



Organoleptic Properties and Microbial Quality of Smoothies Produced from Watermelon-Pineapple and Sweet Melon-Cucumber Blends

*Obasi, Blessing Chidi; Odoh, Persistence Ihotu

Department of Food Science and Technology, Faculty of Agriculture and Life Sciences, Federal University Wukari.P.M.B.1020, Taraba State, Nigeria.

ARTICLE INFO

Article No.: 092123097

Type: Research

Full Text: [PDF](#), [PHP](#), [HTML](#), [EPUB](#), [MP3](#)

Accepted: 22/09/2023

Published: 23/09/2023

*Corresponding Author

Obasi, Blessing Chidi

E-mail: blessed200067@yahoo.com

Phone: 2347035852279,
2348134533991

Keywords: blends, microbial quality, smoothies, sensory characteristics, vegetable sources.

ABSTRACT

Smoothies with improved sensory characteristics and microbial quality were developed by blending watermelon-pineapple and sweet melon – cucumber. The fruits were sorted, washed thoroughly with clean water, peeled, sliced and diced into small cubes and blended. Smoothies from blends of watermelon – pineapple (WMP) and sweet melon – cucumber (SMC) were formulated. The samples were blended in different ratios: watermelon- pineapple control (WMPC-100%), watermelon-pineapple (90:10WMP1), (80:20%WMP2), (70:30%-WMP3), (60:40% WMP4) and (50:50%-WMP5), and the same ratios were also used for sweet melon-cucumber blends respectively. The samples were analysed for organoleptic properties and microbial quality. Significant ($p>0.05$) differences did not exist in sensory evaluation between blends; but within samples. The result for organoleptic properties based on blend ratios for watermelon-pineapple and sweet melon – cucumber in relation to the parameters assessed, for aroma, colour, taste, flavor and general acceptability showed that samples WMP3(70:30), WMP2 (80:20%) and SMC2 (80:20%) were the most preferred. Microbial count result for watermelon-pineapple sample for total bacterial cells, total coliform and fungi count ranged from; 1.5×10^4 to 8.2×10^3 , 1.5×10^3 to 6.4×10^3 and 1.1×10^4 to 9.2×10^3 cfu/ml and for sweet melon-cucumber sample, the count ranged from 1.5×10^4 to 9.1×10^5 , 1.0×10^6 to 9.6×10^3 and 1.8×10^5 to 7.9×10^3 cfu/ml. The biochemical test revealed some microbial floral such as Bacillus, Salmonella spp, Klebsiella spp, E.coli, and Staphylococcus aureus. The overall sensory scores for smoothies containing i) watermelon-pineapple and ii) sweet melon- cucumber was very good (8.0 & 7.0) respectively. With good manufacturing practices safe smoothie beverages prepared and consumed regularly can assist in the enhancement and sustainability of household food and nutrition security.

1.0 INTRODUCTION

Fruits are excellent sources of phytochemicals which are essential for human health and relished by consumers in all seasons. The perishable nature of fruits and vegetables leads to higher pre- and post-harvest losses during distribution and processing. Fruits high in acidity content and astringency have a limited scope for table consumption though they are rich in functional ingredients. Combination of two or more fruits and vegetables will develop novel flavour and taste, which help in consumer acceptance. Presently, blended beverages are available in different flavours such as strawberry, chocolate, banana, vanilla, mango, raspberry, orange, etc.

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 (Zavasta, 2009). 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. A healthy diet should compose of an appreciable quantity of fruits and vegetables, and regular consumption of sufficient amounts to avert major chronic diseases (Maksuda, *et al.*, 2016). 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 (Walker, *et al.*, 2002). Water lemon (*Citrullus vulgaris*) is an excellent source of pro-vitamin A and other phytochemicals such as lycopene, beta-carotene, lutein and zeaxanthin (Charoensiri, *et al.*, 2009 and Edwards, *et al.*, 2003). Cucumbers contain 95 percent water." This makes cucumbers a great way to stay hydrated. Cucumber-based beverages are taking part in balancing electrolyte levels, in case of dehydration. Cucumbers contain several antioxidants, including vitamin C, beta carotene and as well as flavonoids, triterpenes and lignans that have anti-inflammatory properties. The anti-inflammatory compounds in cucumbers help remove waste from the body and also reduce skin irritation.

In recent studies, smoothies (a form of ready-to-drink beverage) have become one of consumers' preferred choices of drink, with suitable sensory properties in combination with nutritional benefits (Anon

2009 and Bordia, 2010). Researchers focused on developing different types of fruit-based smooth beverages/vegetable purees or smoothies made from a combination of fruits and/or vegetables to increase their contemporary value, nutritional content, and shelf life, without altering their sensory attributes (Keenan, *et al.*, 2010; Koutidou, *et al.*, 2017). Therefore, this study aimed at the development of new smoothie formulations using watermelon, pineapple, sweet melon and cucumber as well as to investigate sensory characteristic and microbial quality of the obtained products.

2.0 MATERIALS AND METHODS

2.1 Raw materials and sources

The raw materials used in this study were water melon, pineapple, sweet melon and cucumber. They were purchased from the railway fruit market Makurdi, Benue State, Nigeria, and conveyed to the Department of Food Science and Technology, Federal University Wukari, laboratory where all the analyses were carried out.

2.2 Experimental design

The experiments were carried out based on completely randomized design (Bower, 2013) to obtain seven samples as shown in table 2.1 and 2.2

2.3 Sample preparation

2.3.1 Production of water melon-pineapple smoothie

Water melon-pineapple smoothie was produced as described in Figure 2.1. The fresh fruits of watermelon and pineapple were sorted, thoroughly washed with tap water and peeled with sterile knife and diced. The diced fruits were weighed on an electronic weighing scale and combined using the blending ratio of table (2.1) and then frozen to get a thicker and cold smoothie then blended together using an electric blender. Blending and homogenization took place within 3-5 minute.

2.4 The blending formulation on watermelon-pineapple and sweet melon-cucumber smoothie

Table 2.1: blending formulation on watermelon-pineapple smoothie.

sample code/ratio	%watermelon	%pineapple
WMC	100	0
PSC	100	0
WMP1	90	10
WMP2	80	20
WMP3	70	30
WMP4	60	40
WMP5	50	50

KEY: WMC=watermelon control(100), PSC=pineapple control(100), WMP1=Watermelon-pineapple(90:10), WMP2=watermelon-pineapple(80:20), WMP3=watermelon-pineapple(70:30), WMP4=watermelon-pineapple(60:40), WMP5=watermelon-pineapple(50:50).

