PROXIMATE AND PHYSICOCHEMICAL QUALITYOF JELLY PRODUCED FROM BLENDS OF BEETROOT AND PINEAPPLE JUICE

Abstract

Fruit Jelly was produced from beetroot and pineapple fruits as a value-added product for addressing their gluts during its peak season. The fruits were cleaned and their juices were blended using the following beetroot: pineapple ratio; 50:50, 60:40, 70:30, 80:20, and 90:10. The fruit juice blends were then labeled I, R, O, H, and A, respectively, while the commercial jelly sample K, and beetroot jelly were used only as control. Proximate composition showed that the fruit jellies had a higher nutritional profile than the commercial jelly. The result revealed variation in moisture content (35.11 to 36.17%), Ash content (0.12 to 0.26 %), Carbohydrate content (61.22% to 63.74%), Energy value (257.26 KJ to 262.72 KJ) and protein content (0.88 to 1.77 %). The energy value (262.72 KJ) and carbohydrate content (63.74 %) of the commercial jelly were however significantly ($p < 0.05$) higher than in the beetroot - pineapple fruits jelly. The protein content of the jelly ranged from 1.52 to 1.76 %. Overall, increasing the blending ratio increased the fat, ash, protein, and moisture contents of the jellies. Besides, the jellies with the least amount of beetroot I (50 % beetroot and 50 % pineapple juice) had the highest carbohydrate content (62.69 %) thus providing the highest amount of energy 261.30 KJ.
Physicochemical properties showed the following ranges total soluble solid content 63.84 to 64.89 °Brix, total sugar 43.23 to 43.94 %, reducing sugar 28.30 to 28.77 %, and non-reducing sugar 14.94 to 15.18 %. Titratable acidity and pH showed that an inverse relationship existed between them. The beetroot and pineapple jelly blends produced compared favourably with proximate composition and physicochemical properties of commercial jelly.

Key words: Beetroot, Pineapple, Juice, Jelly, Proximate, Sugar

Introduction

Fruits and vegetables have similar composition, having high water content (70-85%), relatively high carbohydrates but low in fat and protein, and usually contain useful vitamins (Nzelu, 2010). The carbohydrate portion can be further broken down into digestible and indigestible parts which are sugars and starches versus pectin and cellulose material (Potter and Hotchkiss, 2017). Vegetables differ from fruits in chemical composition. Most vegetables contain more starch than sugar as contrasted with fruits which are higher in sugar than starch especially when ripe. Vegetables are edible parts of the plant which are usually cooked and salted before consumption with other foods. These may include leaves, stems, roots, flowers, seeds, fruits, bulbs, tubers, and fungi. (Nzelu, 2010).

Beetroot (*Beta vulgaris L.*) is one of the important root vegetables that belong to the *Chenopodiaceae* family and is originally from temperate climate regions of Europe and North Africa. It is a dark red vegetable whose taste is described as sweet, earthy, and tender to eat (Nottingham, 2004). Beetroot is delicious if eaten raw but is more typically cooked or pickled (Partha et al., 2014). It is grown in the ground and is related to turnips, Swedes, and sugar beet. Beetroots are notable for their sweetness; they have the highest sugar content of vegetables but

they are low in calories. However, fresh beetroots are exposed to post-harvest spoilage due to their high nitrate content. Pineapple (*Ananascomosus)* is a tropical fruit, a member of the *Bromiliaceae* family (TFNET, 2016). Pineapples are rich in vitamins, enzymes and antioxidants. They help boost the immune system, build strong bones and aid digestion. Despite their sweetness, pineapples are low in calories. They are members of the bromeliad family and the only member that produces edible fruit (Arshad et al., 2014).

Different food products like jam, jelly, fruit bars, and marmalade are prepared from raw edible fruits. Fruit jams, jellies and marmalades are made by cooking fruits (pieces, pulps and or juice) with sugars, gelling agents (pectin), and edible acids (CODEX STAN 2009: Fungel et al., 2015).These mixtures are then concentrated until a characteristic and suitable consistency is obtained. The minimum amount of fruits in the final product may vary from about 35–45% (Fugel et al., 2015). Jellies are defined by Codex Alimentarius Commission, (CAC) section 2-2 as a product brought to semi-solid gelled consistency and made from the juice and or aqueous extracts of one or more fruits or vegetables, mixed with foodstuffs with sweetening properties with or without the addition of water (CODEX STAN 2009).

