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Influence of Pasteurization on the Quality of Pineapple, Watermelon and Banana Pulps-based Smoothie Flavoured with Coconut Milk

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Abstract Effect of pasteurization on the quality of pineapple, watermelon and banana pulps-based smoothie flavoured with coconut milk was reported. The fruits were sorted, washed thoroughly with clean salt water, peeled, sliced and diced into small cubes, while coconut heads were processed into milk. Smoothies from blends of pineapple (P), watermelon (W) and banana (B) pulps were formulated and coconut milk (C) was added as a flavourant. The blends: PWBC1 (50:40:10:10), PWBC2 (50:10:40:10) and PWBC3 (50:30:20:10), were of different ratios with each pasteurized to obtain three more samples (A1, A2 and A3). The three non-pasteurized products served as control. Chemical, microbial and sensory analyses were carried out on all smoothie samples. Significant ($p>0.05$) differences did not exist in proximate composition between treatments; but within samples, moisture (65.15-73.68%), crude protein (0.45-1.08%), fat (3.04-3.34%), fibre (6.82-10.14%), ash (1.50-2.80%) and carbohydrate (14.21-18.79%) contents. All the samples had significantly ($p<0.05$) high proportion of vitamin C (220.49-844.71 mg $100ml^{-1}$), pro-vitamin A (63.64-250.72 mg $100ml^{-1}$), potassium (98.73-200.59 mg $100ml^{-1}$) and calcium (17.79-19.10 mg $100ml^{-1}$) contents. Pasteurization treatment gave smoothies of comparable nutritional and organoleptic properties with the conventional non-pasteurized smoothies. The pasteurized samples (A2 and A3) had higher scores in overall acceptability for the sensory attributes. With pasteurization, safe smoothie beverages prepared and consumed regularly can assist in the enhancement and sustainability of household food and nutrition security.

Keywords: *beverage, coconut milk, fruit pulps, pasteurization, smoothies*

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1. Introduction

Smoothie is a thick beverage product prepared from raw fruit pulps and/or the blends. Smoothies may include other ingredients such as vegetables, water, crushed ice, fruit juice, sweeteners (such as honey, sugar, syrup), dairy products (such as milk, yoghurt, low fat or cottage cheese, whey powder), plant milk (such as coconut milk, tiger nut milk, almond nut milk, soy milk), seeds (such as celery seeds), spices (such as ginger, garlic), tea, chocolate, herbal supplements or nutritional supplements [1]. Smoothies contain dietary fiber from the fruit pulp and hence, thicker than fruit juices, with its viscosity resembling that of milkshake [2]. Some commercial smoothies, however, have added sugar, in order to increase sweetness. In some developing countries like Nigeria, smoothies are commonly prepared on demand and sold in big shops, hotels and other relaxation spots and might depend on the combination of fruits. Recently, smoothie products have been made more convenient in that consumers can carry the product out of the point-of-purchase in packaging materials.

Smoothies sold in these outlets are usually not pasteurized and as such the safety of these products cannot be guaranteed. Hence, pasteurization of smoothies may not only ensure reduction of microbial load, but in combination with refrigeration, could increase the shelf-life of the products [3]. The nutritional quality of smoothie could depend on the ingredients used. Coconut milk is an emulsion from grated meat of coconut (*Cocos nucifera*) to which some parts of water have been added. It is an excellent flavouring agent and is highly nutritious with mild-sweet taste like cow milk. It is also rich in protein, fat, vitamins, minerals and carbohydrates [4]. Coconut milk is suitable for vegetarians and for lactose intolerant people who are unable to fully metabolize lactose [5].

Pineapple (*Ananas comosus*) has an outstanding juiciness and strong flavour that balances the taste of sweet and tart. Pineapples are also very rich source of bioactive compound known as bromelain, which is associated with many health benefits [6]. Watermelon

(*Citrullus vulgaris*) is an excellent source of pro-vitamin A and other phytochemicals such as lycopene, beta-carotene, lutein and zeaxanthin [7,8]). Bananas were recorded to have potential health benefits such as lowering the risks of cancer and asthma, lowering blood pressure and improving the heart health. They are also rich in dietary fiber, protein, pro-vitamin A, vitamin B6, vitamin C, folate, riboflavin, niacin, manganese, potassium, magnesium, iron, among others [9].