Table 2.2: blending formulation on sweet melon-cucumber smoothie.

sample code	%sweet melon	%cucumber
SMC	100	0
CUC	100	0
SMC1	90	10
SMC2	80	20
SMC3	70	30
SMC4	60	40
SMC5	50	50

KEY: SMC=sweet melon control (100), CUC=cucumber control (100), SMC1 = sweet melon-cucumber (90:10), SMC2 = sweet melon-cucumber (80:20), SMC3 = sweet melon-cucumber (70:30), SMC4 = sweet melon-cucumber (60:40), SMC5 = sweet melon-cucumber (50:50).

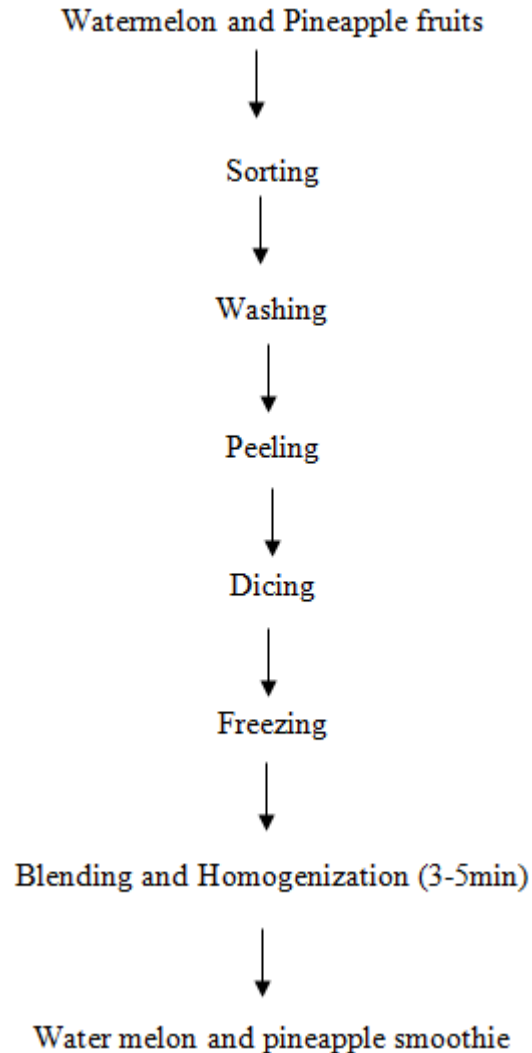


Fig 2.1: Flowchart for the production of water melon and pineapple smoothie
 Source: (Victor-Aduloju et al; 2020).

2.5. Production of sweet melon and cucumber smoothie

Sweet melon and cucumber smoothie was produced as described in Figure 2.2. The sweet melon and cucumber was sorted and thoroughly washed with running tap water and 0.5g sodium chloride (NaCl) to remove moldy and contaminating microorganisms.

Using a sterile knife, the sweet melon was cut and peeled neatly, the cucumber was sliced leaving the peels on to give the smoothie a brighter green color and more nutrients. The sliced sweet melon and cucumber was frozen to give a thicker texture without losing any flavor. The ingredients were blended using the ratio according to table 2.1, in an electric blender. Blending was done for 3-5min.

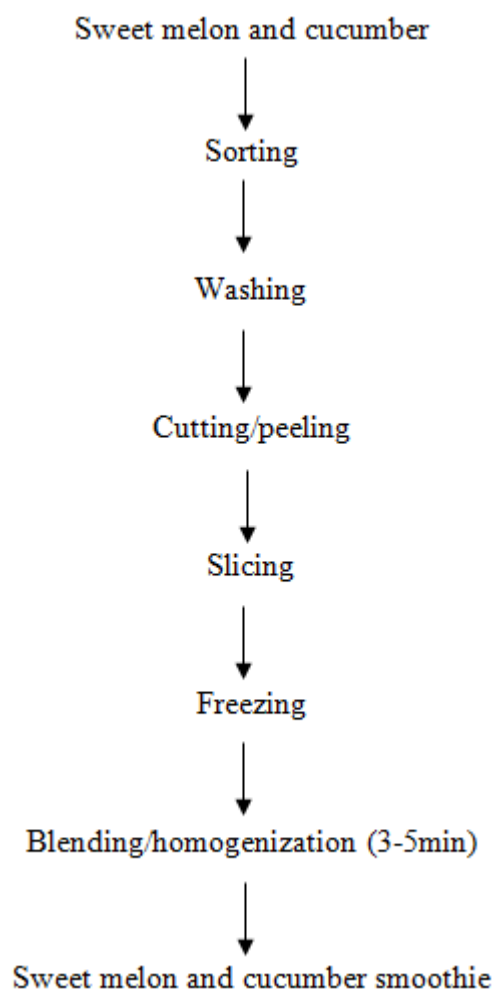


Fig 2.2: Flowchart for the production of sweet melon and cucumber smoothie

Source: (Victor-Aduloju et al; 2020).

2.6 Analytical methods

2.6.1 Determination of pH, Titratable Acidity, Sugar Content and Total soluble Solids (TSS) of the Smoothie Samples

The pH and titratable acidity of the samples were determined using (AOAC, 2010) method. Sugar content (°Brix) was determined using a hand refractometer at 20 °C according to the method of (AOAC, 2010) and the value obtained from the reference to standard table expressed as percentage sucrose by weight (°Brix).

Total soluble solid was expressed as % Total solids $\frac{1}{4}$ $(W_2 \times 100)/W_1 \frac{1}{4}$ (100 - % moisture) as described by (AOAC, 2010). Where, W_1 : Initial weight; W_2 : Dried weight.

2.7 Microbiological Analysis

2.7.1 Isolation and Enumeration

Total viable bacterial cells were determined using the method as described by (Obasi et.al; 2019). Serial dilution (10 fold) was carried out (1:10, 1: 100,

1:1000...10,0000). 0.1ml of appropriate dilutions (10^{-2} and 10^{-4}) was placed on various agar plates using pour plate method and incubated at 37°C for 18-24 hours for total aerobic bacteria and coliform count. For fungi 0.1ml amount of appropriate dilutions (10^{-2} and 10^{-4}) was poured into the plates of potato dextrose agar and incubated at room temperature at $28\pm 1^{\circ}\text{C}$ for 3 to 5 days. All enumeration were expressed as colony forming unit (cfu/ml).

2.7.2 Purification and Maintenance of Microbial Isolate

Bacteria isolates were transferred into fresh agar medium of isolation and incubated at 37°C for 24hours. Pure colonies of bacteria were maintained and stored at 4°C until needed.

