PRODUCTION AND EVALUATION OF JAM PRODUCED FROM COCOA PULP

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Abstract
The rate of postharvest losses of fresh cocoa pulp is very high because little amount is used for the fermentation of the beans in the production of beverages. This work aimed at reducing postharvest loss of cocoa pulp by converting it to jam as value added product. Five (5) cocoa cultivars (RCP1, RCP2, RCP3, RCP4 and RCP5) were selected and processed into jam using standard methods. The jam products were evaluated for proximate, physiochemical, photochemicals and sensory properties using standard methods. Results of proximate composition of raw and jam were protein (2.98-4.98%; 1,20-2.98%), fat (29.2-60.8%; 6.43-15.3%), ash (5.25-11.1%; 9.74-15.99%), crude fibre (5.87-11.4%; 13.5-22.7%), carbohydrate (4.84-32.3%; 20.7-31.9%), moisture content (18.1-24.2%; 26.0-37.4%) and energy (321.98-567.12kcal/100g; 167.47-228.75kcal/100g respectively). Phytochemical results of raw cocoa pulp and jam revealed polyphenols ranged from 0.10-0.96mg/100g; 1.14-2.10mg/100g, flavonoids of raw cocoa pulp and jams ranged from 0.41-0.48mg/100g; 0.37-0.45mg/100g, and total antioxidants of raw cocoa pulp and jams (3.16-5.63mg/100g; 5.86-9.05mg/100g. The results of phytochemicals showed that jam produced from CPJ5 cultivar has the highest polyphenol (2.10 mg/100ml), CPJ3 had highest total antioxidant (9.05 mg/100ml) and CPJ3 cocoa pulp jam had better nutritional and sensory attributes when compared with the control and other cocoa pulp jam samples. Physiochemical results revealed total titratable acids of raw cocoa pulp and jams ranged from 0.18-0.29mg/100g; 0.36-3.78mg/100g, brix (1.20-3.50mg/100g; 62.99-71.00mg/100g) and p^H (5.57-7.16mg/100g; 2.36-6.17%mg/100g). The results of ascorbic acids of the raw cocoa pulp and jams ranged from 0.014-0.020mg/100g; 0.014-0.026mg/100g. The sensory score results showed that CPJ3 was the most liked with the highest score of (7.4), followed by CPJ 1 and CPJ2 (6.9). The study has shown that an acceptable jam can be made from cocoa pulp for children, adult and elderly consumption.

Keywords: Cocoa, jam, phytochemical, physiochemical, proximate.

Received: 03.04.2020 Received in revised form: 20.05.2020 Accepted: 15.06.2020

1. INTRODUCTION

Cocoa (*Theobroma cacao* L.) is one the economic backbone of some countries in West Africa, among which are; Cote d'Ivoire, Ghana and Nigeria. It is originated from Central and Southern America and an important agricultural export commodity in the world (Afoakwa *et al.*, 2011a). Cocoa pod encloses cocoa seeds, whichis made up of the testa (seed coat), the embryo and the cotyledon (Afoakwa, 2010). Sugary and white mucilaginous pulp is attached to the seed coat during pod development from an endocarp meristem and makes up approximately 40% of fresh seed weight. Cocoa pulp mainly consists of water, sugars, acids, and pectin (Afoakwa *et al.*, 2013).

Cocoa pulp contains water, sugars which serves as source of sweetness, reduces microbial activities and helps gelatinization, acids helps to lower the pH for optimum gel formation and pectin which helps as a bidding agent unifying the mixture, which are important ingredient in Jam formulation. Sugars in cocoa pulp are mainly sucrose, fructose, and glucose. The presence of pectin in cocoa pulp gives cocoa pulp a thick consistency, constitutes about 1% on fresh weight basis. Citrate is the major organic acids and its composition inversely affects the pH of cocoa pulp. Other non-volatile organic acids such as malic, tartaric, and oxalic acids are less than 0.1% in cocoa pulp. The most abundant mineral is potassium, while vitamin C (ascorbic acid) is the most abundant, constituting about 97% of all the vitamins

(Batista *et al.,* 2016). The concentrations of the nutrients vary due to different cultivars of cocoa, ripeness as well as growing regions and subsequently, influence of climate. These constituents are rich bioresource for value added product, particularly in the food industry.