2. Materials and Methods

The raw materials which include pineapple, watermelon, banana and coconut were purchased from 'Ogige' main market in Nsukka of the University town. Equipment and chemicals used were obtained from the laboratories in the Department of Food Science and Technology and Department of Crop Science, University of Nigeria, Nsukka (UNN), where all the analyses were carried out.

2.1. Experimental Design

The experiment was carried out based on 3 by 2 nested split-plots in completely randomized design [10].

2.2. Processing of Coconut Milk

The method described by [11] was modified to process coconut milk from the coconut heads. Coconut milk was processed by de-hulling the coconut heads (1 kg) and separating the meat. The meat was thoroughly washed and grated using an electric blender (Sayona Model SB-2816S) and placed in a bowl where a liter of warm water (40°C) was added and left for 10 minutes. The milk was then extracted using cheese cloth. The extract was later filtered with 0.18 mm sieve and squeezed in order to obtain a clear milky emulsion. The coconut milk was pasteurized in laboratory water bath at 75 °C within 10 minutes to obtain an emulsion with sweet coconut flavour.

2.3. Formulation of the Fruit Blends for Smoothie Production

Formulations were obtained after preliminary studies. Quantity of pineapple and coconut milk remained constant, while amounts of watermelon and banana were varied as shown:

$PWBC_1$= 50% pineapple + 40% watermelon + 10% banana + 10% coconut milk; $PWBC_2$= 50% pineapple + 10% watermelon + 40% banana + 10% coconut milk; $PWBC_3$= 50% pineapple + 30% watermelon + 20% banana + 10% coconut milk.

2.4. Production of Pasteurized and Non-pasteurized Smoothies

The fruits (pineapple, watermelon and banana) were sorted in order to remove unwholesome fruits and washed thoroughly with clean water containing table salt to remove dirty and to reduce microbial load. The washed fruits were peeled, sliced and diced into small cubes and blended using electric blender (Sayona Model SB-2816S) at the different ratios of 50:40:10, 50:10:40 and 50:30:20, respectively. Coconut milk (10 ml) was then added per 100 g of fruits to facilitate blending and as flavouring agent. Blending and homogenization took place within 10 minutes. Medium-high speed setting of the blender was chosen. Pasteurization of smoothie samples was carried out by heating in the water bath at 85°C for 5 minutes to inactivate pectic enzymes and destroy pathogenic/spoilage microorganisms, while the unpasteurized samples served as control. The pasteurized (A1, A2 and A3) and non-pasteurized samples were stored in a cold environment after production.

2.5. Analytical Methods

2.5.1. Determination of Proximate Composition of the Smoothie Samples

Proximate analysis for moisture, ash, crude fat, crude protein, crude fiber and carbohydrate (by difference) contents was carried out on the formulated smoothies using the methods of [12].

2.5.2. Determination of the Micronutrient Composition of the Smoothie Samples

Pro-vitamin A content was determined using the method described by Arroyave *et al*. [13], while vitamin C content of the samples was done using the method described by [14]. Potassium and calcium contents of the samples were determined using the method of [12].

2.5.3. Determination of pH, Titrable Acidity and Sugar Content of the Smoothie Samples

The pH and titrable acidity of the samples were determined using [12] method. Sugar content (°Brix) was determined using a hand refractometer at 20 °C according to the method of [12] and the value obtained from the reference to standard table expressed as percentage sucrose by weight (°Brix).

2.5.4. Microbial Analysis of the Smoothie Samples

Total viable count was done using the method described by [15] whereas total coliform count was determined on the samples using the method of [16].

2.5.5. Sensory Evaluation of the Smoothie Samples

Sensory evaluation was carried out on all the samples using the method described by [17]. The samples were coded and served chilled to 20 untrained panelists selected from final year students of Department of Food Science and Technology, UNN. The panelists were asked to indicate their preferences using a 9-point Hedonic scale for appearance, mouth-feel, taste, after-taste, aroma, mouth-feel and overall acceptability. 'Extremely like' and 'extremely dislike' represent 9 and 1, respectively. The order of presentation of the samples was randomized. Table water was presented to the panelists to rinse their mouths in-between sample testing.

2.5.6. Data Analysis

Data collected were subjected to split-plot analysis of variance in completely randomized design using Statistical Product for Service Solutions, Software Version 23.0.

Means were separated using least significant difference with significance accepted at $p<0.05$ [18].