2.7.3 Identification and Characterisation of the Isolates

Bacteria isolates were identified and characterized based on their morphology, structures, cell shape and appearance, and biochemical tests as described by (Cheebrough, 2006; Obasi et.al; 2019). Biochemical Tests determined included- Catalase, Oxidase, Indole, Triple Sugar Ion (TSI), Citrate Utilization Test etc.

2.8. Sensory Evaluation of the Smoothie Samples

Sensory evaluation was carried out on all the samples using the method as described by (Sukanya and Michael, 2014). The samples were coded and served to 15 - man semi-trained panelists consisting of students and staff from the Department of Food Science and Technology, Federal University Wukari, Taraba State. The panelists were asked to evaluate the samples for flavor, color, aroma, taste, and overall acceptability using a 9-point Hedonic scale, where "9" represented extremely liked and "1" represented extremely disliked. The order of presentation of the samples was randomized. Table water was presented to the panelists to rinse their mouth in-between sample testing.

2.9 Statistical Analysis

The data collected were subjected to analysis of variance in completely randomized design using the statistical package for Social Sciences Version 17.0. Means were separated using Duncan's multiple range test with significance accepted at $p < 0.05$ (Bower, 2013).

3.0 RESULTS AND DISCUSSION

3.1 Physicochemical Composition of Watermelon-Pineapple Smoothie and Sweet Melon-Cucumber Smoothie

3.1.1 Physicochemical Composition of Watermelon-Pineapple Smoothie

The physicochemical composition of the watermelon-pineapple smoothie blend presented in Table 3.1a showed results for pH ranging from 3.71 to 4.62, titratable acidity ranging from 2.70 to 10.50g/l, total soluble solid ranging from 0.72 to 2.96 and °Brix 5.00 to 14.50 respectively. The pH of the smoothie blend ranged from 4.04 to 4.62, with sample WMP1 (90:10) having the lowest and WMP5 (50:50) having the highest value. The result obtained from this study agrees with Alake *et al.* (2022) who had similar result. According to literature, pH range of ripe fruits is between 4.5 and 5.35, which is slightly acidic (Gbarakoro, 2021), based on their values, the results from this study fall within the range. The results obtained showed slight significant difference ($p < 0.05$) for all the samples. Total titratable acid is used to determine the acid content or serves as a measurement for determining the acid content of food such as fruits. The total titratable acidity (TTA) of the smoothie blend ranged from 2.70 to 8.10, with sample WMP5 (50:50) having the lowest value and WMP1 (90:10) having the highest value. The results obtained from this study were higher than the result obtained by (Uzodinma, *et al.*; 2020) who obtained very low result from a similar study which also involved the inclusion of water melon. The higher titratable acidity values obtained in this work compared favorably with the study done by (Chaudhary, and Shanta, 2015), who also reported higher value for TTA. The total soluble solids (TSS) for the smoothie blend ranged from 1.19 to 2.96 with sample WMP5 having the lowest values and WMP1 having the highest value. Total soluble solids (TSS) are important quality indicators that relate to sweetness, often referred to as sugar index (Balaswamy, 2011).

The results showed a significant difference ($p < 0.05$) among the samples. The °brix for the smoothie blend ranged from 4.73 to 8.50 with WMP1 (90:10) having lowest value and WMP5 (50:50) having the highest value. The brix content obtained in this study was similar to those obtained for fruit pulps/juices as reported by (Balaswamy, 2013), especially for the major samples used in this study pineapple. The brix indicate the degree of sweetness and the presence of the sugar present in the fruit (Balaswamy, 2011). The result showed significant difference ($p < 0.05$) for all the samples in this study.

Table 3.1a: Physicochemical Composition of Watermelon-Pineapple Smoothie

Sample code	pH	TTA	TSS	°BRIX
WMC	3.71 ^c ±0.01	10.50 ^a ±0.14	2.02 ^c ±0.01	5.00 ^d ±1.41
PSC	4.55 ^a ±0.36	4.05 ^e ±0.07	0.72 ^e ±0.12	14.50 ^a ±0.71
WMP1	4.04 ^{bc} ±0.19	8.10 ^b ±0.14	2.96 ^a ±0.04	4.73 ^d ±0.39
WMP2	4.16 ^{abc} ±0.23	4.80 ^c ±0.14	2.62 ^b ±0.02	5.75 ^{cd} ±0.35
WMP3	4.21 ^{ab} ±0.13	4.46 ^d ±0.20	1.30 ^d ±0.18	7.50 ^{bc} ±0.71
WMP4	4.29 ^{ab} ±0.01	4.10 ^e ±0.14	1.21 ^d ±0.01	7.50 ^{bc} ±0.71
WMP5	4.62 ^a ±0.02	2.70 ^f ±0.14	1.19 ^d ±0.01	8.50 ^b ±0.71

Values are mean ± standard deviation of the physicochemical composition. Means within each column not followed by the same superscript are significantly different ($p \leq 0.05$) from each other using Duncan multiple range test.

Key: WMC: watermelon control (100%), PSC: pineapple control (100%), WMP1: watermelon-pineapple (90:10%), WMP2: watermelon-pineapple (80:20%), WMP3: watermelon-pineapple (70:30%), WMP4: watermelon-pineapple (60:40%), WMP5: watermelon-pineapple (50:50%).

3.1.2 Physicochemical Composition of Sweet Melon-Cucumber Smoothie

The physicochemical composition of the sweet melon-cucumber smoothie blend presented in Table 3.2b showed results for pH ranging from 3.31 to 5.17, titratable acidity ranging from 0.81 to 10.58g/l, total soluble solid ranging from 1.47 to 3.74 and °Brix 2.25 to 5.23 respectively.

The pH value indicates the acidic or basic content of a particular substrate, the pH ranged from 3.31 to 4.19, with sample SMC5 (50:50) having the lowest pH value and SMC1 (90:10) having the highest pH value. The results obtained showed significant difference ($p < 0.05$) among the samples. Similar pH ranges from 6.75-0.15 were obtained in the work done by (Balaswamy, 2021) that developed smoothies from selected fruit pulps/ juices. By the addition of cucumber to the sweet melon, it reduced the acidic content of the smoothie as shown in Table 3.2b. The total titratable acidity (TTA) of the smoothie blend ranged from 7.47 to

10.58, with sample SMC1 (90:10) having the lowest value and sample SMC5 (50:50) having the highest value which is in agreement with the work of (Balaswamy, 2021) who obtained low acidity for fruit pulps/juices for sweet melon as observed also in this study. The results showed significant difference ($p < 0.05$) among the samples. TSS for SMC blends ranged from 1.79 to 2.84 where SMC5 (50:50) had the lowest value and SMC1 (90:10) had the highest value. The results showed a significant difference ($p < 0.05$). The °brix for the smoothie blends ranged from 3.50 to 5.23. Where sample SMC5 (50:50) had the lowest value and sample SMC1 (90:10) had the highest value. The brix indicates the degree of sweetness and the presence of the sugar in the fruit. Sweet melon generally has more (content) natural sugar when compared to cucumber and the result obtained in this study for sample SMC1 (5.23) compared favourably with the report of (Balaswamy, 2021) who obtained a value of 5.93 for fruit pulps/juices from sweet melon sample.