Several researchers have attempted to utilize cocoa pulp extract before and after bean fermentation. Batista *et al.,* 2016 made a fruit wine by fermenting fresh cocoa pulp using *Saccharomyces cerevisiae* strain. Eke *et al.* (2013) evaluated Jam from Jackfruits. Batista *et al.,* 2016 researched on jam from Apricot fruit and Batista *et al.,* 2016 worked on production of marmalade from cocoa beans. Jams are made from the pulp and juice of one fruit rather than the combination of several fruits. Good jam has a soft even consistency without distinct pieces, a bright colour, a good fruit flavor and a semi-jellied structure that is easy to spread but has no free liquid. The cocoa pulp could be processed into jam after concentrating the pulp by removing a large amount of the moisture such that its solute concentration increased from about 10-15% to about 30-35%. The objective of this study was therefore to develop coco pulp jam and to evaluate proximate composition, ascorbic acids, some physicochemical, photochemical and sensory properties of Jam produced from five different varieties of cocoa pulp.

2. MATERIALS AND METHODS

Materials

Cocoa hybrid varieties (RCP1, RCP2, RCP3, RCP4 and RCP5) were obtained from Cocoa Research Institute of Nigeria, Ibadan, Nigeria. A commercial strawberry jam, lemon, Laboratory grade sugar and pectin were purchased from a local market in Ibadan, Oyo State, Nigeria.

Methods

Jam preparation

Jam was produced using a standard method according to Guide 7 (2017). The cocoa pods were washed with water and opened to remove the pulp enclosing the seeds. The pulp was then separated from the beans. 2.5ml of water was added to 400g of the extracted pulp before blending to a homogenous mixture and then heated to evaporate the excess moisture from the pulp. 100g of sugar was added to 400g of the heated pulp and heating of the mixture continued until the sugar was completely dissolved and total soluble solids of 60° brix attained. 20 ml of lemon juice and 0.05g of salt were then added to the mixture to enhance gel formation, improve colour and flavor of the jam. The mixture was thoroughly mixed until the total soluble solids (TSS) reached 68°brix. The mixture was hot filled into sterilized glass jars, cooled under ambient conditions and stored.

Determination of proximate composition

Crude protein, moisture, fat and crude fibre content were evaluated using method of A.O.A.C (2013). Energy was determined according to the method of Mahgoub using the formula as shown below, while carbohydrate was calculated by difference.

Total energy (kcal/100g) = [(% available carbohydrates × 4) + (% protein × 4) + (% fat × 9)]

Determination of phytochemical

The phytochemical screening was done on the sample using methods as described by AOAC, (2013). The dried sample was homogenized and alkaloid was extracted from 10g of the sample for 4 hours using 20% v/v acetic acid in ethanol. The extract was filtered to remove cellulose debris and then concentrated to about one quarter of the original volume. One percent NH_4OH was added drop wise until a precipitate occurred. The crude alkaloid was dried to constant weight in an oven and the percentage alkaloid calculated.

Determination of physicochemical composition

A total soluble solid was estimated using a refractometer and the pH of the samples was measured using microprocessor based digital pH meter using standard methods. The acidity

of the samples, total and reducing sugar, and ascorbic acid were evaluated according to AOAC, 2013. Total phenolic, flavonoid and antioxidants were determined calorimetrically.

