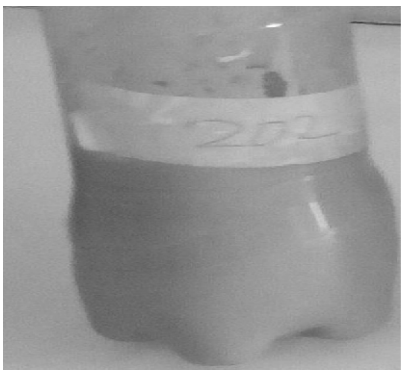

Plate 1c: Sample 312c unpasteurized smoothie

Plate 1d: Sample 312d Pasteurized smoothie

Plate 1e: Sample 423e unpasteurized smoothie

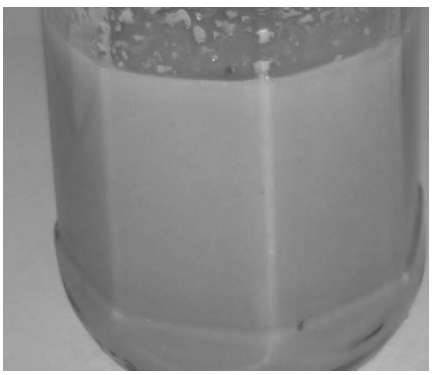

Plate 1f: Sample 423f Pasteurized smoothie

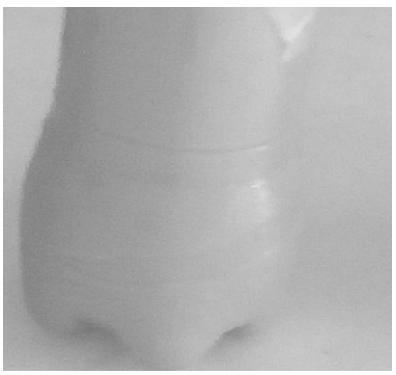

Plate 1g: Sample 544g unpasteurized smoothie

Plate 1h: Sample 544h Pasteurized smoothie

Analyses

Proximate Analyses

All the analyses were determined with AOAC [14] methods.

Moisture content (MC)

Five grams (5g) of each sample were measured into each of the three moisture cans that were previously washed, oven dried, weighed and stored in a desiccator. The cans with their samples were placed in the oven and dried at 105°C for 2 h. Thereafter, they were removed and placed in a desiccator to cool before reweighing. The process was repeated until constant weight was obtained. Percent moisture was calculated as shown:

$$\%\text{Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1}$$

W_1 = weight of the empty moisture can
W_2 = weight of can and sample before drying
W_3 = Weight of can and sample after drying

Ash content

Washed and oven dried crucibles were cooled in a desiccators before weighing. 5g of each sample was added into each of them and placed in a muffle furnace and were allowed to ash at 550°C for 3 h into a grayish-white. After 3 h, the muffle furnace was switched of and allowed to cool before removing the samples and placed them in desiccators for further cooling. The crucibles containing the ash were reweighted and percentage ash content was calculated as below:

$$\%\text{Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

W_1 = weight of the crucible
W_2 = weight of crucible and sample
W_3 = weight of crucible + ash

Crude protein

The Kjeldahl method was used. Two grams (2 g) of each sample, 5 g of NaSO4 1 g of CuSO4, 25 ml of concentrated sulphuric acid and a tablet of selenium catalyst were placed in Kjeldahl digestion flask and the mixture digested to a clear solution which was obtained in a separate flask. The digest was transferred into a 100 ml volumetric flask, made up with distilled water, added 40% NaOH solution and distilled. The distillate was titrated against 10 ml of 4% boric acid solution containing three drops of mixed indicators (Bromocresol green and methyl red) to a deep red end point. Crude protein was calculated thus:-

% Protein = $\%N_2 \times 6.25$

$$\%N_2 = \frac{100}{W} \times \frac{14 \times N}{1000} \times \frac{Vd}{Va} \times T - B$$

W = Weight of the sample analyzed
N = Normality (Conc.) of titirant (0.02 H2SO4)
Vd = Total volume of digest
Va = Volume of digest analyzed
T = Titre value of sample
B = Titre value of reagent blanks

Crude Fibre (CF)

Five grams (5g) of each sample was refluxed for 40 min, filtered, washed with hot water, oven dried over night at 105°C, dry-ashed in a muffle furnace at 500°C for 6 h, cooled, and reweighed.