3. Results and Discussion

3.1. Effect of Pasteurization on Proximate Composition of the Smoothie Samples

Table 1 shows the proximate composition of the smoothie samples. Moisture content of all samples ranged from 65.15-73.68% but that of sample $PWBC_1$ differed significantly ($p<0.05$) from other samples. However, no significant ($p>0.05$) difference existed between the moisture contents of $PWBC_2$ and $PWBC_3$. The $PWBC_1$ had the highest moisture content probably due to the quantity of watermelon. The $PWBC_2$ with highest amount of banana had also the least moisture content. This agreed with the findings of [19] where proximate analysis on some Nigerian fruits was evaluated and moisture content values for pineapple, banana and watermelon recorded as 85.07, 79.58 and 89.60%, respectively. Increase in watermelon content could give rise to increase in moisture content of the smoothie samples, while increase in banana content might lead to decrease in moisture content.

However, mild heat treatment on the smoothie samples had no effect on their moisture contents. Pasteurization is a mild heat (<100^{o}C) treatment usually given to foods such as milk, liquid egg, fruit juices, beer, among others, during processing [20]. Major aim of this treatment is to destroy pathogens, reduce bacteria count, inactivate enzymes and extend shelf-life of the food product. Most times it has no effect on proximate composition of the food product [3]. Crude protein content of the samples ranged from 0.45-1.08%. There were significant ($p<0.05$) differences in the crude protein content within the samples where $PWBC_2$ had the highest value. The differences in the protein contents among the samples could be due to biochemical characteristics of the different types of fruits used and this seemed to agree with results of previous studies o [19] that recorded protein contents for pineapple, banana and watermelon as 0.39, 1.25 and 1.05%, respectively. The sample ($PWBC_2$) with highest amount of banana contained relatively more protein than others.

However, similar results on protein composition were obtained from mixed fruit leather processed from pineapple, banana and apple pulps by [21]. Nevertheless, pasteurization had no effect on the protein contents of the treated samples (A1, A2 and A3) as indicated by [3] research findings for effect of pasteurization on proximate composition of food products.

Crude fat content of the smoothies ranged from 3.04-3.34%. However, no significant ($p>0.05$) differences existed between $PWBC_2$, $PWBC_3$, A2and A3 samples in the content, but $PWBC_1$ differed significantly ($p<0.05$) from all other samples. Similarly, $PWBC_2$ had the highest amount of banana and crude fat contents. The high crude fat content in the samples compared with other fruit-based products could be attributed to the use of coconut milk as the smoothie flavouring agent. Findings of [22] reports' indicated that coconut milk is rich in medium-chain fatty acids (MCFAs) which the body preferred to other fats made up of mainly long chain saturated fatty acids and had been known to promote weight maintenance without raising cholesterol levels.

Crude fiber content of the samples ranged from 6.82-10.14%. The $PWBC_2$ had highest crude fiber content within the control samples while pasteurization had no effect on the content of the treated samples. Hence, increase in banana and decrease in watermelon contents led to increase in the crude fiber contents of the samples. This could be due to high dietary fiber in banana compared to watermelon. The values were within the range of research findings of [21] that produced and evaluated mixed fruit leather from pineapple, banana and apple pulps. Ash contents among samples ranged from 1.50-2.80% and differed ($p<0.05$) significantly within the control. The treatment had no effect on treated samples (A1, A2 and A3) in their ash composition. However, higher ash contents were obtained in this study than what was recorded by the findings of [23] where smoothie was produced from banana pulp and orange juice [21]. The differences in ash content might be due to variation in biochemical characteristics of the fruits used. High values of ash content usually indicate high mineral composition in food samples [24]. Carbohydrate contents of the samples ranged from 14.21-18.79%. Slight significant ($p<0.05$) differences existed between the control and the treated samples due to extent of gelatinization that would have taken place. Sample $PWBC_1$ had the least carbohydrate content which differed significantly ($p < 0.05$) from other samples due to lowest percentage of banana as a high calorie fruit in the mixture. All variants with higher amount of banana had higher percentage of carbohydrate contents. Findings of [19] on proximate and mineral composition of some Nigerian fruits indicated similar results.

