INNOVARE JOURNAL OF FOOD SCIENCE

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

ISSN;2321;550X

Vol 8, Issue 2, 2020

Research Article

PHYSICO-CHEMICAL, PROXIMATE COMPOSITION, ASCORBIC ACID, SENSORY, AND MICROBIOLOGICAL QUALITY OF MINIMALLY PROCESSED *CARICA PAPAYA* CONSUMED IN RIVERS STATE, NIGERIA

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Received: 28 August 2020, Revised and Accepted: 01 September 2020

ABSTRACT

Objective: This study evaluated the physico-chemical, proximate, ascorbic acid, sensory, and microbiological properties of minimally processed *Carica papaya* consumed in Rivers State Nigeria.

Methods: Minimally processed papaya in transparent polyethylene bags were purchased from four different locations: Nwinpi, Mile III, Rumuokuta, and Rumuokoro Junctions in Port Harcourt, Rivers State, Nigeria. Control sample was prepared in the laboratory. Standard analytical methods were used for analysis.

Results: pH and titratable acidity ranged from 4.90–5.20 to 1.00–1.04% citric acid, respectively. Moisture, fat, ash, crude fiber, and carbohydrate ranged, respectively, from 85.80–89.60, 0.64–0.69, 0.55–0.96, 1.71–1.93, and 7.20–10.97%. Energy value was 35.31–50.07 kcal/g while protein was 0.09% for all samples. Ascorbic acid varied significantly ($p<0.05$) from 17.81 to 44.91 mg/100 g. Sensory results showed that 75% of the assessors' degree of likeness for aroma, appearance/color, texture (smoothness), sweetness, and overall acceptability was that of moderate to extreme likeness. Total aerobic, coliform, *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus* counts varied from 3.85–5.76, 3.74–5.68, 3.95–5.57, 3.82–5.58, and 3.30–5.45 Log_{10}CFU/g, respectively. The control had significantly ($p<0.05$) the least bacterial count. Fungi count varied from 3.65 to 4.62 Log_{10}CFU/g.

Conclusion: The minimally processed papaya was low in acidity, rich in ascorbic acid and a good source of the nutrient. Sensory attributes of the products were acceptable to the assessors. Microbial counts were unsatisfactory and can pose a risk factor to public health.

Keywords: *Carica papaya*, Physiochemical, Proximate composition, Ascorbic acid, Sensory attributes, Microbiological quality and safety.

INTRODUCTION

Carica papaya L. commonly known as pawpaw is a popular and important fruit tree in tropical and subtropical areas [1]. Papaya belongs to the family Caricaceae. It is a self-supporting and self-pollinating herbaceous succulent plant that grows in the tropical and subtropical countries [2]. Every part of the papaya serves a useful purpose, either culinary or therapeutic or both. The unripe fruit is added into fresh salads, used as a vegetable for cooking in some places and aids in the remedy of ulcer and impotence [3,4]. The seed of ripe fruits helps in clearing nasal congestion [3]. The green papaya leaf is a source of essential vitamins (thiamine and ascorbic acid) and minerals (Ca, Fe, Mn, Mg, Na, and K) and contains phytochemical bioactive compounds that are utilized as a meat tenderizer to enhance digestibility [5] and in the herbal treatment of various diseases [6]. The mature ripe fruits are consumed in large amounts in developing countries and are fast becoming an international fresh and processed fruit [1]. Ripe papaya is consumed fresh as a dessert fruit and can be processed into juice. Research has shown that papaya is rich in fiber, natural Vitamins (A, B, C, and E) and minerals (Ca, Fe, Mn, K, and P). It is an excellent source of carotenoids, Vitamin A, C, and E which are known as powerful antioxidants that play protective roles against degenerative diseases [7,8]. Papaya contains chymopapain and papain which are biochemically active compounds that aid digestion and used in the treatment of allergies [1,9].

Minimally processed fruits and vegetables are also known as fresh-cut, lightly processed, or ready-to-eat produce. Processing involves basic unit operations such as washing, peeling, chopping slicing, and packaging without heat treatment, some chemical treatments may be included in the study. The purpose of minimal processing is to deliver to the consumer a like-fresh product with an extended shelf life, while simultaneously maintaining the nutritional and sensory quality and ensuring food safety [10,11]. The tissues of minimally processed produce are physiologically active causing ethylene production, respiration, accumulation of secondary metabolites, and water loss from tissues which make them more susceptible to microbial spoilage, and the nutrient composition of the fresh produce may offer good growth media for pathogens [11].