Consumers find the flavour of beetroot repulsive and so avoid it, which calls for the need to make the vegetable available in more palatable forms. On the other hand, beetroots are rich in nitrates. This high concentration of nitrates makes it prone to microbial attacks responsible for the early deterioration of fresh raw beetroots (Nottingham, 2004).In essence, processing beetroots into jelly will solve the problem of high rate of spoilage of fresh beets. It will also enrich health of consumers. More so, blending beetroot juice with pineapple juice will improve the flavour and provide vitamin C which beetroot lacks in a nutritionally significant level.This study aimed to determine the physicochemical and proximate composition jelly from beetroot and pineapple fruits blends. The production of jelly is a value addition that will curb peak season post –harvest fruit losses in Nigeria..

Materials and Methods

Fresh beetroot (*Beta vugaris L*)fruits50 kgwere purchased from Jos, Plateau State, Nigeria. 30 kg pineapples (*Ananascomosus*),golden penny granulated sugar, and Pfizercitric acid were purchased from Ogige main market in Nsukka, Enugu state Nigeria. Sure jell rapid set Pectin was purchased through Alibaba.com (online market) and was supplied through DHL courier service.

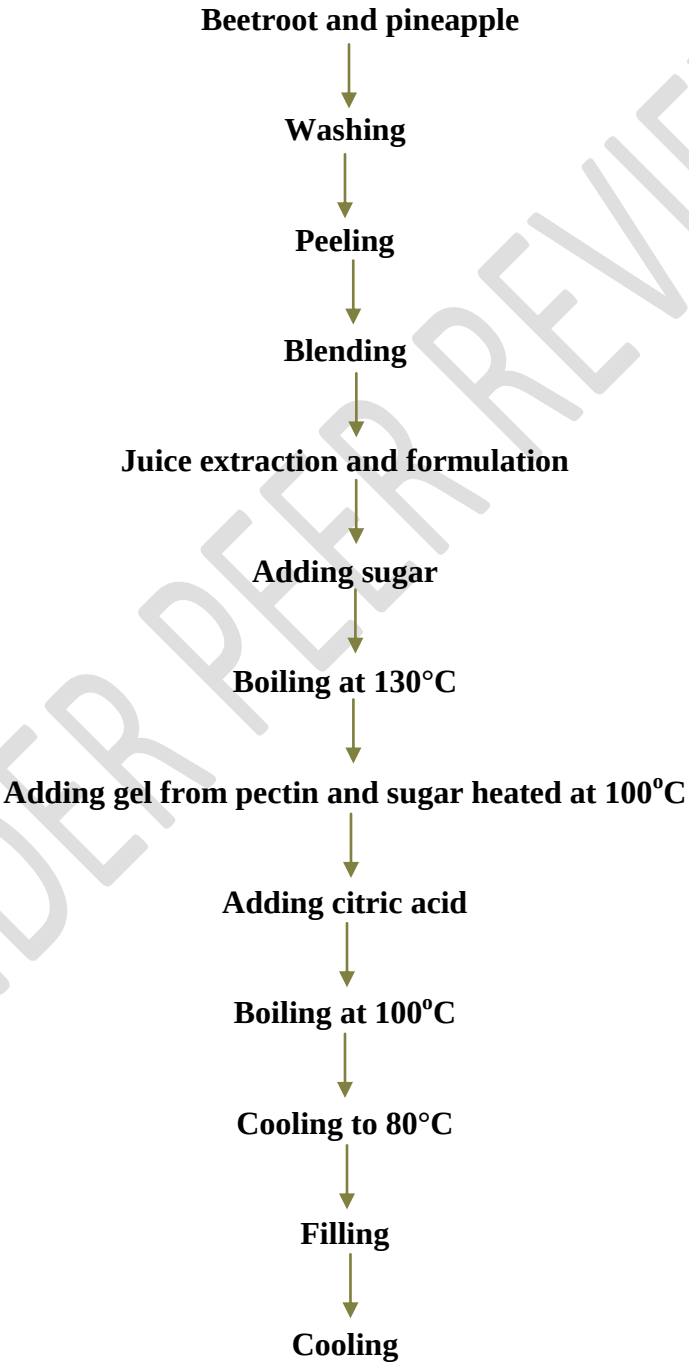
Preparation of beetroot and pineapple juice