$$\text{Percentage Crude Fibre} = \frac{W_1 - W_2}{W} \times 100$$

W_1 = Weight of crucible + dried sample
W_2 = Weight of crucible + ash
W = Dry weight of food sample

Fat

Soxhlet solvent extraction method was used and fat content was calculated using the formula below:

$$\%\ \text{fat} = \frac{W_2 - W_1}{W_3} \times \frac{100}{1}$$

W_1 = Weight of empty porous paper
W_2 = Weight of the paper and sample (wrapped) before extraction
W_3 = Weight of proper sample after drying

Carbohydrate

This was calculated as nitrogen free extract by difference between 100 and a sum total of the other proximate components as shown:

% CHO = 100 - % (A + B + C + D + E)
CHO = carbohydrate
A = Moisture
B = Ash
C = Fat

D = Crude fibre
E = Protein

Atwater factor

The energy values were calculated from the energy substrates of the smoothie samples using Atwater Factor system [15].

Sensory Evaluation

This was conducted with 25 semi-trained panelists randomly selected from the students of Michael Okpara University of Agriculture Umudike, Abia State aged between 17 to 35y who were familiar with smoothie. All samples were served in same coded dishes to the panelists in an illuminated environment along with a bottle of water. They were instructed to rinse their mouth before testing each sample and score their flavour, appearance, consistency and general acceptability according to 9-point Hedonic scale where 1 is dislike extremely, 5 is neither like nor dislike and 9 is like extremely[16].

Statistical Analysis

The data obtained from the analyses and sensory evaluation were subjected to analysis of variance (ANOVA) of a completely Randomized design (CRD) using the SPSS version 20. While treatment mean were separated using Duncan Multiple range test at 95% confidence level ($p<0.05$).

RESULTS AND DISCUSSION

Proximate Composition of Smoothie Samples

The results were presented in Table 2.

Moisture content (MC)

The results showed that pasteurization had significant ($p<0.05$) decreasing effect on the MC of the smoothie samples. This was attested by higher MC of the unpasteurized samples (89.46-90.42%) than their pasteurized (88.33-89.63%) counterparts. This MC decrease could be due vapour evaporation during the pasteurization process resulting in water loss. Besides, the results revealed MC decrease with increase in carrot inclusion levels and increase with increase in soymilk and banana inclusion levels in the blends. These differential contributions by banana, carrot and soymilk must have been the reason for MC variations between blends of the entire smoothie samples. The moisture levels of this present study compared favourably with 87.54 to 91.02% reported for mango, pawpaw and guava blend [17]. The entire smoothie samples studied had high moisture contents which were typical of fresh fruits at maturity [18]. However, the least MC of sample 423P (20% banana puree: 60% carrot puree: 20% soymilk pasteurized smoothie) may suggest relatively higher viscosity than the rest samples. Despite this, the entire smoothie sample will be refreshing and easier to swallow due to their high MC and banana inclusion.

Ash

Like MC, ash content of the smoothie samples was decreased by pasteurization as reflected in higher values of unpasteurized (0.81-0.88%) than pasteurized (0.75-0.87) samples. Ash content was observed to increase with increase in carrot proportion in the blends which typified carrot as the major mineral source. Conversely, ash content was reduced with increase in soymilk inclusion in both the pasteurized and unpasteurized samples. Carrot had been reported to be rich source of vitamin and minerals [19].Minerals speed up metabolic processes and improve growth and development [20].

Crude protein

Crude protein levels of the smoothie samples increased with increase in soymilk inclusion in both pasteurized and unpasteurized followed by banana and carrot. Therefore, soymilk was the major protein source of the smoothie samples. Pasteurization had no significant ($p>0.05$) effect on the smoothie samples. This implies that samples 544 containing 20% banana puree, 20% carrot puree and 60%, pasteurized and unpasteurized, can enhance protein intake and could help to reduce the problem of protein malnutrition. Proteins are essential component of diet needed for human survival which basic function is to supply adequate amounts of required amino acids in nutrition [21]. Protein deficiency causes growth retardation, muscle wasting, edema, abnormal swelling of the belly and collection of fluids in the body [22].