Papaya after washing of the whole ripe fruit is minimally processed by peeling of the skin, slicing into halves or quarters with the removal of seeds. The sliced seed-free portions are packaged in transparent polyethylene bags or in plastic containers when the seed-free pulp is cut into small cubes. The packaged pulps are displayed on trays for sale at major junctions in Port Harcourt Metropolis. The pulp of mature ripe fruit has attractive yellow to red-yellow color depending on the variety. Red-fleshed papaya fruit contains lycopene which is responsible for the attractive red color, whilst this pigment is absent from yellow-fleshed fruit [12]. The ripe mature pulp is characterized by its unique succulence, aroma, flavor, and sweetness for which it is savored by all who consume it. Nutritionally, papaya is high in moisture (>87%) and contains proteins, carbohydrate, lipid, fiber, vitamins, and minerals [13]. Its consumption is linked with the cleansing of bacterial from the intestine and thus encourages the absorption of vitamins and minerals which help in the treatment of chronic indigestion, overweight, obesity, and high blood pressure [14].

Papaya, as a climacteric fruit, shows a remarkable increase in its respiratory rate even after harvest. The fresh fruit with its high water content and near-neutral pH is highly perishable. Diverse microorganisms have been isolated from papaya. They include *Escherichia coli*, *Bacillus cereus*, *Staphylococcus aureus*, *Salmonella*, and *Streptococcus* [15]. Some of these pathogens have been implicated in foodborne disease [16]. Minimally processed papaya

is readily available at major junctions, streets, and public places in Port Harcourt. Its consumption is also on the increase as it meets the busier lifestyle of the people and at the same time, meeting their refreshing and nutritious needs. This is welcoming as daily consumption of fruits is the recommendation of a various organization such as Food and Agriculture Organization, World Health Organization, European Food Safety Authority, and United States Department of Agriculture (USDA) for its health benefit [17,18]. However, the processing, packaging, and display of the minimally processed papaya at the busy junctions, roadside or streets with poor personal hygiene practices of the vendor and the unsanitary roadside environment can lead to contamination of the product. This poses a concern for public health as consumption of the fruit can serve as a vehicle for potential pathogens. Therefore, this study evaluated the physico-chemical, proximate composition, ascorbic acid content, sensory properties, and microbiological quality and safety properties of minimally processed papaya consumed in different areas in Port Harcourt, Rivers State, Nigeria to ascertain its quality and level of safety.

METHODS

Sample collection and preparation

Samples of minimally processed papaya packaged in transparent polyethylene bags were purchased from four different locations in Port Harcourt. The samples were coded according to location as NJ, MI, RK, and RO, respectively, for samples from Nwinpi, Mile III, Rumuokuta, and Rumuokoro Junctions. For the control, mature ripe papaya fruit was bought from Mile III market in Port Harcourt, Rivers State, Nigeria. The fruit was washed with distilled water, peeled with a sharp kitchen knife, cut into the quarter with the seeds removed, and package mimicking the types sold by street vendors. For sensory analysis, the pulps were cut into small cubes served in disposable plastic containers while those for further analysis were stored away at 4°C in the refrigerator for <24 h.

Physicochemical analysis: Determination of pH and titratable acidity (TTA)

pH and TTA as % citric acid were determined according to the standard AOAC, [19] methods. Briefly, a digital pH meter (pH_S-2f Harris, England) was used to determine the pH of 10 ml of the homogenized and filtered sample in a beaker. Thereafter, the sample was titrated with a solution of 0.1N sodium hydroxide using 0.3 ml phenolphthalein as indicator.