Sensory evaluation

The sensory attributes were evaluated on the jams processed from the five cocoa varieties after one month storage at room temperature for taste, flavor, consistency, color and general acceptability at 2 weeks and 4 weeks intervals using 9-point hedonic scale, where 1- dislike extremely and 9-like extremely. A portion of 5grams of sample was served in random coded plates to 25 untrained panelists consisting of staff and students of the University who were very familiar with the jam. For consistency, an additional 5grams of each sample was smeared on a sliced piece of bread for evaluation. The data obtained were subjected to appropriate statistical analysis.

Statistical Analysis

Data generated were subjected to analysis of variance (ANOVA) using statistical package for social scientist (SPSS) and treatment means that are significantly different were compared using the Duncan's multiple range test.

3. RESULTS AND DISCUSSION

Proximate composition of cocoa pulp and jam samples

The proximate composition of raw cocoa pulp and cocoa pulp jam of the five varieties of cocoa as well as control are shown in Tables 1. The proximate composition results of raw cocoa pulp showed that moisture content ranged from 18.1% to 24.2% while the moisture contents in the cocoa pulp jam and control ranged from 25.0% to 37.44%. The values obtained are in accordance with the values reported by Eke *et al.* (2013) ranging from 20.02% to 35.1% in Jackfruit jam. All samples were not within the range of safe moisture content (<11.1%) as reported by Adebayo *et al* (2012). The moisture content of the cocoa pulp jam samples and the control were higher than that of the cocoa pulp raw samples because water were added during sample preparation stage though some were lost during heating. In general, the moisture content of jam samples were high, the lower the moisture content in a product, the longer the potential storage life since the growth of microorganisms are hindered at low moisture content.

Table 1. Proximate composition of the raw and jam samples

Sample	Moisture (%)	Ash (%)	Crude Fiber (%)	Fat (%)	Protein (%)	Cho (%)	Energy Kcal/100g
RCP1	21.3^{c}	10.5^{b}	(Batista *et al.*, 2016). 11.1^{b}	21.4^{e}	3.23^{c}	32.3^{a}	321.98^{e}
RCP2	21.6^{b}	7.49^{d}	9.08^{d}	29.2^{d}	2.98^{d}	29.5^{b}	381.44^{d}
RCP3	18.1^{e}	5.25^{e}	5.87^{e}	60.8^{a}	4.96^{a}	4.84^{e}	567.12^{a}
RCP4	19.7^{d}	9.65^{c}	9.37^{c}	48.7^{b}	4.98^{a}	7.53^{c}	468.59^{b}
RCP5	24.2^{a}	11.1^{a}	11.4^{a}	41.2^{c}	4.91^{b}	7.08^{d}	399.38^{c}
CPJ1	37.4^{a}	12.30^{d}	13.5^{e}	6.43^{e}	2.11^{d}	28.3^{a}	170.91^{c}
CPJ2	27.9^{d}	9.74^{f}	22.7^{a}	6.47^{d}	1.20^{e}	31.9^{a}	200.8^{b}
CPJ3	25.0^{f}	14.60^{b}	20.2^{c}	15.3^{a}	2.20^{c}	31.9^{a}	228.75^{a}
CPJ4	26.0^{e}	11.44^{e}	19.6^{d}	6.46^{d}	2.98^{a}	31.9^{a}	191.84^{bc}
CPJ5	30.9^{c}	15.99^{a}	20.4^{b}	9.41^{c}	2.98^{a}	20.7^{b}	167.49^{c}
CTR	34.5^{b}	13.04^{c}	21.1^{b}	12.4^{b}	2.98^{a}	25.1^{b}	211.89^{ab}

Mean with the same superscripts along the column are not significantly different at 5% probability.
CTR = Control. RCP1= Raw cocoa pulp hybrid 1. RCP2= Raw cocoa pulp hybrid 2. RCP3= Raw cocoa pulp hybrid 3. RCP4= Raw cocoa pulp hybrid 4. RCP5= Raw cocoa pulp hybrid 5. CPJ1=Cocoa pulp jam hybrid 1. CPJ2=Cocoa pulp jam hybrid 2. CPJ3=Cocoa pulp jam hybrid 3. CPJ4=Cocoa pulp jam hybrid 4. CPJ5=Cocoa pulp jam hybrid 5.