Fibre

Pasteurization significantly ($p<0.05$) decreased the fibre content of the smoothie samples despite the increasing effect by banana followed by carrot level of inclusion in the blends which points to banana as the major source. This was justified by the significant ($p<0.05$) higher fibre content of unpasteurized (0.20-1.17%) than pasteurized (0.14-0.19%) samples. Fiber was found to decrease with increase in soymilk level of

inclusion probably because it has the least fibre content. Diet low in crude fibre is undesirable and may cause constipation. Its prolonged deficiency in diets may also cause colon disease like piles, appendicitis and cancer [23]. On the other hand, high fibre level is essential in food as it absorbs water and provides roughage for the bowels and assists intestinal transit [24]. The fibre contents were within the [25] recommended level of not more than 5% daily.

Fat

Pasteurization had no significant ($p>0.05$) fat content variation between pasteurize and unpasteurized smoothie samples. Rather, fat increased significantly ($p<0.05$) with soymilk and insignificantly ($p>0.05$) with banana and carrot levels of inclusion in the blends. Fat content increased from 2.65 to 3.15% with sample 204 (20% banana puree: 20% carrot puree: 60% soymilk unpasteurized smoothie) having the highest fat value (3.15%), while sample 423 (20% banana puree: 60% carrot puree: 20% soymilk unpasteurized smoothie) had the lowest (2.65%). Similar results were obtained in their pasteurized counterparts (2.6-2.91%). Fat is the major energy sources and fat soluble vitamins which are likely to be higher in sample blends containing more soymilk.

Carbohydrate

Carbohydrate content of the smoothie increased significantly ($p<0.05$) with pasteurization. This was substantiated by the significant ($p<0.05$) higher values (2.82-3.90%) of pasteurized samples than their unpasteurized counterparts (1.97-3.02%). This could probably be as a result of decreasing effects of pasteurization on other proximate compositions since carbohydrate was calculated by difference. Besides, carbohydrate increased with increase in carrot level of inclusion in the blending which appeared to be the major source. This was followed by banana with soymilk being the least contributor may be due to sprouting. Carbohydrate is one of the energy substrate which means that pasteurized samples will give more energy than unpasteurized samples.

Energy values

Pasteurization decreased the energy values significantly ($p<0.05$), but those of the unpasteurized samples were significantly ($p<0.05$) increased by the increase in soymilk inclusion levels followed by carrot and banana. This pointed to soymilk as the major energy source of the smoothie samples probably because it is the major oil source of both pasteurized and unpasteurized smoothie samples, and oil is the highest energy substrate. Carrot was the second energy source may be because it is the major carbohydrate source of both pasteurized and unpasteurized smoothie samples which is the second energy substrate. Banana as the third energy source could stem from conversion some of the carbohydrate to sugar during ripening.

Table 2: Proximate composition of smoothie samples (%)

Sample	Moisture	Ash	Crude Protein	Crude Fibre	Fat	Carbohydrate	Ev (Kj/g)
201	$90.42^{a}\pm0.02$	$0.85^{ab}\pm0.01$	$3.84^{b}\pm0.02$	$0.17b^{cd}\pm0.02$	$2.78^{c}\pm0.02$	$1.97^{c}\pm0.05$	$192.318^{d}\pm0.011$
312	$89.61^{ab}\pm0.01$	$0.83^{ab}\pm0.05$	$3.76^{c}\pm0.00$	$0.20^{a}\pm0.00$	$2.69^{d}\pm0.01$	$2.94^{abc}\pm0.01$	$203.833^{c}\pm0.001$
423	$89.46^{ab}\pm0.01$	$0.88^{a}\pm0.02$	$3.76^{c}\pm0.01$	$0.19^{ab}\pm0.01$	$2.65^{d}\pm0.01$	$3.02^{abc}\pm0.11$	$205.235^{b}\pm0.007$
544	$89.69^{ab}\pm0.01$	$0.81^{b}\pm0.01$	$3.91^{a}\pm0.01$	$0.19^{ab}\pm0.00$	$3.15^{a}\pm0.02$	$2.26^{bc}\pm0.06$	$211.474^{a}\pm0.006$
201P	$89.63^{ab}\pm0.04$	$0.83^{ab}\pm0.01$	$3.82^{b}\pm0.01$	$0.15^{de}\pm0.01$	$2.77^{c}\pm0.03$	$2.82^{abc}\pm0.06$	$159.208^{f}\pm0.011$
312P	$89.22^{bc}\pm0.54$	$0.81^{b}\pm0.01$	$3.76^{c}\pm0.01$	$0.19^{abc}\pm0.01$	$2.69^{d}\pm0.00$	$3.40^{ab}\pm0.52$	$156.337^{g}\pm0.004$
423P	$88.33^{c}\pm0.67$	$0.87^{a}\pm0.00$	$3.74^{c}\pm0.00$	$0.16^{cde}\pm0.00$	$2.66^{d}\pm0.04$	$3.90^{a}\pm1.23$	$154.027^{h}\pm0.01$
544P	$88.71^{bc}\pm0.70$	$0.75^{c}\pm0.01$	$3.90^{a}\pm0.01$	$0.14^{e}\pm0.02$	$2.91^{b}\pm0.01$	$3.56^{ab}\pm0.67$	$168.811^{e}\pm0.001$