Proximate analysis

The proximate composition of the samples was analyzed according to AOAC method [19]. Briefly, moisture was determined by drying the samples to a constant weight in a hot air oven (DHG 9140A) at 130°C. Crude protein was assayed by Kjeldahl method with a nitrogen conversion factor of 6.25 used for computation. The lipid content was determined by Soxhlet extraction method with ethyl ether. Ash was obtained gravimetrically after the incineration of the samples in a muffle furnace (Model SXL) at 550°C for 2 h. Chemical solubilization and gravimetric method were used to determine the crude fiber content. The carbohydrate was calculated by difference {100 - (Crude protein + crude fiber + ash + fat)} and energy values were obtained using Atwater factor of 4 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat.

Ascorbic acid determination

The 2,6-Dichlorophenolindophenol titrimetric method described by James, [20] with some modifications was used in the determination of ascorbic acid content of the samples. Briefly, 0.5 g of the sample was mixed with 5 ml of metaphosphoric-acetic mixture, homogenized in a blender for 1 min and then centrifuged at 4000× g for 10 min. This was repeated twice and the supernatant was mixed together. The metaphosphoric-acetic extract was titrated with 2,6-Dichlorophenolindophenol solution until a faint pink color persisted for 15 s.

Sensory evaluation

Sensory analysis was carried out according to the method described by Iwe [21]. The aroma, appearance/color, juiciness, taste (sweetness), texture (smoothness), and overall acceptability of the fruits were assessed by 20 untrained panelists from the university community who often buy and consume minimally processed papaya. The rating of the attributes was based on a 9 – point hedonic scale with the degree of likeness expressed as: (1) Disliked extremely, (2) dislike very much, (3) dislike moderately, (4) dislike slightly, (5) neither like nor dislike, (6) like slightly, (7) like moderately, (8) like very much, and (9) like extremely.

Microbiological analysis

Microbiological analysis was carried out by conventional microbiological method [22]. A serial dilution of 10^6 was prepared from the stock made of 25 g of the fruit sample homogenized in 225 ml of sterile peptone water. Aliquot (0.1 ml) of the dilutions was spread plated on appropriate media for each microorganism. Nutrient agar, eosin methylene blue, *Salmonella*-Shigella Agar, and Mannitol Salt Agar incubated at 37°C for 24–48 h, was used, respectively, for the enumeration of total aerobic count, *E. coli, Salmonella*, and *S. aureus*. Coliform was enumerated on MacConkey Agar incubated at 30°C for 24–48 h. Potato dextrose agar incubated at 25°C for 72 h was used for mold and yeast enumeration.

Statistical analysis

Data obtained were analyzed using Minitab (Release 18.0) Statistical Software (Minitab Ltd., Coventry, UK). Statistical differences were obtained using analysis of variance under the general linear model and Fisher pairwise comparison at 95% confidence level. Statistical differences among the sensory attributes were established using the non-parametric Friedman test.

RESULTS AND DISCUSSION

Physicochemical properties of the minimally processed papaya consumed in Rivers State, Nigeria

The pH and total TTA of minimally processed papaya from the different locations in Port Harcourt, Rivers State is shown in Figs. 1 and 2, respectively. There was no significant ($p>0.05$) difference in the pH and TTA of the samples. pH ranged from 4.90 to 5.20 for location MI and RO, respectively. Similar pH value was reported by Penteado and Leitao [23], confirming that papaya is a low acid fruit. This range of pH of papaya accounts for its low tartness [24]. The TTA values ranged 1.00–1.04% citric acid for RO and the control sample, respectively. The acidity level was in agreement with the record of Moy [24], but lower than the report of Penteado and Leitao [23], this may depend on the equivalent organic acid used in the computation. The organic acids in papaya are mainly malic and citric acid others are ascorbic and α-ketoglutaric acid [24]. Citric acid is important in the alkalization of the body [25].

Proximate composition of minimally processed papaya consumed in Rivers State, Nigeria