The ash content of the raw samples ranged from 5.25% to 11.1% while that of the cocoa pulp jam samples and control ranged from 9.74% to 15.99% and all the samples were significantly different at $p<0.05$. These values were slightly different from the values reported for jack fruit- pineapple jam by Eke *et al*., 2013.

However, this work has shown that CPJ5 variety has the highest ash content and consequently very rich in minerals. Ash content is an indication of the presence of mineral in food (Adebayo *et al*., 2012).

The results contents of protein showed that the values of cocoa pulp jam and control ranged from 0.19% to 2.98% while the protein content of the raw samples ranged from 2.98% to 4.98%. Control sample (CTR) had the lowest protein content (0.18%). The values obtained from raw cocoa pulp were higher than that obtained for the cocoa pulp jam and this might be due to protein denaturation by high temperature during heating. These values obtained were not in accordance with the results obtained by Batista *et al.*, 2016 in production of marmalade from cocoa beans and this could be due to environmental factors, agronomy factors or variety of the samples used. There was significant difference between the values obtained at $p<0.05$.

The fat content of the raw sample ranged from 21.4% to 60.8% and that of the jam samples and control ranged from 6.43% to 15.34%. It was observed that the fat content of the raw samples obtained were higher than the values obtained for the jam samples as a result of the heat treatment. CPJ3 had the highest fat content and this could be as a result of variety differences. CPJ3 and CPJ2 showed no significant difference at $p<0.05$ while others were all significantly different at $p<0.05$ and this could be due to the variety differences. The values obtained were higher than values reported by Batista *et al.*, 2016 in production of marmalade from cocoa beans (8.16% to 15.10%) and this could be due to environmental factors, agronomy factors or species of the samples used.

The crude fibre of the jam samples and control ranged from 5.87% to 11.4%. The crude fibre results showed no significant difference between CPJ5 and Control (CTR) at $p<0.05$ whereas there was significant difference between the other samples at $p<0.05$ and this could be as a result of the different cultivars. The crude fibre content values ranged from 13.48% to 22.7%. The high fibre content in the jam constitutes greatly to its weight and helps to aid digestibility in the bowel. The crude fibre contents obtained were higher than those reported by Batista *et al.*, 2016 in apricot jam (11.2% to 21.1%). This could be due to agronomy factors or environmental factors.

The carbohydrate content of the raw samples ranged from 4.84% to 32.3% while the carbohydrate content of the jam samples and control ranged from 20.7% to 33.4%. CPJ1, CPJ2 and CPJ4 were not significantly different at $p<0.05$ but was significantly different among CPJ5, CPJ3 and control at $p<0.05$. This difference could be due to difference in their cultivars. The results obtained were in accordance to the values obtained by Eke *et al.* (2013) in jackfruit jam (19.06% to 25.10%). The gross energy content ranged from 321.9 g/100cal to 567.1 g/100cal for both the raw samples, jam samples and the control. All samples were significantly different at $p<0.05$. Sample CPJ3 Jam had the highest energy value and this might be due to high fat content of the cultivars.

Phytochemical properties of raw cocoa pulp and cocoa pulp jam

Results of the phytochemical analysis of raw cocoa pulp and cocoa pulp jam from five (5) varieties are shown in Table 2. The result for raw samples showed that total polyphenol content ranged from 1.14 to 2.09 mg/100ml. All the samples were significantly different at $p<0.05$ and this could be due to differences in their cultivars. Total flavonoids content ranged from 0.41 to 0.48mg/100ml. RCP1 and RCP2 were not significantly different at $p<0.05$ while RCP3, RCP4, RCP5 were significantly different from RCP1 and RCP2.