Table 1. Proximate composition of the smoothie samples

Parameters (%)	Non-pasteurized			Pasteurized		
	$PWBC_1$	$PWBC_2$	$PWBC_3$	A1	A2	A3
Moisture content	$73.68^a \pm 0.07$	$65.15^b \pm 0.05$	$68.30^b \pm 0.08$	$73.68^a \pm 0.07$	$65.15^b \pm 0.05$	$68.30^b \pm 0.08$
Crude protein	$0.45^c \pm 0.01$	$1.08^a \pm 0.01$	$0.52^b \pm 0.01$	$0.45^c \pm 0.01$	$1.08^a \pm 0.01$	$0.52^b \pm 0.01$
Crude fat	$3.04^b \pm 0.03$	$3.34^a \pm 0.02$	$3.31^a \pm 0.02$	$3.04^b \pm 0.03$	$3.34^a \pm 0.02$	$3.31^a \pm 0.02$
Crude fibre	$6.82^c \pm 0.02$	$10.14^a \pm 0.03$	$8.32^b \pm 0.02$	$6.82^c \pm 0.02$	$10.14^a \pm 0.03$	$8.32^b \pm 0.02$
Ash	$1.80^b \pm 0.30$	$1.50^b \pm 0.00$	$2.80^a \pm 0.30$	$1.80^b \pm 0.30$	$1.50^b \pm 0.00$	$2.80^a \pm 0.30$
Carbohydrate	$14.31^b \pm 0.03$	$18.79^a \pm 0.04$	$16.75^c \pm 0.03$	$13.20^b \pm 0.03$	$17.70^a \pm 0.04$	$15.55^d \pm 0.03$

*Values are the mean ± standard deviation of triplicate determinations. Values in the same row with different superscripts are significantly ($p<0.05$) different. **KEY:** $PWBC_1$= 50% pineapple + 40% watermelon + 10% banana + 10% coconut milk; $PWBC_2$= 50% pineapple + 10% watermelon + 40% banana + 10% coconut milk

$PWBC_3$= 50% pineapple + 30% watermelon + 20% banana + 10% coconut milk

A1-pasteurized $PWBC_1$; A2-pasteurized $PWBC_2$; A3-pasteurized $PWBC_3$

Table 2. Micronutrient composition of the smoothie samples

Micronutrient (mg $100ml^{-1}$)	Non-pasteurized			Pasteurized		
	$PWBC_1$	$PWBC_2$	$PWBC_3$	A1	A2	A3
Vitamin C	$895.29^a \pm 0.05$	$318.84^e \pm 0.09$	$741.31^c \pm 0.02$	$844.71^b \pm 0.05$	$220.49^f \pm 0.02$	$722.24^d \pm 0.03$
Pro-vitamin A	$391.54^a \pm 0.05$	$135.02^c \pm 0.02$	$111.83^d \pm 0.05$	$250.72^b \pm 0.05$	$69.39^e \pm 0.05$	$63.64^f \pm 0.03$
Potassium	$168.92^e \pm 0.05$	$237.34^b \pm 0.20$	$238.32^a \pm 0.05$	$98.73^f \pm 0.05$	$200.59^c \pm 0.02$	$173.63^d \pm 0.04$
Calcium	$18.77^d \pm 0.04$	$21.69^a \pm 0.02$	$20.05^b \pm 0.05$	$18.69^d \pm 0.02$	$17.59^e \pm 0.01$	$19.10^c \pm 0.10$

*Values are the means ± standard deviation of triplicate determinations. Values in the same row with different superscripts are significantly ($p<0.05$) different. $PWBC_1$= 50% pineapple + 40% watermelon + 10% banana + 10% coconut milk; $PWBC_2$= 50% pineapple + 10% watermelon + 40% banana + 10% coconut milk; $PWBC_3$= 50% pineapple + 30% watermelon + 20% banana + 10% coconut milk; **A1-pasteurized $PWBC_1$; A2-pasteurized $PWBC_2$; A3-pasteurized $PWBC_3$.**

3.2. Effect of Pasteurization on Micronutrient Composition of the Smoothie Samples

The micronutrient composition of the smoothie samples is presented in Table 2. Vitamin C contents of the non-pasteurized samples ranged from 318.84-895.29 mg $100ml^{-1}$. Pasteurization brought reductions in vitamin C among the treated blends (A1, A2 and A3) up to 5.65, 30.88 and 2.57%, respectively. Within the control and the treated samples, samples with higher amount of watermelon and pineapple combinations had higher vitamin C contents. Nevertheless, all the samples had exceptionally high vitamin C contents when compared with commercial fruit-based products that ranged from 33-50 mg/100ml [25]. This might be due to the use of blends of 100% fruit pulps naturally rich in vitamin C for the formulation. Reduction in vitamin C contents of the pasteurized samples could be due to heat destruction of the vitamin C during pasteurization [3] that dependent on the ratio of the fruit pulps combined. Similar reduction in vitamin C content was observed in the findings of [26] and [27] when comparing vitamin C levels of pasteurized and unpasteurized fruit juices.