Values were mean triplicate determinations± standard deviations. Means with different superscripts within the same column are significantly different ($p<0.05$). 201=33.5% banana: 33.5% carrot: 33% soymilk unpasteurized smoothie, 312=60% banana: 20% carrot: 20% soymilk unpasteurized smoothie, 423=20% banana: 60% carrot : 20% soymilk unpasteurized smoothie and 544=20% banana : 20% carrot: 60% soymilk unpasteurized smoothie. 201P=33.5% banana: 33.5% carrot: 33% soymilk pasteurized smoothie, 312P=60% banana: 20% carrot: 20% soymilk pasteurized smoothie, 423P=20% banana: 60% carrot: 20% soymilk pasteurized smoothie and 544P=20% banana : 20% carrot : 60% soymilk pasteurized smoothie.

Sensory Evaluation of the Smoothie Samples

The results were presented in Table 3.

Pasteurization had insignificant ($p>0.05$) decreasing effect on the flavour of samples 423 (20% banana: 60% carrot: 20% soymilk unpasteurized smoothie) and 544 (20% banana: 20% carrot: 60% soymilk unpasteurized smoothie), but increased same in samples 201(33.5% banana: 33.5% carrot: 33% soymilk unpasteurized smoothie) and 312 (60% banana: 20% carrot: 20% soymilk unpasteurized smoothie) and their pasteurized counterparts. Flavour of the smoothie increased significantly ($p<0.05$) with increase in banana level of inclusion followed by soymilk. This therefore revealed that flavor of the smoothie is dependent on the amount of banana inclusion followed by soymilk. There was no significant difference ($p>0.05$) in the flavour of the entire smoothie samples except in samples 312 (60% banana: 20% carrot: 20% soymilk unpasteurized smoothie) and 201P= (33.5% banana: 33.5% carrot: 33% soymilk pasteurized smoothie) which were similar probably due to higher banana content in their blends.

Appearance

Pasteurization increased the appearance of the smoothie insignificantly ($p>0.05$) in samples 201P (33.5% banana: 33.5% carrot: 33% soymilk pasteurized smoothie) and 423P (20% banana: 60% carrot: 20% soymilk pasteurized smoothie), but significantly ($p<0.05$) decreased same in the rest of pasteurized samples. This insignificant ($p>0.05$) pasteurization effect on appearance could be due to colour counterbalance may be as a result of equal proportions of banana and carrot. The colour of unpasteurized samples was dominated by carrot pink colour (Plates 1a, 1c, 1e and 1g) but was significantly ($p<0.05$) reduced by pasteurization (Plates 1b, 1d, 1f and 1h). The reduced carrot pink colour led to manifestation of milk colour of banana and soymilk milky which was not affected by pasteurization was equally preferred by the panelists. This was validated by the significantly ($p<0.05$) increasing effect on appearance by increasing banana inclusion level followed by carrot and soymilk in the blend. Therefore banana was the major appearance determinant of the smoothie samples followed by carrot and soymilk.

Consistency

Consistency rating of the smoothie samples decreased significantly ($p<0.05$) with pasteurization in samples 423 (20% banana: 60% carrot: 20% soymilk unpasteurized smoothie) and insignificantly ($p>0.05$) in sample 544 (20% banana: 20% carrot: 60% soymilk unpasteurized smoothie). There was significant ($P<0.05$) increased in samples 201(33.5% banana: 33.5% carrot: 33% soymilk unpasteurized smoothie) and 312 (60% banana: 20% carrot: 20% soymilk unpasteurized smoothie). These could be attributed to moisture loss during pasteurization. Consistency decrease could also be attributed to increase in carrot in the blends. While significant ($p<0.05$) increase may be due to increase in banana inclusion level followed by soymilk. Banana is characterized with smooth pulpy texture which adds to consistency as opposed to the gritty mouth feel resulting from inadequate blending and fibre content of carrot. Also, lower moisture content may increase consistency rating as observed in the higher consistency rating (6.42) of sample 312P (60% banana: 20% carrot: 20% soymilk pasteurized smoothie) with MC of 89.22% than 6.40 score of sample 312 (60% banana: 20% carrot: 20% soymilk unpasteurized smoothie) with MC of 89.61%. Lower MC of pasteurized than unpasteurized samples may stem from evaporated water during pasteurization.