Table 2: Phytochemical composition of the raw and jam samples (mg/100g)

Sample	Total Polyphenol	Total Flavonoid	Antioxidant
RCP1	1.35^{c}	0.41^{b}	3.16^{d}
RCP2	1.67^{b}	0.42^{b}	3.61^{c}
RCP3	1.14^{d}	0.44^{ab}	4.39^{b}
RCP4	1.63^{b}	0.44^{ab}	5.63^{a}
RCP5	2.10^{a}	0.48^{a}	5.52^{a}
CPJ1	0.10^{d}	0.37^{d}	5.86^{c}
CPJ2	0.15^{d}	0.42^{c}	6.62^{c}
CPJ3	0.31^{c}	0.43^{c}	9.05^{a}
CPJ4	0.96^{a}	0.42^{c}	7.88^{b}
CPJ5	0.28^{c}	0.45^{b}	7.62^{b}
CTR	0.82^{b}	0.50^{a}	2.26^{d}

Mean with the same superscripts along the column are not significantly different at 5% probability.
CTR = Control. RCP1= Raw cocoa pulp hybrid 1. RCP2= Raw cocoa pulp hybrid 2. RCP3= Raw cocoa pulp hybrid 3. RCP4= Raw cocoa pulp hybrid 4. RCP5= Raw cocoa pulp hybrid 5. CPJ1=Cocoa pulp jam hybrid 1. CPJ2=Cocoa pulp jam hybrid 2. CPJ3=Cocoa pulp jam hybrid 3. CPJ4=Cocoa pulp jam hybrid 4. CPJ5=Cocoa pulp jam hybrid 5.

The total antioxidant content ranged from 3.163 to 5.516 mg/100ml. RCP4 and RCP5 were not significantly different at $p<0.05$, while All other samples were significantly different at $p<0.05$ and this could be due to variety differences. Results of the Jam revealed that total polyphenol content ranged from 0.10 to 0.96 mg/100ml. CPJ1 and CPJ2 were not significantly different at $p<0.05$, CPJ3 and CPJ5 were not significantly different from each other too while CPJ4 were significantly different at $p<0.05$ from others and had the highest value (0.96mg/100g). This could be due to the difference in soil type, climate conditions and environmental factors. It was observed that the total phenolic content of the jam samples had lower values compared to that of the raw samples and this might be due to the adverse effect of heat treatment, light or oxygen that leads to oxidation and degradation of phenolic compounds (Batista *et al.,* 2016). The results of phenolic obtained were in accordance to those obtained by Batista *et al.,* 2016.

The total antioxidant content of jam samples and control ranged from 2.25 to 9.04 mg/100ml. CPJ1, CPJ2, CPJ4 and CPJ5 were not significantly different at $p<0.05$ while others were significantly different at $p<0.05$. The values obtained were in accordance to that reported for green grape jam (Batista *et al.,*). The increase in the antioxidants in the jam samples compared to the raw samples could be due to the degradation of tannins and polyphenolic compounds. It could also be due to the release of phytochemicals from the cell matrix (Batista *et al.,* 2016). In addition, the higher antioxidant values could be due to maillard reaction formed during the heat treatment (Batista *et al.,* 2016).

The Total flavonoid content of jam samples and control ranged from 0.37 to 0.50 mg/100ml. CPJ4, CPJ3 and CPJ2 were not significantly different at $p<0.05$ while others were significantly different at $p<0.05$. This could be due to their different soil properties and environmental factors. Flavonoids are group of antioxidants that have been proven to exhibit a wide range of biological activities like antimicrobial, anti-inflammatory, analgesic, anti-allergic, cytostatic and antioxidant properties (Ioannone *et al.,* 2015). The flavonoid composition in the jam samples had values lower than that reported for Roselle jam from dark red calyces (2.52g/100g) (Darkwa *et al.,* 2016). This could be due to environmental factors, agronomy factors or variety of the samples used.