The proximate composition and energy content of the minimally processed papaya are shown in Table 1. The moisture content of the minimally processed papaya varied from 85.80 to 89.60% and is lower than the report of Awe *et al*., [4] but comparable with the USDA standard reference and other reports [13,26]. The high moisture content of papaya makes it a highly perishable food as moisture is an index of the keeping quality of food and can encourage microbial growth. The high moisture content is also a good quality for the fruit to be a refreshing one. The protein content of 0.09 % was comparable with that of 0.12% reported by Awe *et al*., [4] but lower than the standard reference of 0.47 [26]. Fruits are not good sources of protein; hence, the protein content of the minimally processed papaya can only meet 0.19% of the recommended daily intake of 0.66 g/kg/day for adults between the ages of 18–60 years weighing 50 kg [27]. The fat content ranged from 0.64 to 0.69%. These values were higher than the USDA standard reference of 0.26% [26]. The ash content ranged from 0.55 to 0.96% for the sample from location RO and RK, respectively. This was higher than the standard reference [26] and the values reported by Ekpete *et al*., [13]. Ash is the inorganic residue after incineration or complete oxidation of organic matter in the food. It is an indication of the minerals present in the food [28]. The crude fiber content of 1.71–1.93% was in agreement with the standard reference and the

report by Ekpete *et al*., [13]. Dietary fiber is those carbohydrates that are indigestible and unabsorbed in the body. They provide bulk to the gut which stimulates peristalsis and result in shorter passage time and more frequent defecation [29]. The carbohydrate and energy value ranged, respectively, from 7.20–10.97% and 35.31–50.07 Kcal/g. Samples from location MI and NJ had significantly ($p<0.05$) the least and highest values, respectively. These values were comparable with the USDA reference standard of 10.82% and 43 kcal/100 g, respectively, for carbohydrate and energy. The energy value of minimally processed papaya is equivalent to 147.73–209.51 KJ/g and will be able to, respectively, meet 70–99% and 81–114% of the daily energy requirement of 212 KJ/Kg for an adult male and 183 KJ/Kg for an adult female aged 18–60 years with body weight of 50 kg [27]. The proximate composition reviewed that the minimally processed papaya from the selected locations in Port Harcourt is a good source of nutrient in comparison to the reference standard and will meet more than 70% of the energy requirement of an average adult.

Ascorbic acid content of minimally processed papaya consumed in Rivers State, Nigeria

The ascorbic acid content of the minimally processed papaya varied significantly ($p<0.05$) from 17.81 to 44.91 mg/100 g, as shown in Fig. 3. Samples from location MI had significantly ($p<0.05$) the least ascorbic acid content and the value was comparable with 19. 20 mg/100 g reported by Awe *et al*. (2013). Samples from location RO had significantly ($P<0.05$) the highest ascorbic acid content. The values were lower than 60.9 mg/100 g standard reference reported by USDA [26]. The Recommended Nutrient Intakes (RNIs) for ascorbic acid is 40 and 45 mg/day, respectively, for adolescents between the ages of 10–18 years and adults of 19–60 years [30]. The ascorbic acid content in 100 g of the minimally processed papaya will be able to meet 45–112% of the RNIs for adolescents between the ages of 10–18 years and 40–100% for adults of 19–60 years. More than 100 g of the papaya can be consumed in a serving, implying that consumers of this fruit will be able to meet their dietary need of Vitamin C. Papaya is, therefore, a rich source of ascorbic acid that is known for its immune-boosting and antioxidant capacity. It targets many mechanisms that cancer cells utilize for growth and survival [31] and has also been reported to offer protection against infectious diseases, including coronavirus [32].

Sensory properties of minimally processed papaya consumed in Rivers State, Nigeria

The result of the assessors' degree of likeness of the sensory attributes: Aroma, appearance/color, taste (sweetness), texture (smoothness), juiciness, and the overall acceptability of the minimally processed papaya from different locations in Port Harcourt are shown in Fig. 4. The mean scores for the aroma, taste (sweetness), and the overall acceptability varied from 5.65–6.85, 5.20–6.95, and 5.05–6.82 for location RO and RK, respectively. The values indicated that the average degree of likeness of the aroma, sweetness, and overall acceptability of the minimally processed papaya was between neither like nor dislike to like slightly. However, the third quartile value indicated that 75% of the assessors had moderate to extreme likeness for the attributes. The mean score for the appearance and texture (smoothness) varied from 4.55–6.85 and 4.95–6.40 for location RO and RK, respectively, indicating that the average degree of likeness of the appearance/color and texture (smoothness) of the minimally processed papaya by the assessors was that of dislike slightly to like slightly. The interquartile value showed that 75% of the assessors had moderate to extreme likeness for the attributes. Samples from MI and RO, however, had 75% of slight likeness. The mean value for the juiciness of the papaya ranged from 6.50 to 6.85 for location NJ and the control, respectively, indicating that the average degree of likeness by the assessors was that of like slightly. The third quartile value indicated that 75% of the rating was that of like very much. The degree of likeness is dependent on the preference of the individual assessor, although other factors such as the variety of the fruit, the preparation process, and duration of storage before consumption may also affect the assessor's sense of judgment. Sensory properties of the food are very useful in making a quick decision on the quality of the product and its conformity with consumers' expectations [33,34]. The minimally processed papaya was of good sensory quality as indicated by the assessors rating and acceptability of the attributes. The fruit is, therefore, one that is enjoyed by its consumers.