Fresh beetroots and pineapples were washed separately under running tap water to remove dirt and dust. Food processing hand gloves were put on before they were further manually peeled and sliced using kitchen knife. The slices were blended separately using an electric kitchen blender. Passed through muslin clothe with 2mm pore size to get the juices. Beetroot juice 2,500 ml and pineapple juice 2,000 ml were obtained, before formulating into the different required blends.

Making beetroot and pineapple blend jelly

The beetroot and pineapple juices obtained were then blended according to the following ratios: 50:50, 60:40, 70:30, 80:20, and 90:10. The resultant blends were then labeled as I,R,O,H, and A respectively. Afterwards, 400 ml of each blend was weighed as the working volume. A 500 g of

sugar was weighed and divided into three equal portions (166.67 g) each. The first part was added to the juice and boiled at 130 ^{o}C. The second part was mixed with pectin (6 g), the heat was reduced to 100^{o}C and the pectin and sugar mixture was heated until a gel is formed. The gel was added to the juice and was stirred continuously till it was dissolved before the third part was added. Upon reaching 60 degree Brix, citric acid was added to get a pH of 3.4 for gel enhancement. Heating was discontinued at 65- degree Brix and the jelly was allowed to cool to 80 ^{O}C before they were filled into already pre-sterilized glass jars leaving about ¼ inch head space for vacuum formation.



Beetroot-pineapple jelly

Figure 1: Flow diagram for beetroot and pineapple blend jelly production
Source:*Gava*et al. (2008).

Proximate Analyses
The proximate composition of jellies was determined according to the method of The Association of Official Analytical Chemists (AOAC) (2010).

Determination of moisture content
Moisture content was determined by the hot air oven drying method to constant weight. A stainless steel moisture dish was cleaned and pre dried in the oven (Memmert Model UN30) until constant weights was attained and cooled in a desiccator. Two grams of each sample was weighed into respectively labeled moisture dish and dried at 100 ^{o}C, for 1 h. this was followed by cooling in a desiccator. The moisture dishes were re dried and weighed intermittently until a constant weight was attained. The loss in weight from the original sample weight was calculated as the moisture content using the formula

$$\% \text{ moisture content} = \left(\frac{W_2 - W_3}{W_2 - W_1}\right) \times \frac{100}{1}$$

Where: W_1 = weight of empty moisture dish, W_2 = weight of moisture dish + sample before drying, W_3 = weight of moisture dish + sample after drying.

Determination of ash content
Two grams of each sample was weighed into clean crucibles previously weighed. It was then placed in a muffle furnace (Vecstar, Model Lf3, USA) and ignited at 550 ± 2 ^{o}C for 4 h. afterward. The muffle furnace was cooled and crucible reweighed. The ash content was calculated as:

$$\% \text{ Ash content} \left(\frac{W_2 - W_3}{W_2 - W_1}\right) \times \frac{100}{1}$$

Where: W_1 = weight of empty crucible, W_2 = weight of crucible and sample before ashing, W_3 = weight of crucible and sample after ashing.

Determination of fat content
A Soxhlet extractor with a reflux condenser and a previously dried cooled and weighed 250 ml round bottom flask was assembled. Two grams of each sample was weighed into a labeled thimble and petroleum ether (150 ml, boiling point 60 – 80 ^{O}C) was filled into the round bottom flask. The extraction thimble was plugged with cotton wool. The Soxhlet apparatus after assembling was allowed to reflux for 6 hours. The thimble was removed with care and the petroleum ether was recovered for reuse. The round bottom flask containing the petroleum ether was dried at 70 ^{O}C for 1 hour in an oven (Memmert UN30, Germany), cooled in a desiccator, and weighed.