Pro-vitamin A contents of the control ($PWBC_1$, $PWBC_2$ and $PWBC_3$) were also reduced as shown in Table 2 up to 36.12, 48.61 and 43.0%, respectively, after pasteurization. Pro-vitamin A carotenoids are usually carotenoid precursors from plants (Fruit and vegetable plant products majorly) and being unsaturated are easily exposed to trans-cis isomerization and oxidation that could result to loss of colour and pro-vitamin A activity [28]. The findings of [28] also indicated that the main cause of destruction of carotenoids during processing was enzymatic and non-enzymatic oxidation. Moreover, size reduction of fruits and vegetables during food preparation could enhance exposure to oxygen and subsequent coming together of carotenoids and enzymes. Hence, reduction in the amount of pro-vitamin A in all samples might not be from pasteurization only. The untreated sample PWBC1 had highest pro-vitamin A content which could be due to higher percentage of watermelon inclusion. Studies of [29] underscored watermelon as an excellent source of pro-vitamin A such as lycopene, beta-carotene; lutein and zeaxanthin (known for maintenance of vision by preventing macular degeneration in the retina). Potassium contents of the non-pasteurized samples ($PWBC_1$, $PWBC_2$ and $PWBC_3$) were similarly affected after pasteurization up to 41.60, 15.48 and 27.14%, respectively. The $PWBC_2$ with highest amount of banana in the blend was least affected after the heat treatment. This agreed with the research reports of [19] and [30], where fruits were classified based on proximate and micronutrient composition.

Calcium contents of the non-pasteurized samples ranged from 18.77-21.69 $mg100ml^{-1}$, while values for pasteurized samples (A1, A2 and A3) varied between 17.59 and 19.10 mg $100ml^{-1}$. Sample A1 had the least calcium content (0.43%) decrease, while A2 had the highest percentage reduction (18.90%). The amount of calcium recorded in the present study could be due to blending ratios of the fruit pulps used during formulation.

3.3. Effect of Pasteurization on the Sugar Content, pH and Titrable Acidity of the Smoothie Samples

The sugar content, pH and titrable acidity of the smoothie samples are presented in Figure 1. No significant ($p<0.05$) differences existed within the sugar content of the samples after pasteurization according to the ratio of blending of the fruits and agreed with the work done by [31] on shelf-life and sensory attributes of a fruit smoothie-type beverage processed with mild heat and pulse electric fields. Also, no significant ($p>0.05$) differences existed within the pH of the non-pasteurized and pasteurized samples.

Similar pH ranges were obtained in the work done by [32] for production of smoothie from fruits. There were no significant ($p>0.05$) differences in titrable acidity within the samples and between treatments. The titrable acidity of the non-pasteurized samples ranged from 0.16-0.18, while those of pasteurized samples ranged from 0.19-0.21. Titrable acidity values of the samples were generally lower than that obtained by [32] that developed smoothies from selected fruit pulps/ juices. This could be due to inclusion of watermelon which has low acidity. The titrable acidity values obtained in the work done by [23] were higher, probably due to the use of 30% yoghurt as the smoothie starter, together with varying ratios of banana pulp, orange juice, fruit pectin and sugar in the formulation.