Table 3.2b: Physicochemical Composition of Sweet Melon-Cucumber Smoothie

Sample	pH	TTA	TSS	BRIX
SMC	5.17 ^a ±0.01	0.81 ^f ±0.01	3.74 ^a ±0.01	4.25 ^a ±1.06
CUC	3.59 ^{bc} ±0.02	6.79 ^e ±0.01	1.47 ^g ±0.01	2.25 ^a ±1.06
SMC1	4.19 ^b ±0.69	7.47 ^d ±0.02	2.84 ^b ±0.01	5.23 ^a ±1.09
SMC2	3.47 ^c ±0.04	8.81 ^c ±0.01	2.74 ^c ±0.01	5.00 ^a ±1.41
SMC3	3.41 ^c ±0.01	9.38 ^b ±0.04	2.68 ^d ±0.04	5.00 ^a ±1.41
SMC4	3.41 ^c ±0.01	9.41 ^b ±0.01	2.15 ^e ±0.01	4.00 ^a ±1.41
SMC5	3.31 ^c ±0.02	10.58 ^a ±0.04	1.79 ^f ±0.02	3.50 ^a ±0.70

Values are mean ± standard deviation of the physicochemical composition. Means within each column not followed by the same superscript are significantly different ($p \leq 0.05$) from each other using Duncan multiple range test.

Key: SMC (100): sweet melon control, CUC (100): cucumber control, SMC1: sweet melon-cucumber (90:10), SMC2: sweet melon-cucumber (80:20), SMC3: sweet melon-cucumber (70:30) SMC4: sweet melon-cucumber (60:40), SMC5: sweet melon-cucumber (50:50).

3.2 Sensory Evaluation

3.2.1 Sensory evaluation for watermelon-pineapple smoothie

A sensory evaluation aims at measuring consumer's sensory perception of products as well as the effective, emotional responses that arise from this perception (Delarue, 2022). The result presented in Table 3.3a shows the sensory evaluation of watermelon-pineapple smoothie.

Taste ranged from 6.47-7.60. The highest value was WMP3 (7.60) followed by WMP5 (7.27) and the least value recorded was WMP4 (6.47). The high rating of taste for WMP3 could be as a result of the substitution of pineapple. The result obtained from this study is similar to the findings of Teleszko and Wojdylo, (2014) and Nowicka *et al.*, (2016) where sweeter products were more accepted when compared to other less sweet samples (varied ratio) and this is because pineapple have more sugar in the base of the fruit.

The values for aroma ranged from 6.67 to 7.33. Based on the samples analyzed, the lowest value was WMP1 (6.67) and the highest values were obtained from samples WMP2, WMP3 and WMP5 (7.33)

respectively having the highest rated aroma value which may be because pineapple 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 (Walker *et al.* 2002, in Uzodinma *et al.*, 2020). The results were not significantly different ($p < 0.05$).

The ratings for color by the panelists ranged from 7.07 to 7.40. The highest rating for colour was sample WMP1 (7.40) for the varied samples while WMP4 (7.07) had the least value. The control sample PSC (7.93) was the most appealing by the panelist because generally, pineapple has an acceptable colour used in liquid beverage such as juice as a result of the presence of (lycopene) alpha-carotenoid Uzodinma, (2020). The results were not significantly different ($p < 0.05$).

The general acceptability of watermelon-pineapple smoothie showed that sample WMP2 (7.73) was most preferred by consumer followed by WMP5 (7.33), WMP1 (7.07), WMP3 (7.07) and the least was WMP4 (6.60) respectively. There was a significant difference ($p < 0.05$) between the samples.

TABLE 3.3a: Mean Sensory Score of Watermelon-Pineapple Smoothie

Sample Code	Taste	Aroma	Colour	Flavor	General Acceptability
WMC	6.87 ^a ±1.51	6.93 ^a ±1.53	7.80 ^a ±1.21	7.00 ^a ±1.36	7.47 ^{ab} ±1.25
PSC	7.27 ^a ±1.95	7.60 ^a ±1.12	7.93 ^a ±1.28	7.07 ^a ±1.27	7.89 ^a ±1.19
WMP1	7.00 ^a ±1.51	6.67 ^a ±1.35	7.40 ^a ±1.50	6.73 ^a ±1.49	7.07 ^{ab} ±1.49
WMP2	7.00 ^a ±1.07	7.33 ^a ±1.05	7.33 ^a ±1.23	7.27 ^a ±0.90	7.73 ^a ±0.96
WMP3	7.60 ^a ±1.12	7.33 ^a ±1.04	7.33 ^a ±1.40	6.93 ^a ±1.49	7.07 ^{ab} ±1.44
WMP4	6.47 ^a ±0.99	6.73 ^a ±1.22	7.07 ^a ±1.22	6.93 ^a ±1.44	6.60 ^b ±0.91
WMP5	7.27 ^a ±1.16	7.33 ^a ±1.23	7.33 ^a ±0.90	7.13 ^a ±1.30	7.33 ^{ab} ±0.81

Values are mean ± standard deviation of 15 panelists. Means within each column not followed by the same superscript are significantly different ($p < 0.05$) from each other using Duncan multiple range test.

Key: WMC: watermelon control (100%), PSC: pineapple control (100%), WMP1: watermelon-pineapple (90:10%), WMP2: watermelon-pineapple (80:20%), WMP3: watermelon-pineapple (70:30%), WMP4: watermelon-pineapple (60:40%), WMP5: watermelon-pineapple (50:50%).

3.2.2 Sensory evaluation for sweet melon-cucumber smoothie

The result of the sensory rating for the smoothie blend of sweet melon-cucumber is shown in the Table 4.4b. Taste ranged from 5.67 to 7.33. The highest rating by the panelist was recorded for sample SMC2 (7.33) and the least value was for sample SMC4 (5.67). The result obtained from this study in terms of taste is in agreement with the work done by Balaswamy, *et al.*, (2013) who had a similar result (7.8). The result showed significant difference ($p < 0.05$).