Calculation:

$$\%Fat = \frac{Weight\ of\ fat}{Weight\ of\ sample} \times \frac{100}{1}$$

Determination of fiber content

Two grams of each sample were weighed and defatted using petroleum ether (Boiling point of 40 to 60°C). The defatted sample was boiled for 30 minutes in 200 ml of 1.25% H_2SO_4 and the solution was filtered through a funnel fitted witha muslin cloth. It was washed with boiling water until it was free of acid. The residue was boiled for another 30 minutes with 100 ml of 0.02 M NaOH. It was further washed with boiling water then with 1 % hydrochloric acid and finally with boiling water to ensure that it was free of acid. The final residue was transferred into a crucible and dried in the oven for 1 hour. The crucible with its content was cooled in a desiccator and weighed. The residue was transferred intothe crucible and dried at 100 ^{o}C to a constant weight. Incineration to ash was done at 600 ^{o}C for 30 minutes, cooled in a desiccator and weighed. The difference in weight between oven-dry weight and weight after incineration was taken as the fiber content of the sample. This was expressed as a percentage of the original weight ofthe sample taken for analysis.

$$\text{Crude fiber (\%)} = \frac{Weight\ of\ dried\ sample - weight\ of\ sample\ after\ incineration}{Initial\ weight\ of\ sample} \times \frac{100}{1}$$

Determination of crude protein content

Protein was determined using the Kjeldahl method. Two grams of each sample were weighed into a Kjeldahl flask and added anhydrous sodium sulphate (5g of Kjedahl catalyst), concentrated H_2SO_4 (25 ml) and a few boiling chips. The samples were digested in the fume chamber toa clear solution. Each sample digest was allowed to cool and then transferred into a 250 ml volumetric flask made up to volume with distilled water. Five milliliters of 2% boric acid solution witha few drops of methyl red indicator were introduced into a distillate collector (100 ml conical flask) and placed under the condenser in a distillation unit. Five milliliters of each sample digest was pipetted into the distillation unit washed down with distilled water followed by the addition of 5 ml of 60% sodium hydroxide solution to the digest. The sample was heated until 50 ml of the distillate was collected in the receiving flask. The distillate was titrated against 0.01N HCl to a pink-colored end point. Theblank diluted digest from filter paper was also distilled and the distillate was titrated against 0.01N HCl Total nitrogen (%) was estimated using the expression:

$$\text{\% Nitrogen} = \frac{Titre\ value - Blank \times Normality\ of\ acid}{Weight\ of\ sample} \times \frac{100}{1}$$

Crude protein = %N x 6.25

Where T= Titre

B= Blank

N= Normality

W= weight of acid

Determination of carbohydrate content

Thecarbohydrate content of each sample was calculated by difference. The difference between 100 and the sum of percentages of moisture, protein, fat, fiber and, ash of each sample was calculated and the result expressed as

% carbohydrate = 100 – (% moisture + % crude protein + % crude fiber + % ash + % fat)

Determination of energy value

The values obtained for protein, fat, and carbohydrate was used to calculate the energy value of the samples, using the At-water factor described by AOAC (2010).

Calorific value (Kcal/100g) = P×4.0+F×9.0+C×3.75

Where P, F, and C are (%) protein, fat, and carbohydrate in the samples respectively

Physicochemical analyses

Determination of Total soluble solid (TSS)

The TSS content of pulp was determined by AOAC [2010], using Erma hand refractometer at 20 ^{o}C and by reference tables expressed as % sucrose by weight (^{O}Brix) The prism of the refractometer was washed with water and wiped to dry after each reading.

Determination of total sugars

Total sugar was determined using the method described by AOAC (2010). Five grams of sample was put in a 500 ml beaker, 100 ml of warm water was added and it was neutralized with 10% NaOH. Two milliliters of lead acetate solution was added it were allowed to stand for 10 minutes. The necessary amount of sodium oxalate was added to remove excess lead in the solution. The volume was made up tothe 250 ml mark with distilled water and filtered. Fifty milliliters of the clarified and deleaded solution was transferred into a 250 ml flask. Ten milliliters of 1N HCL was added to the flask. This solution was boiled for two minutes. After cooling, 3 drops of phenolphthalein were added and the content was neutralized with NaOH. The solution was filtered and the volume, made up to 250 ml with distilled water. Ten milliliters of a mixed Fehling's solution was pipetted into a conical flask. A burette was filled with the clarified sample solution and running the whole volume required to reduce the Fehling's solution so that, 0.5-1.0 ml was still required to complete the titration. The content of the flak was mixed and heated to boiling for 2 minutes. Three drops of methylene blue indicator were added then the titration continued until the color completely disappeared. The percentage of total sugar was calculated as follows:

$$\text{Mg total sugar per 100 ml} = \frac{Factor \times 100}{Titre}$$

$$\text{Percentage oftotal sugar} = \frac{mgper\ 100ml \times Dilution}{weightofthesample \times 1000} \times 100$$

Determination of reducing sugars

Reducing sugars were determined using the method described by AOAC (2010). Five grams of sample was put in a 500 ml beaker, 100 milliliters ofwarm water wasthen added and it was neutralized with 10 % NaOH. Two milliliters of lead acetate solution was added and allowed to stand for 10 minutes. The necessary amount of sodium oxalate was added to remove excess lead in the solution. The volume was made up to 250 milliliter mark with distilled water and filtered. Ten milliliters of mixed Fehling's solution was pipetted into a conical flask. A burette was filled with the clarified sample solution and running the whole volume required to reduce the Fehling's solution so that, 0.5-1.0 ml was still required to complete the titration. The content of the flak was mixed and heated to boiling for 2 minutes. Three drops of methylene blue indicator were

added then the titration continued until color completely disappeared. The percentage reducing sugar was calculated as follows:

Mg reducing sugar per 100 ml = $\frac{Factor \times 100}{Titre}$

Percentage reducing sugar = $\frac{mg per\ 100ml \times Dilution}{weight of the sample \times 1000} \times 100$

Determination of non-reducing sugar

Non-reducing sugars was determined using the method described by AOAC (2010). Percentage reducing sugar was subtracted from total sugar and the result obtained were values for the non-reducing sugar.

Determination of pH

pH was determined using a standard pH (model 20 pH) meter (Denver instrument united national inventory database) as described by AOAC (2010). Two grams of sample was homogenized in 20 ml of distilled water in a beaker. The pH meter was first standardized using buffer solutions of pH 4 and 9. The electrode was rinsed with distilled water and then dipped into the homogenate, allowing sufficient time for stabilization before taking the reading.

Determination of titratable acidity

Titratable acidity was determined by the methods described by AOAC (2010). Ten grams of the sample was diluted into 250 ml of boiled distilled water and titrated just before the end point using 0.1 N NaOH and 0.3 ml phenolphthalein as an indicator. Two grams of sample was diluted in 20 ml of distilled water. With this, the colour was easily noticed and then it was titrated with NaOH solutionuntil a pink colour was obtained that persisted for 30 sec. The titration was done in duplicates. The acidity was calculated using the formula:

Titratable acidity (%) = $\frac{0.1N(NaOH) \times T \times 75}{V \times 1000} \times 100$

Where T = titre value

V = volume of sample

Data analysis

The experiment was laid on a Completely Randomized Design (CRD). The mean and standard deviation were calculated by one-way analysis of variance using statistical package foe service solution (SPSS) software version 22. Means were separated by Duncan's new multiple range test. Significant difference were at $p < 0.05$ according to Steel and Torrie, (1980).

Result and Discussion

Proximate composition of beetroot and pineapple blend jelly

The protein content of the beetroot and pineapple blend jelly (Table 1) ranged from 0.88 to 1.77 %. The result showed no significant ($p>0.05$) difference between sample A, H and O. Sample K varied significantly ($p<0.05$) from the rest of the samples while no variation ($p>0.05$) was observed between samples I and R. Comparatively, sample K had the least protein content while sample A had the highest. The protein content is generally about 1% of fresh fruits and 2% in most vegetables (Nzelu, 2010). In this study the protein content of the jellies were observed to increased with an increase in the beetroot ratio. This is because beetroots have more protein than

pineapples. The same trend was observed by Ajenifujah and Aina (2011), in a study on the physicochemical properties and sensory evaluation of jam made from black-plum and beetroot fruits. Attributably, the beetroots have higher protein content than pineapples that could contribute to the increase contents of the fruit blend.