Physiochemical compositions of raw cocoa pulp and cocoa pulp jam

Results of the physiochemical analysis of raw cocoa pulp and cocoa pulp jam from five (5) varieties of cocoa and control are shown in Table 3. The result for raw samples showed that the pH content values ranged from 5.57 to

7.36mg/100ml. All samples were significantly different at p<0.05 and this could be due to their different cultivars, soil properties and environmental conditions (Iftikhar *et al*, 2010). Total soluble solids content (Brix) values ranged from 1.19 to 3.50^{o}B. All the samples were significantly different at p<0.05. The results of titratable acid ranged from 0.18 to 0.29mg/100ml). RCP3 and RCP1 were not significantly different at p<0.05, while all other samples were significantly different at p<0.05.

Results of the Jam samples showed that the pH content ranged from 2.36 to 6.17mg/100ml. All samples were significantly different at p<0.05 and this could be due to the presence of several organic acids such as citric acid, lactic and acetic acid (Iftikhar *et al*, 2010). These acids help to preserve the colour, flavor compound of the pulp and prevent the jams from spoilage by non-acidophilic bacteria (Samira Lagha *et al.*, 2018). The reason for pH difference between the raw cocoa pulp and the jam samples may be due to the breakdown of pulp sugars that was reported to reduce citric acid concentration (Samira Lagha *et al.*, 2018). The pH of jam is an important factor to obtain optimum gel condition. The pH in the present study, particularly CPJ1 and CPJ2 were slightly lower than that reported by Awolu *et al.*, 2018 for jam from blends of banana, pineapple and water melon, meanwhile the P^{H} value of CPJ3, CPJ4 and CPJ5 were similar to the finding of Awolu et al, 2018. This could be due to environmental factors, agronomy factors or varieties of the samples used.

Total soluble solids (Brix) content of the Jam samples and control values ranged from 62.3 to 71.0^{o}B. CPJ1 and CPJ2 were not significantly different at p<0.05 while CPJ3, CPJ4 and CPJ5 were significantly different at p<0.05. This could be as a result of their different cultivars. The sugar present in jam comprises of natural and added sugar, which serves as a preservative by creating an osmotic environment that can inhibit microbial growth in the jam. The proportion of sugar to fruit varies according to the type of fruit and its ripeness. However, The results of the total soluble solids obtained from the jam products are in accordance to values reported by Eke *et al.,* (2013) for jackfruit jam (67.29 to 70.0)^{o}B

The total titratable acid content (TTA) of the jam samples and control values ranged from 0.36 to 3.78mg/100ml. CPJ1 and CPJ2 were not significantly different at p<0.05, while all other samples were significantly different at p<0.05. This could be due to their differences in structural and nutritional composition. These results obtained were higher than the values reported by Eke *et al.,* (2013) for jackfruit jam (0.36 to 2.88mg/100ml) and this could be due to environmental factors, agronomy factors or cultivars of the samples used.

Table 3: Physiochemical composition of the raw and jam samples

Sample	Brix (^{o}B)	TTA (mg/100g)	Ph (mg/100g)
RCP1	2.20^{c}	0.18^{c}	5.57^{e}
RCP2	1.20^{e}	0.27^{ab}	6.26^{d}
RCP3	3.00^{b}	0.18^{c}	7.16^{b}
RCP4	2.01^{d}	0.29^{a}	7.36^{a}
RCP5	3.50^{a}	0.25^{b}	6.76^{c}
CPJ1	67.99^{c}	0.36^{e}	6.06^{a}
CPJ2	67.99^{c}	0.36^{e}	6.17^{a}
CPJ3	71.00^{a}	0.90^{c}	3.76^{c}
CPJ4	69.49^{b}	1.01^{b}	3.07^{d}
CPJ5	68.00^{c}	0.57^{d}	4.36^{b}
CTR	62.99^{d}	3.78^{a}	2.36^{e}