Sweet melon is largely sought for due to its sweet refreshing fruit Harini and Nithyalakshmi. (2017). Also, Allwood *et al.*, (2014) reported that the flavor and

aroma of the fruit is dictated by the amount of volatile organic compounds present in it. Aroma ranged from 5.93 to 6.73. SMC5 had the highest value and sample SMC4 had the lowest. The result showed a significant difference ($p < 0.05$). Colour ranged from 5.86 to 6.93. Sample SMC4 had the lowest value and sample SMC1 had the highest compared to other samples. The result is not significantly different ($p < 0.05$). Flavour ranged from 5.80 to 6.80. Sample SMC5 had the lowest and SMC2 had highest value. The flavour of food ultimately determines its acceptance or rejection even though its appearance may evoke initial response Ojinnaka and Nnorom, (2015). The results were not significantly different ($p < 0.05$).

The general acceptability of the control (SMC) is expected and might be due to higher sweetness as indicated by the °brix value. Based on the various blends sample SMC2 (7.00) was the most preferred in

relation to all the parameters assessed. The result was not significantly different ($p < 0.05$).

TABLE 3.3b: Mean Sensory Score of Sweet melon-Cucumber Smoothie

Sample Code	Taste	Aroma	Colour	Flavor	General Acceptability
SMC	7.07 ^a ±2.60	7.60 ^a ±1.12	7.07 ^a ±2.02	6.87 ^a ±2.03	7.33 ^a ±1.91
CUC	6.27 ^{ab} ±1.94	6.73 ^{ab} ±1.62	6.20 ^a ±1.57	5.80 ^a ±1.70	6.33 ^a ±1.88
SMC1	7.07 ^a ±1.44	6.60 ^{ab} ±1.35	6.93 ^a ±0.96	6.67 ^a ±1.59	6.93 ^a ±1.49
SMC2	7.33 ^a ±1.05	6.60 ^{ab} ±1.50	6.80 ^a ±1.01	6.80 ^a ±1.78	7.00 ^a ±1.25
SMC3	6.13 ^{ab} ±1.13	6.53 ^{ab} ±1.13	6.33 ^a ±1.63	6.07 ^a ±1.49	6.53 ^a ±1.13
SMC4	5.67 ^b ±1.29	5.93 ^b ±1.39	5.86 ^a ±1.64	6.00 ^a ±1.36	6.20 ^a ±1.26
SMC5	6.33 ^{ab} ±1.84	6.73 ^{ab} ±1.33	6.13 ^a ±1.88	5.80 ^a ±1.52	6.33 ^a ±1.80

Values are mean ± standard deviation of 15 panelists. Means within each column not followed by the same superscript are significantly different ($P < 0.05$) from each other using Duncan multiple range test.

Key: SMC: sweet melon control (100%), CUC: cucumber control (100%), SMC1: sweet melon-cucumber (90:10%), SMC2: sweet melon-cucumber (80:20%), SMC3: sweet melon-cucumber (70:30%), SMC4: sweet melon-cucumber (60:40%), SMC5: sweet melon-cucumber (50:50%)

3.3 Microbial Load

3.3.1 Total aerobic plate count (TAPC) of bacterial cells (cfu/ml) for watermelon-pineapple smoothie

The result presented in table 3.4a showed the total aerobic plate count (TAPC) of the bacterial cells, coliform and fungi counts for the watermelon-pineapple smoothie. The total bacteria cells, coliform and fungi count (cfu/ml) for samples analyzed at different ratios included watermelon control (WMC:100%), pineapple smoothie control (PSC:100%), watermelon pineapple (WMP:90:10, 80:20, 70:30, 60:40 and 50:50%) ranged from 1.5×10^4 - 8.2×10^3 , 1.5×10^3 - 6.4×10^3 , 1.1×10^4 - 9.2×10^3 cfu/ml respectively.

The total bacteria count for all the samples were within the maximum acceptable level for any fruit juice as listed in the microbiological criteria for foodstuffs by Gulf Standards (2000) which is 1.0×10^4 cfu/ml. Generally smoothie production which do

undergo pasteurization have been reported to have a total bacterial count above 10^2 margin by Uzodinma *et al.*, (2020). However, the results obtained from this study did not surpass the Commission Regulation (EC) No. 2073/2005 on microbiological criteria for foodstuffs for unpasteurized fruits and vegetable juices (ready-to-eat).

The coliform count ranged from 1.5×10^3 to 6.4×10^3 cfu/ml with sample WMP5 (50:50) having a higher count which could be as a result of non-pasteurization. The high coliform count did not exceed 1000 cfu/ml of the sample since it is within the maximum acceptable level for any fruit smoothie (Gulf Standards 2000; Anon, 2005).

The fungi count ranged from 1.1×10^4 to 9.2×10^3 cfu/ml with sample WMP3 (70:30) having highest count of which agrees with the food safety and standard authority for microbial limit for fruit juice and fruit nectar FSSAI, (2011).

Table 3.4a: Total aerobic plate count (TAPC) of bacterial cells (cfu/ml) obtained from watermelon-pineapple Smoothie

Sample code	Ratio	Total bacteria count (cfu/ml)	Coliform count	Fungi count
WMC	100	1.7×10^4	1.6×10^4	3.6×10^3
PSC	100	5.3×10^3	1.6×10^4	6.4×10^5
WMP1	90:10	2.1×10^4	1.7×10^4	3.0×10^3
WMP2	80:20	1.5×10^4	1.5×10^3	1.3×10^4
WMP3	70:30	8.2×10^3	5.3×10^3	9.2×10^3
WMP4	60:40	6.3×10^3	6.0×10^3	1.1×10^4
WMP5	50:50	8.1×10^3	6.4×10^3	1.4×10^4

Key: WMC: (100%) watermelon control, PSC: pineapple control (100%), WMP1: watermelon-pineapple (90:10%), WMP2: watermelon-pineapple (80:20%), WMP3: watermelon-pineapple (70:30%), WMP4: watermelon-pineapple (60:40%), WMP5: watermelon-pineapple (50:50%).

3.3.2 Total aerobic plate Count (TAPC) of bacterial cells (cfu/ml) for sweet melon-cucumber smoothie

The result presented in table 3.4b showed the total aerobic plate count (TAPC) of the bacterial cells, coliform and fungi counts for the sweet melon-cucumber smoothie. The total bacteria cells, coliform and fungi count (cfu/ml) for samples analyzed at different ratios include sweet melon control (SMC:100%), cucumber-smoothie control (CUC:100%), sweetmelon-cucumber (SMC:90:10, 80:20, 70:30, 60:40 and 50:50%) ranged from 1.2×10^4 to 8.0×10^3 for total bacterial count, 1.3×10^4 to 7.0×10^5 coliform count and fungi count 1.8×10^5 to 7.9×10^3 respectively.