3.4. Effect of Pasteurization on the Microbial Counts of the Smoothie Samples

Figure 2 shows the results from microbial counts (total viable and total coliform counts) of the formulated smoothies. The total viable count of the non-pasteurized smoothies ranged from 2.7 × 10^2 - 2.9 × 10^2 cfu ml^{-1}, while that of the pasteurized smoothies ranged from 1.1 × 10^1 - 2.1 × 10^1 cfu ml^{-1}. These were below the maximum acceptable level for any fruit juice as listed in the microbiological criteria for foodstuffs by [33] which is 1.0 × 10^4 cfu ml^{-1}. The total coliform count of the non-pasteurized smoothies ranged from 8 × 10^1-1.0 × 10^2 cfuml^{-1} which did not exceed the maximum acceptable level for any fruit juice as listed in the microbiological criteria for foodstuffs by [33] which is 1.0 × 10^2 cfu ml^{-1}. The low microbial load in the non-pasteurized smoothies could be attributed to good manufacturing practices applied during processing of the smoothies. The obvious reduction in the total viable and total coliform counts of the pasteurized smoothies compared to the non-pasteurized smoothies indicates the effectiveness of the pasteurization treatment.

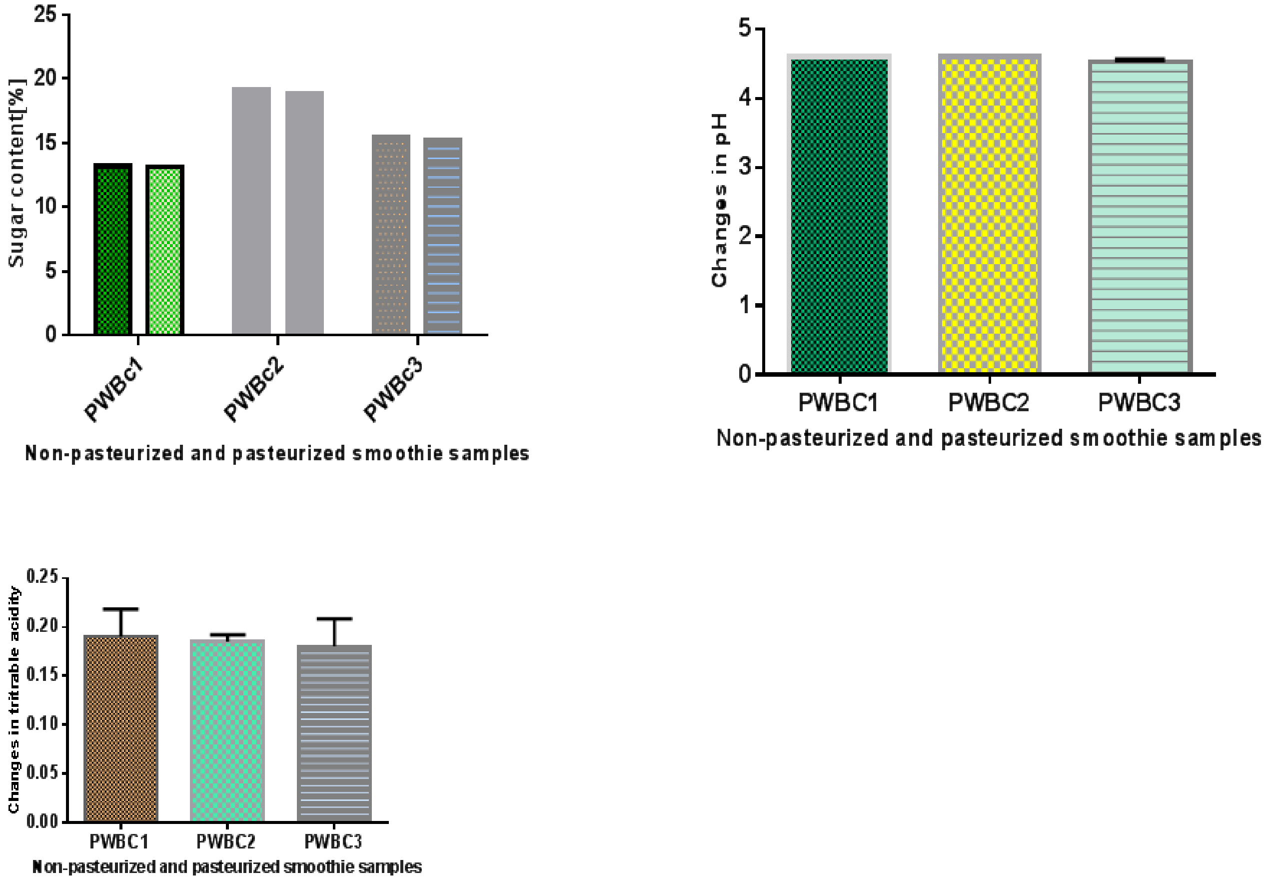

Figure 1. Effect of pasteurization on sugar content, pH and titrable acidity of smoothie samples ($PWBC_1$= 50% pineapple + 40% watermelon + 10% banana + 10% coconut milk; $PWBC_2$= 50% pineapple + 10% watermelon + 40% banana + 10% coconut milk; $PWBC_3$= 50% pineapple + 30% watermelon + 20% banana + 10% coconut milk)