Mean with the same superscripts along the column are not significantly different at 5% probability.
CTR = Control. RCP1= Raw cocoa pulp hybrid 1. RCP2= Raw cocoa pulp hybrid 2. RCP3= Raw cocoa pulp hybrid 3. RCP4= Raw cocoa pulp hybrid 4. RCP5= Raw cocoa pulp hybrid 5. CPJ1=Cocoa pulp jam hybrid 1. CPJ2=Cocoa pulp jam hybrid 2. CPJ3=Cocoa pulp jam hybrid 3. CPJ4=Cocoa pulp jam hybrid 4. CPJ5=Cocoa pulp jam hybrid 5.

Table 4: Ascorbic acids composition of the raw and jam samples (mg/100g)

Sample	Ascorbic acids (mg/100g)
RCP1	0.014^{c}
RCP2	0.020^{a}
RCP3	0.020^{a}
RCP4	0.018^{ab}
RCP5	0.170^{b}
CPJ1	0.021^{b}
CPJ2	0.021^{b}
CPJ3	0.021^{b}
CPJ4	0.026^{a}
CPJ5	0.026^{a}
CTR	0.014^{c}

Mean with the same superscripts along the column are not significantly different at 5% probability.
CTR = Control. RCP1= Raw cocoa pulp hybrid 1. RCP2= Raw cocoa pulp hybrid 2. RCP3= Raw cocoa pulp hybrid 3. RCP4= Raw cocoa pulp hybrid 4. RCP5= Raw cocoa pulp hybrid 5. CPJ1=Cocoa pulp jam hybrid 1. CPJ2=Cocoa pulp jam hybrid 2. CPJ3=Cocoa pulp jam hybrid 3. CPJ4=Cocoa pulp jam hybrid 4. CPJ5=Cocoa pulp jam hybrid 5.

Table 5: Sensory analysis of the jam samples

Sample	Color	Taste	Aroma	Texture	Appearance	Mouth feel	Overall acceptability
CTR	8.2^{a}	6.90^{a}	7.00^{a}	6.90^{a}	7.00^{a}	7.50^{a}	8.7^{a}
CPJ1	5.4^{c}	5.30^{b}	5.30^{b}	4.80^{b}	5.50^{b}	5.90^{b}	5.7^{c}
CPJ2	5.3^{c}	5.20^{b}	5.10^{b}	5.10^{b}	4.90^{b}	5.2^{ab}	5.7^{c}
CPJ3	6.9^{b}	6.90^{a}	6.60^{a}	7.10^{a}	7.00^{a}	7.10^{a}	7.4^{b}
CPJ4	5.7^{c}	5.20^{b}	5.40^{b}	5.30^{b}	5.30^{b}	5.6^{ab}	5.6^{c}
CPJ5	5.5^{c}	4.90^{b}	5.00^{b}	5.00^{b}	4.80^{b}	5.00^{a}	5.4^{c}

Mean with the same superscripts along the column are not significantly different at 5% probability.
CTR = Control. CPJ1=Cocoa pulp jam hybrid 1. CPJ2=Cocoa pulp jam hybrid 2. CPJ3=Cocoa pulp jam hybrid 3. CPJ4=Cocoa pulp jam hybrid 4. CPJ5=Cocoa pulp jam hybrid

Ascorbic Acid content of the raw cocoa pulp and jam samples

Table 4 showed the results of ascorbic acid content of the raw samples, jam samples and control from five (5) varieties of cocoa as well as the control sample. The ascorbic acid content raw cocoa samples ranged from 0.014 to 0.020mg/100ml. RCP2, RCP3 and RCP4 are not significantly different ($p<0.05$). The remaining samples were significantly different ($p<0.05$) and this could be due to the difference in nutritional composition of the cultivars. The findings below revealed that ascorbic acid obtained from jam sample ranged from (0.0014 to 0.026mg/100ml). CPJ1, CPJ2, CPJ3, CPJ4 and CPJ5 are not significantly different ($p<0.05$). Reports showed that cocoa pulp jam was found to contain lesser amount of ascorbic acid than orange (Okudu *et al*, 2017). The ascorbic acid values obtained for the jam samples were higher than that of the raw samples which normally after heat treatment should have reduced since Vitamin C is heat labile. This increase was due to the addition of citric acid from lime, which is known to be a very rich source of ascorbic acid. The citric acid was added to prevent the sugar from caramelization. The values obtained were lower and not in accordance to that reported for orange (Okudu *et al*, 2017). This could be due to climatic, topographic and environmental factors.