The fat content of the jellies ranged from 0.46 in sample K to 0.60 % in sample A. No significant ($p>0.05$) differences existed between samples K, I, R, and O but there was a significant ($p<0.05$) difference between them and samples H and A.The amount of lipids found in fruits and vegetables are usually small, comprising less than 1% of the bulk with avocado as an exception (Nzelu, 2010) (They are usually associated with the cell membranes). The fat content in the samples showed that beetroots contains, even though they are in trace levels, higher amount of fat than pineapples as seen.

Table 1: Proximate composition of beetroot and pineapple blend jelly

Samples	Protein (%)	Fat (%)	Moisture (%)	Ash (%)	Fiber (%)	Carbohydrate (%)	Energy value (kj)
K	$0.88^{a}\pm0.02$	$0.46^{a}\pm0.04$	$34.80^{a}\pm0.00$	$0.12^{a}\pm0.02$	ND	$63.74^{f}\pm0.04$	$262.72^{e}\pm0.09$
I	$1.52^{b}\pm0.02$	$0.50^{a}\pm0.00$	$35.11^{b}\pm0.00$	$0.19^{b}\pm0.01$	ND	$62.69^{e}\pm0.01$	$261.30^{d}\pm0.06$
R	$1.54^{b}\pm0.01$	$0.53^{ab}\pm0.04$	$35.14^{b}\pm0.01$	$0.21^{b}\pm0.01$	ND	$62.59^{d}\pm0.03$	$261.25^{d}\pm0.15$
O	$1.75^{c}\pm0.00$	$0.53^{ab}\pm0.04$	$35.40^{c}\pm0.01$	$0.20^{b}\pm0.00$	ND	$62.13^{c}\pm0.02$	$260.23^{c}\pm0.23$
H	$1.77^{c}\pm0.02$	$0.58^{bc}\pm.0.04$	$35.75^{d}\pm0.03$	$0.25^{c}\pm0.01$	ND	$61.66^{b}\pm0.03$	$258.88^{b}\pm0.12$
A	$1.76^{c}\pm0.01$	$0.60^{c}\pm0.00$	$36.17^{e}\pm0.02$	$0.26^{c}\pm0.01$	ND	$61.22^{a}\pm0.00$	$257.26^{a}\pm0.03$

Values are means ± standard deviation of 2 replications. Values with the same superscripts in a column are not significantly different ($p>0.05$).
Key: Sample K=commercial mixed fruit jelly, I=50:50% beetroot and pineapple blend jelly, R=60:40% beetroot and pineapple blend jelly, O=70:30% beetroot and pineapple blend jelly, H=80:20% beetroot and pineapple blend jelly, A=90:10% beetroot and pineapple blend jelly.

The moisture content of the beetroot and pineapple blend jelly ranged from 34.80 to 36.17 %. The finding of this study conform to the 32 to 35% moisture levels reported for jellies (USDA 2015). No significant ($p>0.05$) difference was found in sample I and R but the rest of the samples varied significantly ($p<0.05$) from each other. In this study sample K had the least amount of moisture and sample A, the highest. Usually, fruits are high moisture foods (Nzelu, 2010). However, with heat treatment of the fruit juice about 60 % reduction in the moisture content could be attained. In this study, moisture content was observed to increase with increased beetroot proportion. This could be attributed to the higher moisture content (87.5 %) of beetroots than the pineapple fruit (Gajanan et al, 2014). In a study, about 1.5% more moisture content was reported in beetroots than pineapples fruits (Black, 2012). Olugbenga et al. (2018) observed a similar trend in the moisture content of banana, watermelon and pineapple blend jam where the sample with the highest amount of pineapple had the least moisture level.

The ash content of the beetroot and pineapple blend jelly ranged from 0.12 to 0.26 %. Sample K, was significantly ($p<0.05$) different from the rest of the samples, while no significant ($p>0.05$) difference was observed between samples I, R and O. Sample K (commercial jelly) had the least amount of ash, while within the blends, sample I had the least amount of ash and sample A the highest. The ash content was seen to be increasing with incorporation of beetroot. This confirms the report of Bakkali et al. (2009) that the ash content of most vegetables are generally higher than that of fruits. Since ash content of a food material is a measure of the inorganic compounds present, it is not wrong to assume that the samples with higher ash content are rich in inorganic compounds.