The total bacterial count did not surpass the Commission Regulation (EC) No. 2073/2005. The counts were below the maximum acceptable level for

any fruit juice/smoothie as listed in the microbiological criteria for foodstuffs by Gulf Standards (2000) which is 1.0×10^4 cfu/ml. for all the samples assessed.

The coliform count ranged from 1.3×10^4 to 9.6×10^3 cfu/ml. Sample SMC5 (50:50), SMC4 and SMC1 were within the acceptable limit for coliform count in any microbiological criteria for

juices and smoothies. Sample SMC3 was above the acceptable limit for coliform count, but SMC2 had no growth.

The fungi count ranged from 1.8×10^5 to 7.9×10^3 cfu/ml. The total fungi count of the non-pasteurized smoothies did not exceed the maximum acceptable level for any fruit juice as listed in the microbiological criteria for foodstuffs by (Gulf Standards 2000 and Uzodinma *et al.*, (2020).

Table 3.4b Total aerobic plate count (TAPC) of Bacterial Cells (Cfu/ml) obtained from sweet melon-cucumber smoothie

Sample code	Ratio	Total bacteria count(cfu/ml)	Coliform count (MCA)	Fungi count (PDA)
SMC	100	9.1×10^5	7.0×10^5	5.6×10^3
CUC	100	2.1×10^4	1.6×10^4	7.3×10^3
SMC1	90:10	1.5×10^4	1.4×10^4	1.8×10^5
SMC2	80:20	1.7×10^4	NG	5.3×10^3
SMC3	70:30	1.8×10^6	1.0×10^6	7.7×10^3
SMC4	60:40	2.1×10^4	1.3×10^4	3.2×10^3
SMC5	50:50	1.9×10^4	9.6×10^3	7.9×10^3

Key: SMC (100): sweet melon control, CUC (100): cucumber control, SMC1: sweet melon-cucumber (90:10), SMC2: sweet melon-cucumber (80:20), SMC3: sweet melon-cucumber (70:30), SMC4: sweet melon-cucumber (60:40), SMC5: sweet melon-cucumber (50:50).

3.3.3 Morphological and Biochemical Characteristics of Bacterial Strains Isolated from Watermelon-Pineapple and Sweet Melon-Cucumber Smoothie Blends

The microbial flora for watermelon-pineapple and sweet melon-cucumber smoothies as shown in Figure 3.1 and 3.2. Watermelon-pineapple isolate revealed the following species *Salmonella spp* 12.96%, *Klebsiella pneumonia* 12.96%, *Staphylococcus aureus* 12.96%, *E.coli* 11.11%, *Enterobacteriaceae* 11.11%, *Proteus vulgaris* 9.255, *Pseudomonas spp* 7.40%, *Klebsiella spp* 7.40%, *Micrococcus* 5.56% and *Bacillus* 3.70%, while sweet melon-cucumber showed the species of the microbial flora which includes *Salmonella spp* 12.19%, *Klebsiella pneumonia* 14.63%, *Staphylococcus aureus* 17.07%, *E.coli* 17.07%, *Enterobacteriaceae* 17.07%,

Proteus vulgaris 7.31%, *Klebsiella spp* 7.31%, *Bacillus* 4.87% and *Shigella* 2.43% respectively.

The presence of pathogenic *Escherichia coli*, and *Staphylococcus aureus* usually constitute a direct proof of faecal contamination of irrigation water (Cheesbrough, 2006). The identified non-lactic acid bacteria (*E. coli*, *Bacillus species* and *Proteus species*) reported in this study has also been reported by other authors (Onovo *et al.*, 2007). The *Enterobacteriaceae* family mostly involves harmless bacteria, some of them contribute to food spoilage or exist as foodborne pathogens (Edelstein, 2014). The bacterial contamination of plant origin in food as revealed in this study may occur through fertilizers with animal manure, soil, and irrigation water, as well as washing, handling, and processing vegetables or fruit during the postharvest period (Berger *et al.*, 2010) (Seo and Matthews 2014).

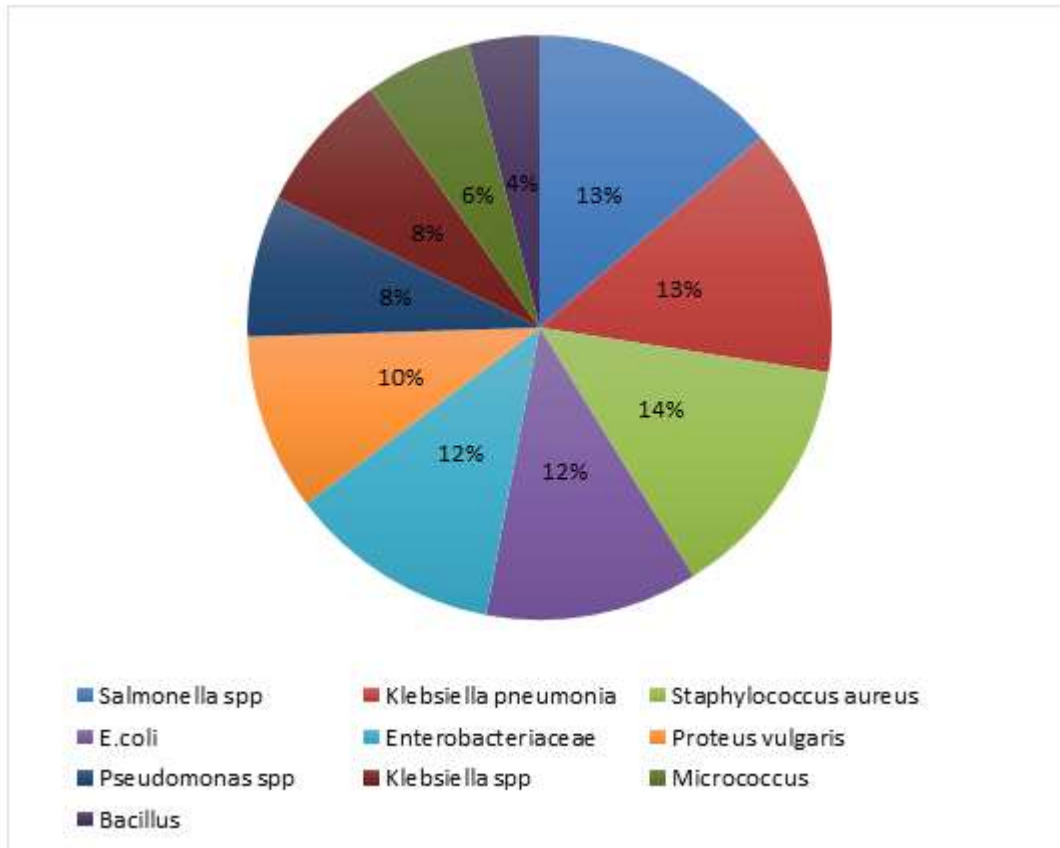


Fig 3.1: Prevalence of microorganisms isolated from watermelon-pineapple smoothie blends