Sensory properties of jam made from raw cocoa pulp

The results of sensory evaluation of jam produced from five cocoa pulp varieties revealed that jam produced from pulp hybrid 3 (CPJ3) had the highest value of colour (6.9) among the jams produced from the five varieties for colour, followed by jam produced from cocoa pulp hybrid 4 (CPJ4) with score of 5.7 while jam produced from cocoa pulp hybrid 2 (CPJ2) had the lowest score (5.3) but the

control sample (CTR) had the highest score (8.2) when compared the value of control sample with the jam products. The values obtained were in accordance to those obtained by Eke *et al.,* (2013).

In-term of taste, control sample and jam produced from cocoa pulp hybrid 3 (CPJ3) had the highest score (6.9), followed by jam produced from cocoa pulp hybrid 1 (CPJ1) with score of 5.3 while jam produced from cocoa pulp hybrid 5 (CPJ5) had the least score (4.9). The values obtained were in accordance to those obtained by Eke *et al.,* (2013).

In-term of aroma, control sample had the highest score (7.0), followed by jam produce from cocoa pulp hybrid 3 (CPJ3) with score of 6.6 while jam produced from cocoa pulp hybrid 5 had the lowest score (5.0). The values obtained were in accordance to those obtained by Eke *et al.,* (2013).

Texture results revealed that jam produced from cocoa pulp hybrid 3 (CPJ3) had highest score (7.1), followed by the control sample (6.9) while the jam produced from cocoa pulp hybrid 1 (CPJ1) had the lowest score (4.8). These values were in accordance to those obtained by Eke *et al.,* (2013).

The appearance results showed that the control sample and the jam produced from cocoa pulp hybrid 3 (CPJ3) had the highest score (7.0), followed by jam produced from cocoa pulp hybrid 1 (CPJ1) with score of 5.5 while jam produced from cocoa pulp hybrid 5 had the lowest score (4.8).

In term of mouth feel, control sample (CTR) had the highest score (7.5), followed by the jam produced from cocoa pulp hybrid 3 (CPJ3) with score of 7.1, followed by jam produced from cocoa pulp hybrid 1 (CPJ1) with score of 5.9.

The overall acceptability of the jams revealed that the control sample is the most preferred (with score of 8.7), followed by the jam produced from cocoa pulp hybrid 3 (7.4), and the jam produced from cocoa pulp hybrid 1 (CPJ1) with score of 5.7, and CPJ2 (5.7) while the jam produced from cocoa pulp hybrid 5 has the lowest overall acceptability score (5.4).

4. CONCLUSIONS

The study has shown that acceptable jam products can be made from cocoa pulp. The jam produced from cocoa pulp hybrid 3 (CPJ3) was the most preferred and acceptable sample with sensory score of 7.4. The jam produced from all the five (5) cocoa cultivars are rich in antioxidant and flavonoids but jam produced from cocoa pulp hybrid 3 had the highest flavonoid content (0.43mg/100g), antioxidant (9.05 mg/100g), total energy (228.75Kcal/100g), and the least moisture content (25.0%) among all the five varieties. These, however, can helps to salvage free radicals in the body. Therefore, instead of allowing the bulk of the pulp not used for beans fermentation to waste away, it could be processed into jam since it would equally supply the dietary needs a normal fruit jam will supply and help protect the body from keeping excess free radicals.

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