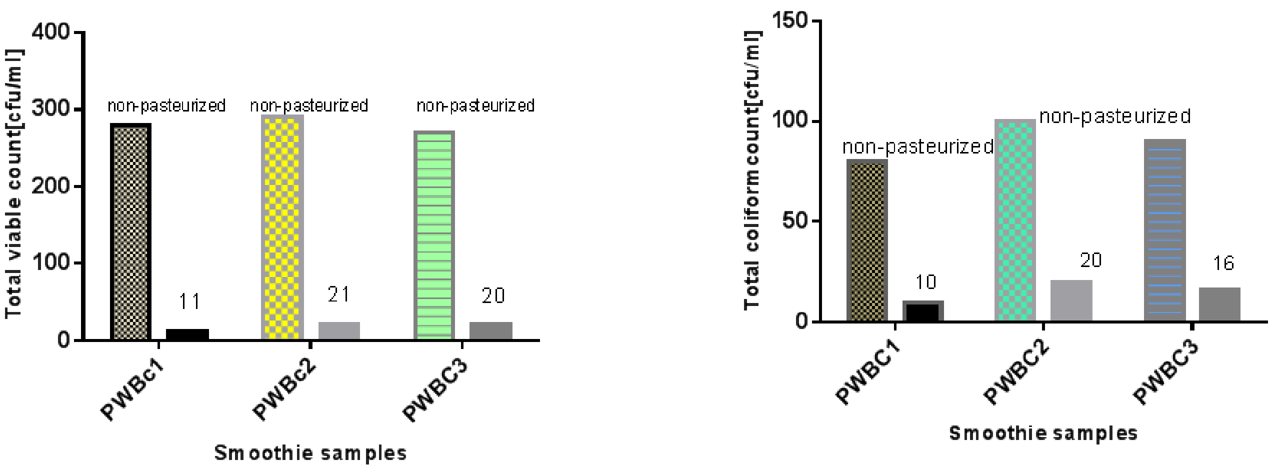

Figure 2. Total viable and coliform counts for non-pasteurized and pasteurized and smoothie samples ($PWBC_1$= 50% pineapple + 40% watermelon + 10% banana + 10% coconut milk; $PWBC_2$= 50% pineapple + 10% watermelon + 40% banana + 10% coconut milk; $PWBC_3$= 50% pineapple + 30% watermelon + 20% banana + 10% coconut milk)