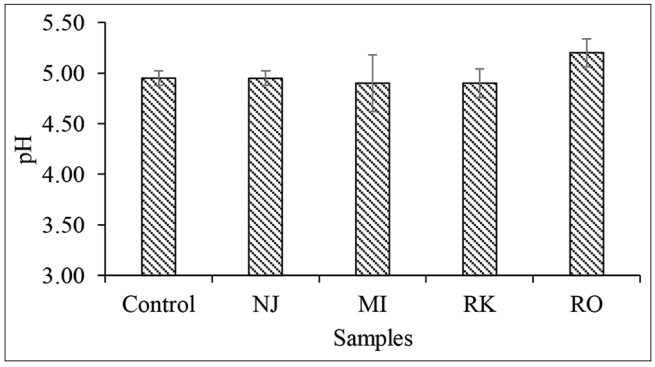

Fig. 1: pH of minimally processed papaya consumed in Rivers State, Nigeria. NJ, MI, RK, and RO represent samples from Nwinpi, Mile III, Rumuokuta, and Rumuokoro Junctions, respectively

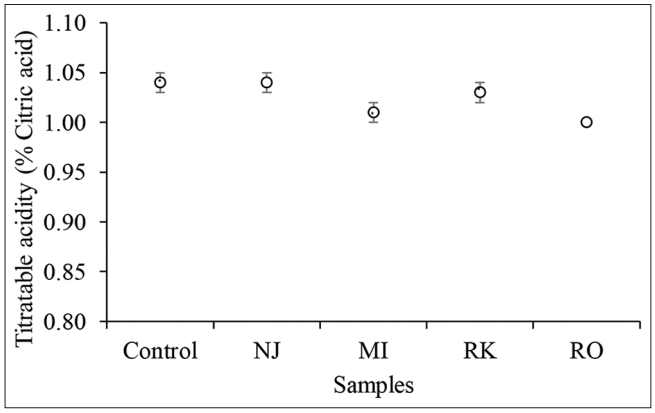

Fig. 2: Titratable acidity (%citric acid) of minimally processed papaya consumed in Rivers State, Nigeria. NJ, MI, RK, and RO represent samples from Nwinpi, Mile III, Rumuokuta, and Rumuokoro Junctions, respectively

Table 1: Proximate composition (%) and energy content (kcal/g) of minimally processed papaya consumed in Rivers State, Nigeria

Samples	Moisture	Total solid	Protein*	Fat	Ash	Fiber	Carbohydrate	Energy
Control	88.60±0.45^{a}	11.40±0.45^{b}	0.09±0.01	0.64±0.00^{b}	0.60±0.05^{b}	1.74±0.00^{b}	8.34±0.49^{b}	39.42±2.01^{b}
NJ	85.80±1.09^{b}	14.20±1.09^{a}	0.09±0.00	0.65±0.01^{ab}	0.56±0.07^{bc}	1.93±0.06^{a}	10.97±1.20^{a}	50.07±4.94^{a}
MI	89.60±0.31^{a}	10.40±0.31^{b}	0.09±0.01	0.66±0.03^{ab}	0.69±0.13^{b}	1.71±0.02^{b}	7.20±0.16^{b}	35.31±0.39^{b}
RK	86.21±0.40^{b}	13.79±0.40^{a}	0.09±0.00	0.69±0.001^{a}	0.96±003^{a}	1.71±0.04^{b}	10.61±0.45^{a}	49.01±1.95^{a}
RO	89.09±0.44^{a}	10.91±0.44^{b}	0.09±0.00	0.67±0.01^{ab}	0.55±0.00^{c}	1.93±0.05^{a}	7.90±0.16^{b}	37.96±0.78^{b}