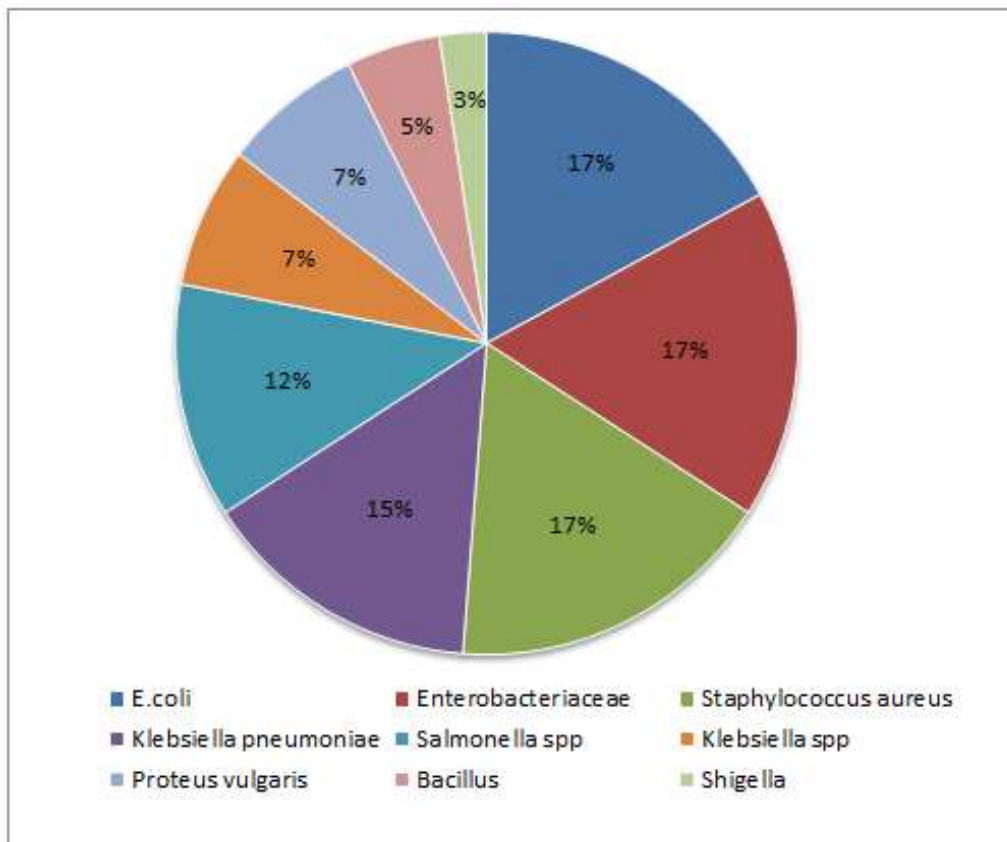


Fig 3.2: Prevalence of microorganisms isolated from sweet melon-cucumber smoothie blends

4.0 CONCLUSION AND RECOMMENDATION

Smoothies could be prepared and preserved by blending various tropical fruits and vegetables without any addition of external sweetener. Smoothies based on fruits and vegetables viz., blends of watermelon-pineapple and sweet melon-cucumber in this study were organoleptically acceptable. Smoothies containing: watermelon-pineapple (WMP) and sweet melon-cucumber (SMC), WMP1: (90:10%), WMP2: (80:20%), WMP3 and (70:30%) and SMC1: (90:10), SMC2: (80:20), SMC3: (70:30) respectively were found to be best combinations in terms of sensory score (>7.0). A variety of smoothies can be prepared depending on availability of seasonal fruits/vegetables leading to new product development. The microbial counts since it was not above the allowable limit by Commission Regulation (EC) No. 2073, may not pose any threat to the health and safety of consumers.

Disclosure of conflict of interest

No conflict of interest to disclose.