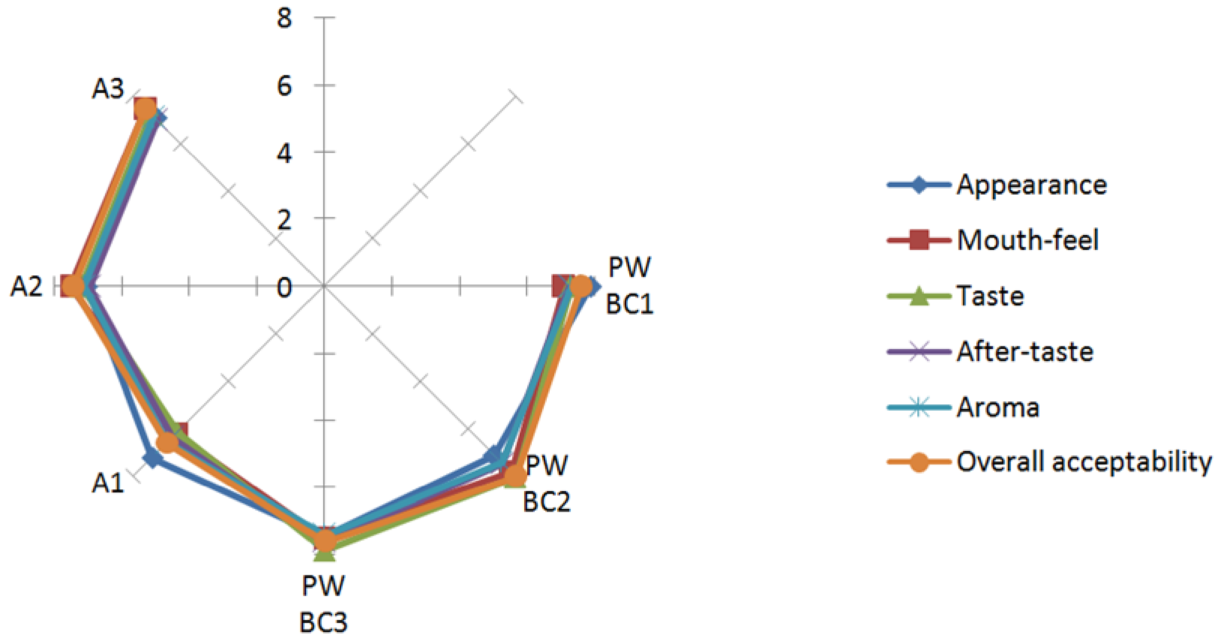

Figure 3. Radar plot for the sensory scores of the smoothie samples ($PWBC_1$= 50% pineapple + 40% watermelon + 10% banana + 10% coconut milk; $PWBC_2$= 50% pineapple + 10% watermelon + 40% banana + 10% coconut milk; $PWBC_3$= 50% pineapple + 30% watermelon + 20% banana + 10% coconut milk; **A1-pasteurized $PWBC_1$; A2-pasteurized $PWBC_2$; A3-pasteurized $PWBC_3$**)

3.5. Effect of Pasteurization on Sensory Scores of the Smoothie Samples

Figure 3 shows a radar plot of the sensory scores for the smoothie samples. The mean sensory scores for colour/appearance within the non-pasteurized samples ranged from 7.10-7.90, while that for the pasteurized (A1, A2 and A3) ranged from 7.05-7.20. No significant ($p>0.05$) differences existed in colour of all samples. However, pasteurization slightly affected appearance/colour attribute of the formulated smoothies due to possible enzymatic product modification [31]. Moreover, differences that existed within the mouth-feel of the samples were not significant ($p>0.05$). However, only sample A1 with highest amount of watermelon differed significantly ($p<.05$) in mouth-feel within the pasteurized samples. This could be due to easy degradation of pectin polysaccharides [34] on heating. The mean sensory scores for taste within the non-pasteurized samples ranged from 7.30-8.00 but differences that existed within the samples were not significant ($p>0.05$).

Mean sensory scores for taste within the pasteurized samples ranged from 6.15-7.25. The A1 had lowest score for taste among pasteurized samples. Values for A2 and A3 indicated that pasteurization had no significant ($p>0.05$) effect on their taste. Further, mean sensory scores for after-taste were higher for the non-pasteurized samples than pasteurized and indicated the benefit of the heat treatment on the beverages. Pasteurized A1 had the lowest score for after-taste among all samples probably due to the ratio of the fruit pulps. Mean sensory scores for aroma within the non-pasteurized samples varied between 7.30 and 7.40. The difference that existed within aroma of the samples was not significant ($p>0.05$). This might be due to higher banana composition because of isoamylacetate in banana [35] but heating might have affected the aroma of $PWBC_1$ whose banana content was lowest in the formulation.

4. Conclusion

Smoothies processed from pineapple with varying ratios of watermelon and banana pulp blends flavoured with coconut milk had an improved nutritional quality. Even though results of proximate composition parameters (moisture, ash, crude fibre, crude fat, crude protein and carbohydrate by difference) varied depending on blending ratios of the fruit pulps, pasteurization had insignificant ($p > 0.05$) effect on the values of the parameters for each blend. Vitamin C (30.88 %), Pro-vitamin A (48.61 %) and Ca (18.90 %) losses for sample A2 (Pasteurized PWBC2) were of highest amounts, among other samples, which might depend on the quantity of each fruit pulp in the blend. Sample A1 (pasteurized PWBC1) had highest percentage loss of K (potassium-41.60 %) among other pasteurized samples. However, the non-pasteurized sample had only 10 % of banana pulp in the blend. Besides, all samples had high scores in the tested sensory attributes without addition of any external sweetener, thereby making it ideal for end-users who guard against high intake of sugar. The pasteurized samples (A2 and A3) had higher scores (7.45 and 7.50, respectively) in overall acceptability for the sensory attributes.

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