General acceptability

Sensory scores revealed that sample 312 (60% banana: 20% carrot: 20% soymilk unpasteurized smoothie) and 312P (60% banana: 20% carrot: 20% soymilk pasteurized smoothie) were preferred to other smoothie samples with respective general acceptability score of 7.05 and 6.85. However, there was not significant ($p>0.05$) preference variation between them probably due to no significant ($p>0.05$) pasteurization effect. This implies that pasteurization process did not have significant ($p<0.05$) effect on the acceptability of the smoothie products. High general acceptability score of sample 312(60% banana: 20% carrot: 20% soymilk unpasteurized smoothie) and 312P (60% banana: 20% carrot: 20% soymilk pasteurized smoothie) could be due to increased banana inclusion which has a desirable characteristic sweet taste. Also, soymilk and carrot contributed as well. Besides, both sample scored first in all the attributed scored

Table 3: Sensory evaluation of the smoothie samples

Sample	Flavour	Appearance	Consistency	General acceptability
201	$5.30^{bc}\pm1.38$	$6.40^{ab}\pm1.39$	$5.45^{bc}\pm1.53$	$5.90^{bc}\pm0.97$
202	$6.25^{ab}\pm1.65$	$6.75^{a}\pm1.12$	$6.40^{a}\pm1.16$	$7.05^{a}\pm1.10$
203	$4.60^{c}\pm2.01$	$5.90^{ab}\pm1.12$	$5.35^{bc}\pm1.19$	$5.70^{bc}\pm1.53$
204	$4.95^{c}\pm1.50$	$6.55^{a}\pm1.50$	$5.95^{abc}\pm1.47$	$5.55^{bc}\pm1.50$
201P	$6.15^{ab}\pm1.63$	$6.45^{ab}\pm1.47$	$6.15^{ab}\pm0.99$	$6.35^{ab}\pm1.18$
202P	$6.50^{a}\pm1.54$	$5.25^{b}\pm1.77$	$6.42^{a}\pm1.35$	$6.85^{a}\pm1.27$
203P	$4.40^{c}\pm1.67$	$6.25^{ab}\pm1.68$	$5.25^{c}\pm1.45$	$5.25^{c}\pm1.45$
204P	$4.50^{c}\pm1.93$	$5.80^{ab}\pm1.44$	$5.65^{abc}\pm1.39$	$5.55^{bc}\pm1.61$

Values are means of triplicate determinations ±standard deviation. Means with different superscripts within the same column are significantly different ($p<0.05$). 201=33.5% banana:33.5% carrot: 33% soymilk unpasteurized smoothie, 312=60% banana: 20% carrot: 20% soymilk unpasteurized smoothie, 423=20% banana : 60% carrot: 20% soymilk unpasteurized smoothie and 544=20% banana: 20% carrot: 60% soymilk unpasteurized smoothie. 201P=33.5% banana: 33.5% carrot: 33% soymilk pasteurized smoothie, 312 P=60% banana: 20% carrot: 20% soymilk pasteurized smoothie, 423P=20% banana: 60% carrot: 20% soymilk pasteurized smoothie and 544P=20% banana: 20% carrot: 60% soymilk pasteurized smoothie.

CONCLUSION

This study showed that nutritious, refreshing and acceptable smoothie could be made from blends of soymilk, banana and carrot. Addition of soymilk to the smoothie product increased the protein content which implies that consumption will help to reduce the problem of protein malnutrition among the vulnerable group. Addition of carrot which enhanced the vitamin and mineral content will project the smoothie as a potential functional food while banana contributed to the consistency and taste thereby boost the acceptability level. However, this study revealed that pasteurization affected some but not all the nutrients. Therefore, pasteurization before storage is a matter of choice depending on the targeted nutrients as it has no significant effect on acceptability.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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