REFERENCES

- Alake, O.T., Abraham, D.O., Akinola, T.O., Fatunmibi, O.O., Agboola, T.O., & Akua, S.I. (2022). Production and evaluation of smoothies made from various fruits sold in Lagos market. *International Journal of Innovative Science and Research Technology*, 7(1), 642-646.
- Allwood JW, Cheung W, Xu Y, Mumm R, De Vos RC, Deborde C, Biais B, Maucourt M, Berger Y, Schaffer AA, Rolin D, Moing A, Hall RD, Goodacre R. Metabolomics in melon: A new opportunity for arome analysis. *Phytochemistry*. 2014; 99: 61-72.
- Anon, (2005). Commission regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs. 2.5. Vegetables, fruits and products thereof. *OJEU*. L 338/23. Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005R2073&from=EN> (accessed on 10 October 2020).
- Anon, (2009). Smoothies consumer knowledge, attitudes and beliefs around the nutritional content of smoothies. http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Publications/Research%20Reports/9354-Smoothies-AW_web-FINAL-030309.pdf. (accessed 29.01.17.).
- AOAC (2010). *Official Methods of Analysis*. Association of Official Analytical Chemists (18th eds.), Washington D. C., United States of America.
- AOAC Association of Official Analytical Chemist (2005). *Official Methods of Analysis of AOAC International*. 18th ed. (AOAC-925.10), (AOAC-2003.05), (AOAC-923.03), (AOAC-960.52) (Nx6.25). AOAC International, Maryland, USA. 111-333
- Balaswamy, K., Prabhakara Rao, P. G., Nagender, A. and Satyanarayana, A. 2011. Preparation of sour grape (*Vitis vinifera*) beverages and evaluation of their storage stability. *Journal of Food Processing and Technology* 2:3 <http://dx.doi.org/10.4172/2157-7110.1000116>.
- Balaswamy, K., Prabhakara, R. P. G., Nagender, A., Narsing, R. G., Sathiya, M. K., Jyothirmayi, T., Math, R. G. and Satyanarayana, A. (2013). Development of smoothies from selected fruit pulps/juices. *International Food Research Journal*, 20 (3): 1181-1185
- Bordbia (2010). Consumer attitudes towards and usage of fruit, vegetables and potatoes. <http://www.bordbia.IndustrymanufacturersinsightpublicationsreportsDocumentsConsumerAttitudesTowardsandUsageofFruitVegetablesandPotatoesMay.pdf>.
- Bower, J. A. (2013). *Statistical Methods for Food Science: Introductory Procedures for the Food Practitioner*, 2nd edition. Wiley Blackwell, United Kingdom. pp. 165-170.
- Charoensiri, R., Kongkachiuchai, R., Suknicom, S. and Sungpuang, P. (2009). Beta-carotene, lycopene alpha-tocopherol contents of selected Thai fruits. *Food Chemistry*, 113:202-207.
- Chaudhary, P. S. and Shanta, P. (2015). Development of smoothies from banana pulp and orange juice. *International Journal of Applied Research*, 1 (9): 261-263.
- Cheesbrough M. (2006). *District Laboratory Practice in Tropical Countries*, Part 2. London: Cambridge University Press, UK; 22-31
- Delarue, J. (2022). Overview of sensory methods for the evaluation of nonfood products. *Nonfood sensory practice*. <https://doi.org/10.1016/B978-0-12-821939-3.00020-8>
- Edelstein, M.; Sundborger, C.; Hergens, M.P.; Ivarsson, S.; Dryselius, R.; Insulander, M.; Jernberg, C.; Hutin, Y.; Wallensten, A. (2014) Barriers to Trace-back in a Salad-associated EHEC Outbreak, Sweden, June 2013. *PLoS Current*. 6, 1-18.
- Edwards, A. J., Vinyard, B. T. and Wiley, E. R. (2003). Consumption of watermelon juice increases plasma concentrations of lycopene and beta-carotene in humans. *Journal of Nutrition*, 133 (4): 1043-1050.
- Food Safety and Standards (Licensing and Registration of Food businesses) Regulation, 2011. *Food Science Technology*, 49, 98-106. <https://doi.org/10.1111/ijfs.12280>

- Gbarakoro, S.L., Adooh, L.S.K., & Akinfolarin, O.M. (2021). Effects of natural and artificial fruits ripening agent on the pH of selected fruits in Port Harcourt Nigeria. *Asia Journal of Science and Technology*, 12(2), 11535-11539.
- Gulf Standards (2000). Microbiological criteria for foodstuffs, Part 1. GCC, Riyadh, Saudi Arabia. pp. 27-30.
- Harini K, Nithyalakshmi V. Phytochemical Analysis and Antioxidant Potential of *Cucumis melo* Seeds. *International Journal of Life-Sciences Scientific Research*. 2017; 3(1): 863-867.
- Keenan, D.F., Brunton, N.P., Gormley, T.R., Butler, F., Tiwari, B.K., Patras, A., (2010). Effect of thermal and high hydrostatic pressure processing on antioxidant activity and colour of fruit smoothies. *Innovation of Food Science and Emergency Technology*. 11 (4), 551556.
- Koutidou, M., Grauwet, T., Loey, A.V., Acharya, P., (2017). Potential of different mechanical and thermal treatments to control off-flavour generation in broccoli puree. *Food Chemistry*. 217, 531541.
- Maksuda, M., Abu Torab, M.A., Rahim, M., Nazmu, H. and Shahjalal, H. K. (2016): Proximate and Water Soluble Vitamin Contents in Some Selected Bangladeshi Fruits and Vegetables, *Journal of Scientific Research & Reports*,11(6): 1-8.
- Nowicka, P., Wojdy, A., & Samoticha, J. (2016). LWT - Food Science and Technology Sensory attributes and changes of physicochemical properties during storage of smoothies prepared from selected fruit, 71. <http://doi.org/10.1016/j.lwt.2016.03.021>
- Obasi, B.C, Sunday, B. A & T.C Brown (2019). Enumeration of microbial Quality of Yoghurt Incorporated with moringa Oleifera seed flour during storage. *FUW. Trends in Science and Technology Journal volume*. 4(3):703-706.
- Onovo, J.C and Ogaraku, A.O. (2007). Studies on Some Microorganisms Associated with Exposed Tigernut (*Cyperus esculentus* L.) Milk. *Journal of Biological Sciences*, 7: 1548-1550.
- Seo, S.; Matthews, K.R. (2014) Exposure of *Escherichia coli* O157: H7 to soil, manure, or water influences its survival on plants and initiation of plant defense response. *Food Microbiology*. 38, 87–92.
- Sukanya, W. and Micheal O'M (2014). The 9-point hedonic scale and hedonic ranking in Food Science: some reappraisals and alternatives. *Journal of the Science of Food and Agriculture*.95(11) DOI:10.1002/jsfa.6993
- Teleszko, T., Wojdyło, A., (2014). Bioactive compounds vs. organoleptic assessment of 'smoothies'-type products prepared from selected fruit species. *International Journal of Food Science. Technology*. 49, 98e106.
- Uzodinma, E.O., Mbaeyi-Nwaoha, I.E, Onwurafor, E.U., and Chidinma Ezinne Ochulor,(2020) Influence of Pasteurization on the Quality of Pineapple, Watermelon and Banana Pulps-based Smoothie Flavored with Coconut Milk." *American Journal of Food Science and Technology*, volume. 8, no. 3: 99-105.
- Victor-Aduloju, A.T., Nwanja, N.M., Ezegbe, CC., Okocha, K.S., & Aduloju, T.A. (2020). Phytochemicals and vitamin properties of smoothie flavored with mint leaves extract. *International Journal of Biochemical Research and Review*. 29(7), 24-30. <https://www.researchgate.net/publication/344306486>.
- Walker, A. F., Bundy, R. and Hicks, S. M. (2002). Bromelain reduces mild acute knee pain and improves well-being in a dose-dependent fashion in an open study of otherwise healthy. *Phytomedicine*. 9(8): 681-687.
- Zavasta, T. (2009). Smoothie moves: Enjoy the benefit of green smoothies and puddings. *Raw Food and Hot Yoga*, pp. 39. In: <https://www.en.wikipedia.org/wiki/smoothie>; ISBN 0-9742434-9-3. Accessed on 07-02-2019.

Cite this Article:

Obasi, BC; Odoh, PI (2023). Organoleptic Properties and Microbial Quality of Smoothies Produced from Watermelon-Pineapple and Sweet Melon–Cucumber Blends. *Greener Journal of Agricultural Sciences*, 13(3): 186-197.