Means that share the same superscript in the same column are not significantly ($p>0.05$) different. N=2±SD. *Protein content for all location did not differ significantly ($p>0.05$). NJ, MI, RK, and RO represent samples from Nwinpi, Mile 3, Rumuokuta, and Rumuokoro Junctions, respectively

Microbiological quality and safety of minimally processed papaya consumed in Rivers State, Nigeria

The microbiological quality and safety of the minimally processed papaya from different locations in Port Harcourt are shown in Table 2.

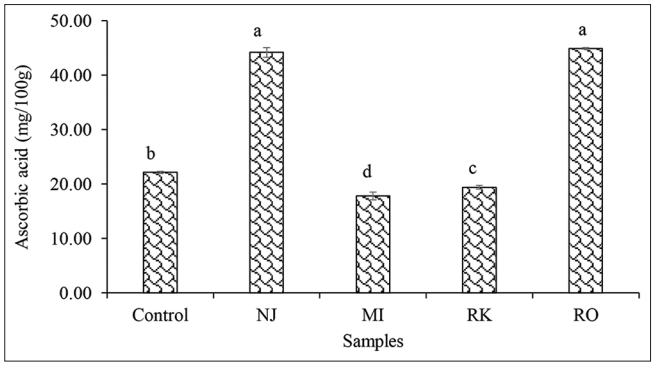

Fig. 3: Ascorbic acid (mg/100 g) content of minimally processed papaya consumed in Rivers State, Nigeria. Means with the same superscript are not significantly (p>0.05) different. N=2±SD. NJ, MI, RK, and RO represent samples from Nwinpi, Mile III, Rumuokuta, and Rumuokoro Junctions, respectively

The total aerobic count in the papaya samples varied from 3.85 to 5.76 Log_{10}Cfu/g. The control had significantly ($p<0.05$) the least count while samples from location RK had significantly ($p<0.05$) the highest count. These values are lower than 10^6 CFU/g reported for papaya samples from Otta [35]. Variation could be attributed to heterogeneity of the organisms in the sample, sampling, and analytical techniques in addition to other factors. The total aerobic count provides useful information about the general quality and shelf-life of the fruits and it is not of main concern in terms of safety [36]. According to the guidelines for the microbiological examination of ready-to-eat foods, for a level 1 and 2 standard plate count (i.e., food with some level of heat treatment), counts $<10^4$ and $<10^6$ CFU/g, respectively, are considered satisfactory, while for Level 3 which applies to fresh fruits and vegetables no categorization is applicable, as it would be expected that these foods would have an inherent high plate count because of the normal microbial flora present [37]. This implies that in terms of the aerobic count, the minimally processed papaya is of good quality.

Total coliform in the papaya samples varied from 3.74 to 5.68 Log_{10}CFU/g for control and location MI, respectively. This result is lower than 10^6 CFU/g reported by Oranusi and Owrunfemi, [35] for papaya samples from Otta. Total coliform in the minimally processed papaya exceeded the maximum permitted levels of 2 Log_{10}CFU/ml (100 CFU/ml) in fresh produce [36]. Coliform is an indicator of quality