Crude fibre was tested for but was not detected in any of the samples because the raw materials were juiced and the fibrous materials were removed before further processing.

In this study, the carbohydrate content of the jellies ranged from 61.22 % to 63.74%. All the samples varied significantly ($p<0.05$) from each other in terms of carbohydrate content. The finding of this study revealed that jelly A had the least amount of carbohydrate. Sample I with the least proportion of beetroot to pineapple fruits however, had the highest amount of carbohydrate. Similar trend was observed by Anuradha et al. (2017) in a study on pineapple and papaya blend jam where increased pineapple fruit proportion resulted to higher carbohydrate content Olugbenga et al. (2018) had similarly observed that in banana, watermelon and pineapple blend, sample with increased pineapple fruits had the highest carbohydrate content. In general, fleshy fruits possess high sugar content, glucose, fructose, sucrose and starch constitute than vegetables. Besides, starches in fruits usually could also disappears on ripening (Nzelu , 2010).

The energy value of the products ranged from 257.26 Kj in sample A to 262.72 Kj in sample K. No significant ($p>0.05$) difference was observed between sample I and R but the rest of the samples differed significantly from each other. Within the blends, sample I had the highest energy level of 261.30 Kj. The energy value of a food indicates its value to the body as fuel (Schmidt, 2015). Energy requirement can be thought of as the amount needed to maintain the basic processes of life at rest, that is, basal metabolism, plus the amount needed for physical activity under a variety of circumstances. Body weight is an important factor in determining how much energy we need, since more energy will be needed to sustain and move a greater body mass (Schmidt, 2015).USDA (2015) recommends that the daily energy intake of the average man should be about 10,500kj and 40 to 65% of this should come from dietary carbohydrate which is about 6300kj from carbohydrates. The carbohydrate in the product provides about 244.88kj which is roughly 4.0% of the daily requirements for carbohydrates

Physicochemical properties

The total soluble solids (TSS) content of the jellies in the study range between 63.84 to 65.20 % (Table 2), the result showed comparatively lower total soluble solids (TSS) content of the jellie with the commercial sample. The total soluble solids (TSS) content of the jelly observed is in conformity with standard of 60 to 65 % stipulated by CODEX STAN, (2009). The TSS is a measure of the amount of material that is soluble in water expressed as a percentage. A product with 100 % soluble solids has no water and one with 0 % soluble solids is all water. The correct

sugar content is critical for proper gel formation and for preservation of jelly. If the final TSS is lower than 60-65 % the shelf life will be reduced. The product will have a runny consistency and bacteria and moulds will be able to grow in the product. If the TSS is higher than 65%, the jelly will be very stiff and the sugar might start forming crystals in the product (CODEX STAN 2009). However, according to CODEX STAN (2009), all the products fell within this range therefore the products can be said to be of adequate quality.

Table 2: Total soluble solids, total sugar, reducing and non-reducing sugar composition

Samples	Total soluble solids (°Brix)	Total sugar (%)	Reducing sugars (%)	Non-reducing sugars (%)
K	$65.20^{e} \pm 0.00$	$44.15^{e} \pm 0.02$	$28.90^{e} \pm 0.00$	$15.25^{c} \pm 0.02$
I	$64.89^{d} \pm 0.00$	$43.94^{d} \pm 0.00$	$28.77^{d} \pm 0.04$	$15.18^{bc} \pm 0.04$
R	$64.86^{d} \pm 0.01$	$43.92^{d} \pm 0.03$	$28.76^{d} \pm 0.00$	$15.16^{bc} \pm 0.03$
O	$64.60^{c} \pm 0.01$	$43.75^{c} \pm 0.05$	$28.60^{c} \pm 0.01$	$15.15^{b} \pm 0.06$
H	$64.25^{b} \pm 0.03$	$43.51^{b} \pm 0.00$	$28.49^{b} \pm 0.00$	$15.02^{a} \pm 0.00$
A	$63.84^{a} \pm 0.02$	$43.23^{a} \pm 0.02$	$28.30^{a} \pm 0.02$	$14.94^{a} \pm 0.04$

Values are means ± standard deviation of 2 replications. Values with the same superscripts in a column are not significantly ($p>0.05$) different.
Key: Sample K=commercial mixed fruit jelly, I=50:50% beetroot and pineapple blend jelly, R=60:40% beetroot and pineapple blend jelly, O =70:30% beetroot and pineapple blend jelly, H=80:20% beetroot and pineapple blend jelly, A=90:10% beetroot and pineapple blend jelly.