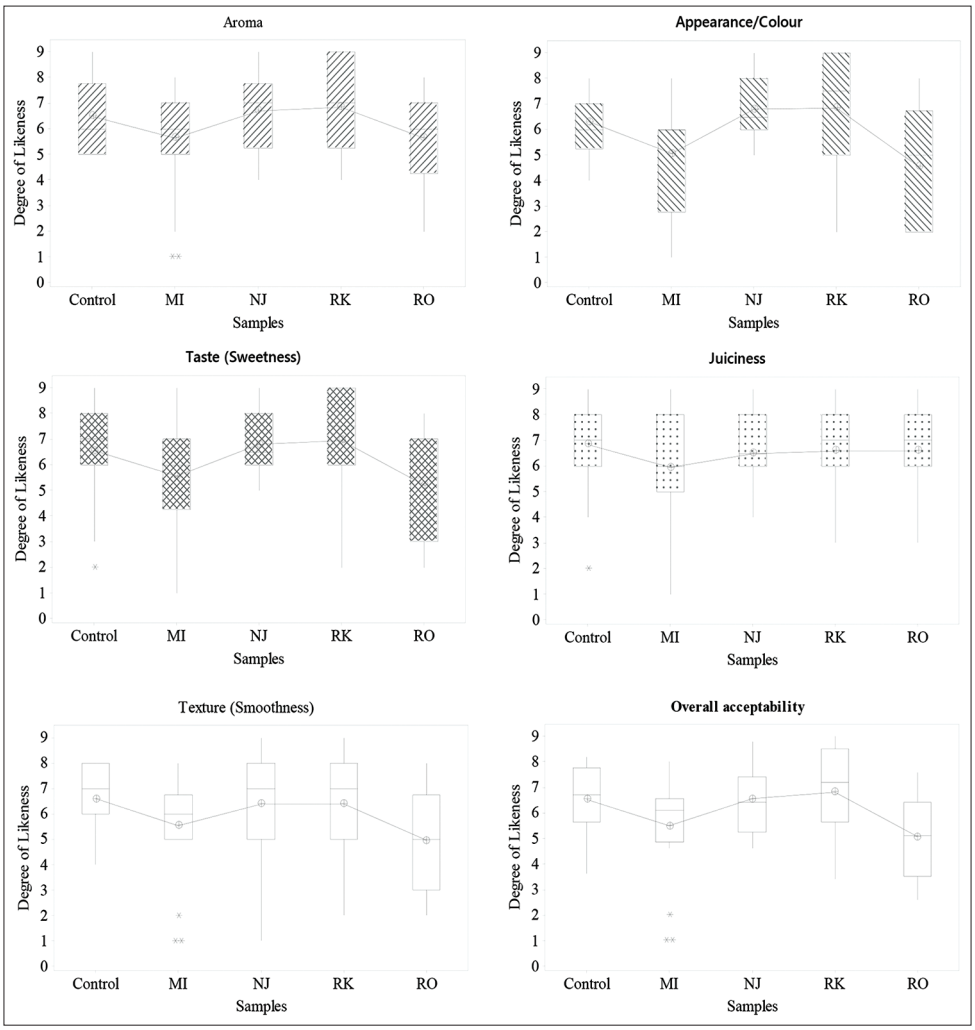

Fig. 4: Boxplot of the sensory properties of the minimally processed papaya consumed in Rivers State, Nigeria. NJ, MI, RK, and RO represent samples from Nwinpi, Mile III, Rumuokuta, and Rumuokoro Junctions, respectively. Expression of the degree of likeness: (1) Disliked extremely, (2) dislike very much, (3) dislike moderately, (4) dislike slightly, (5) neither like nor dislike, (6) like slightly, (7) like moderately, (8) like very much, and (9) like extremely

Table 2: Microbiological quality of the minimally processed papaya consumed in Rivers State, Nigeria

Samples	Total aerobes	Total coliform	*Escherichia coli*	*Salmonella*	*Staphylococcus aureus*	Fungi
Control	3.85±0.21^{b}	3.74±0.37^{b}	3.95±0.49^{a}	3.82±0.28^{c}	3.30±0.00^{b}	3.78±0.00^{a}
NJ	5.50±0.71^{a}	5.16±0.45^{a}	4.83±1.23^{a}	4.19±0.16^{bc}	5.45.0.64^{a}	3.65±0.49^{a}
MI	5.30±0.43^{a}	5.68±0.45^{a}	5.25±0.49^{a}	5.14±0.22^{ab}	5.44±0.57^{a}	4.62±0.46^{a}
RK	5.76.0.40^{a}	4.60±0.43^{ab}	5.23±0.04^{a}	4.92±0.63^{ab}	5.39±0.12^{a}	4.01±0.55^{a}
RO	5.48±0.00^{a}	5.50±0.65^{a}	5.57.±0.39^{a}	5.58±0.57^{a}	5.42±0.311^{a}	NG

Means that share the same superscript in the same column are not significantly (p>0.05) different. N=2±SD. NG=No growth. NJ, MI, RK, and RO represent samples from Nwinpi, Mile 3, Rumuokuta, and Rumuokoro Junctions, respectively

attributable to inadequate processing, cross-contamination with raw materials and dirty utensils as well as improper storage temperature which can lead to the multiplication of pathogenic and toxigenic organism though coliforms are non-pathogenic [27].