The values for the total sugars in the samples ranged from 43.23 in sample A to 44.15% in sample K. All the samples varied significantly ($p<0.05$) from each other except for sample I and R that had no significant ($p>0.05$) difference. As seen on the table, the total sugar level was decreasing as beetroot increased showing that beetroot contained less sugar than pineapples.

Reducing sugars ranged from 28.30 in sample A to 28.90 % in sample K. No significant ($p>0.05$) difference was seen between sample I and sample R, every other sample differed significantly ($p<0.05$) from each other. The result obtained was in accordance with that obtained by Lokonuzzaman et al. (2015) in quantitative estimation of the amount of sugar in fruit jams available in Bangladesh where the reducing sugars for pineapple jam was 28.00 %.

The values for the non-reducing sugars followed the same trend as that of reducing sugar where sample I and R had no significant ($p>0.05$) difference between them. Sample A had the least value of 14.94 % while sample K had the highest value of 15.25 %. According to Lokonuzzama et al (2015), the values for non-reducing sugar was 10.00 % which corresponds to the values from the samples.

The pH of the products ranged from 3.41 in sample K to 3.46 in sample H. No significant ($p>0.05$) difference existed between sample R, H, and A, but they differed ($p<0.05$) significantly from sample K, I and O. Therefore it can be said that pineapple contributed significantly to the acid concentration of the product. The result was also in line with that from Olugbenga et

al.(2018). The pH of jams and jellies are very essential as low pH is maintained in the product to prevent microbial growth and enhance the colour and flavour of the product. On the other hand, low pH is necessary for the setting of jams or jellies.

The acidity in the products ranged from 0.28 % in sample H to 0.32 % in sample K. Sample K varied significantly ($p<0.05$) from sample H and no significant ($p>0.05$) difference was seen between the rest of the samples. Acidity reduced with increase in beetroot fruit addition. The level of acidity in jams and jellies are inversely related to the pH as seen from Table 3. High acidity is required for preservative actions, colour and flavour improvement and setting of the jelly.High acidity of the jelly bind available water, and deters the growth of micro organisms. A moderate level of acid is critical as too much acid will cause the jelly to weep and too little acid, may deter the product from setting (Tomas *et al*. 2007).

Table3: Physicochemical composition of beetroot and pineapple blend jelly

Sample	pH	Titratable Acidity (%)
K	$3.41^{a}\pm0.01$	$0.32^{b}\pm0.03$
I	$3.42^{a}\pm0.00$	$0.31^{ab}\pm0.01$
R	$3.45^{b}\pm0.00$	$0.30^{ab}\pm0.00$
O	$3.42^{a}\pm0.02$	$0.30^{ab}\pm0.01$
H	$3.46^{b}\pm0.01$	$0.28^{a}\pm0.01$
A	$3.45^{b}\pm0.01$	$0.29^{ab}\pm0.01$

Values are means ± standard deviation of 2 replications. Values with the same superscripts in a column are not significantly ($p>0.05$) different.
Keys: Sample K=commercial mixed fruit jelly, I=50:50% beetroot and pineapple blend jelly, R=60:40% beetroot and pineapple blend jelly, O=70:30% beetroot and pineapple blend jelly, H=80:20% beetroot and pineapple blend jelly, A=90:10% beetroot and pineapple blend jelly.

Conclusion

Proximate and physicochemical analysis of jelly from beetroot and pineapple shows that the formulated jelly had a better profile as compared to the commercial jelly. This study also shows that beetroot and pineapple utilization in Nigeria can be improved and postharvest losses reduced by processing them into value added products such as jellies.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly used products in our area of research and country. The research was funded by personal efforts of the authors.

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