E. coli count ranged from 3.95 to 5.57 Log_{10}CFU/g for the control and samples from location RO, respectively. These levels exceeded the guideline of <2 Log_{10}CFU/g and are unsatisfactory for consumption. *E. coli* is a natural component of the human gastrointestinal tract and its presence in the minimally processed papaya is an indication of fecal contamination. Although *E. coli* is generally an indicator of hygiene, it can pose food safety problems as some are enterotoxigenic [38].

Salmonella in the minimally processed papaya varied from 3.82 to 5.58 Log_{10}Cfu/g for the control and location RO, respectively. The guideline requires the absence of *Salmonella* in 25 g of the sample [36]. The papaya samples from the different locations by the guideline are unsafe for consumption. *Salmonella* is a pathogen, hence a pointer to safety. Its presence in papaya has been implicated in the outbreak of diseases [16]. Cross-contamination and poor hygiene practices could be responsible for the presence of *Salmonella* in the samples and the low pH of the papaya with its high water activity can encourage the growth of the organisms. According to Penteado and Leitao, [23] for contaminated samples, refrigeration storage can only reduce the growth rate but not inhibit the organism. This implies that even if the minimally processed samples are stored in chilled condition, it would still be unsafe with the presence *Salmonella.*

S. aureus varied significantly from 3.30 to 5.45 Log_{10}CFU/g. The control had significantly ($p<0.05$) the least count. According to FSANZ guideline for the microbiological examination of ready-to-eat foods, levels of 10^2–10^3 are unsatisfactory while levels ≥10^4 CFU/g are considered to be potentially hazardous to health [39]. With the exception of the control sample, which is unsatisfactory, the papaya samples from the different locations have levels of *S. aureus* that is considered hazardous. *S. aureus* is one of the natural microflora of the human orifices and its presence in the minimally processed papaya show contamination from the human handlers.

Fungi were not detected in samples from location RO but varied from 3.65 to 4.62 Log_{10}CFU/g for samples from location NJ and MI, respectively. The fungi count in the minimally processed papaya was lower than values of 10^5 CFU/g reported by Nwachukwu and Osuocha [40], in sliced papaya from Umuahia but higher than 10^1–10^2 CFU/g for ready-to-eat papaya from Otta [35]. Several factors could be responsible for this variation from the specie of the papaya to the heterogeneity of the distribution of the microbes in the sample, handling, sampling, and analytical techniques. Contamination with fungi in addition to the natural flora of the fruit includes poor hygiene and the environment as most fungi are airborne. Some fungi are important spoilage organisms in fruits and are favored by low pH and high water content. While some fungi like *Aspergillus* are associated with the production of mycotoxins that is hazardous to public health.

The microbiological quality of the minimally processed papaya with the exception of the total aerobic count was unsatisfactory. The microbial counts exceeded the permitted levels stated in the microbiological guidelines. The level of contamination of the minimally processed papaya can be attributed mainly to the lack of adequate hygienic practices by the vendor during the preparation process, the unsanitary roadside environment, and the display of the product in harsh weather conditions. It is important, therefore, for the vendor to be properly enlightened on good hygiene practices required when handling such read-to-eat products. The introduction of the use of cool temperature carts for storage and display of the product will provide adequate temperature <5°C to minimize the growth of any contaminant and improve upon the microbiological quality and safety of the product.

CONCLUSION

This study revealed that the minimally processed papaya is low in acidity, rich in ascorbic acid, and a good source of nutrient in comparison to the reference standard, which is very good for the nourishment of the body. Although the products were acceptable to the sensory assessors, the microbial counts were unsatisfactory and can pose a risk factor to public health. Exposing the need for enlightenment of food handlers on good hygiene practices when processing fruits to avoid the risk of contamination with foodborne pathogens.

ACKNOWLEDGMENT

The authors appreciate the technical assistance of the laboratory technicians of the Microbiological and Analytical unit of the Food Science and Technology Laboratory, Rivers State University, Port Harcourt, Nigeria.

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