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Production and Quality Assessment of Infusion Tea from Banana Peels

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Abstract

The main objective of this study was to assess the quality of infusion tea produced from banana peels. Banana peels were processed and dried at 55°C for 10 h, and substituted with ginger powder to make “tea”. Six samples were obtained and tagged A (100% banana peel), B (90% banana peel, 10% ginger), C (85% banana peel, 15% ginger), D (80% banana peel, 20% ginger), and E (75% banana peel, 25% ginger). Sample F is a commercially sold tea (Lipton Yellow Label Tea), and served as the control. Two grams (2 g) of the samples were bagged and brewed in 100 ml of hot water (100°C) for 5 min. Protein, ash, magnesium, manganese, copper and potassium content of the brew was analysed. Also, antioxidant properties, pH and sensory evaluation of the brew was determined. The protein and ash content of the samples ranged from 0.24-0.94% and 0.14-0.31%, with the control recording the highest value. Substituting banana peel with ginger reduced the magnesium and copper content of the brew which ranged from 0.84-6.12 mg/100 ml and 0.013-0.899 mg/100 ml respectively. Manganese and potassium content of the brew increased with increase in the quantity of ginger. The total phenol, tannin and flavonoid content of the brews ranged from 2.03-3.58 mg/100g, 3.62-21.98 mg/kg and 1.20-1.43% respectively. There was significant difference ($p<0.05$) between the control and the ginger substituted samples in their pH values which ranged from 6.63-7.42. Overall acceptability score showed that the control was liked best (7.29), followed by sample B (7.08). Production of infusion tea from banana peel have shown to be feasible. Its use as a tea alternative have shown its richness in micronutrients as magnesium and copper, as well as manganese and potassium when substituted with ginger. The substitution of 25% banana peel with ginger in “tea” production is recommended. Despite being liked slightly for sensory over all acceptability, the protein, potassium and antioxidant properties can compete favourably with the 100% banana peel brew.

Keywords: *Banana peel tea, food waste, infusion tea, mineral composition, antioxidant properties*

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1. Introduction

Tea (*Camellia sinensis*), is the most consumed drink after water (Valavanidis, 2019). It is a popular beverage prepared from the leaves of camellia sinensis, also called tea plant, which originated in ancient China and has become increasingly popular all over the world in recent decades. The popularity of tea is not just because of its taste and attractive aroma, but also because of its many pharmacological benefits like suppressing tumor cell formation, anti-obesity, preventing cardiovascular diseases and lowering the risk of atherosclerosis (Shang *et al.*, 2021). Tea's health benefits are generally linked to the chemicals found in it. A typical cup of tea (especially green tea) usually contains 250–350 mg tea solids, of which 30–42% are catechins and 3–6% caffeine (Khan *et al*., 2021). Flavonoids are the most significant quality parameters of tea because of their color and taste. According to the structural skeleton, flavonoids found in tea were predominantly flavanols, theaflavins, anthocyanins, flavanols, and bioflavonoids (He *et al*., 2021). The major active constituents of tea are polyphenols that have strong antioxidant activity. 450-500ml per day, consumed by approximately two-thirds of the world's population (Das *et al*., 2022). A typical cup of tea (especially green tea) usually contains 250–350mg tea solids, of which 30–42% are catechins and 3–6% caffeine (Khan *et al.*, 2021). Plants are still major sources of the foods worldwide and phytochemicals can play a significant role in modern food and pharmaceutical industries (Kibria *et al*., 2019). Since those parts of the plant contain only trace amounts of carbs, tea is virtually a calorie and fat free beverage (Lang, 2019). Studies have also shown that excessive consumption of tea has its own side effects due to its high caffeine content. Some adverse effects of tea consumption include headache, anxiety, gastrointestinal issues, iron absorption, interaction with medication, potential contaminants, irregular heart rate etc (Ansley, 2023).

Banana (*Acuminita musa*) is an important tropical fruit traded commercially (Regnier *et al.*, 2023). Banana waste includes small-sized, damaged, or rotting fruit, banana peels, leaves, stems, and pseudo parts. The peel and the pulp are the two main sections of the banana fruit. The secondary product of bananas (peel), which is approximately 40% of the weight of bananas, is a major by-product which needs to be managed properly. The average banana consumption is 12 kg per capita, making it the world's leading food crop after rice, wheat and maize. Many researchers are working on finding out the composition of banana peel, hence paving ways for different applications in the food and non-food sector (Zaini *et al*., 2022). The organic composition of banana peel comprises lipids, fibres, carbohydrates and protein which results in presence of several bioactive molecules. These bioactive compounds including alkaloids, flavonoids, phenolics, steroids (tannic acid, catechol, β-sitosterol, ferulic acid) help to perform different biological activities and cures antitumor, antiparasitic, antibacterial, antifungal, anti-aging, antioxidant and antiviral activities (Hashim *et al.*, 2022). The mechanism of its bioactive compounds helps to cure infections and diseases. A study by Elisha *et al.* (2022) states that banana peel is a valuable byproduct which has several benefits and it can be used in different industries like pharmaceutical, cosmetics, food, lather, biodiesel, bioethanol and alternative tea production. Potential applications for banana peel depend on its chemical composition. Banana peel is rich in dietary fiber (50% on a dry matter (DW) basis), proteins (7% DW), essential amino acids, polyunsaturated fatty acids and potassium. Banana peel is rich in phytochemical compounds, mainly antioxidants. The total amount of phenolic compounds in banana peel ranges from 0.90 to 3.0 g/100 g DW (Elisha *et al.*, 2022).

Banana peel is one of the most important waste products that might be employed in the food sector as a functional additive (Zaini *et al.*, 2020). It can serve as an herbal tea. Herbal teas are not made from the *Camellia* plant but from dried herbs, spices, flowers, fruit, seeds, roots, or leaves of other plants; they do not typically contain caffeine as do traditional teas. Herbal teas are naturally caffeine-free and do not undergo a decaffeination process. People have varying sensitivity to caffeine but it is classified as a stimulant that has the potential to affect the nervous system and heart rate, and cause jitteriness (McKenzie *et al*., 2016). In general, traditional teas already have about half the caffeine of coffee and even less if the brewing time is shorter. Herbal teas are naturally caffeine-free and do not undergo a decaffeination process.

Excess consumption of caffeine induced tea is associated with several adverse health conditions such as insomnia, nervousness, restlessness, nausea, increased heart rate, and other side effects. Larger doses might cause headache, anxiety, and chest pain. Caffeine is likely unsafe when used in very high doses (McKenzie *et al*., 2016). Banana peel which is a by-product of banana is packed with certain nutrients and antioxidants that can be beneficial when consumed (Munsu *et al*., 2022) and has been underutilized in food processing and hence the use for tea production. Also, producing infusion tea from banana peels addresses food waste reduction and promotes health.

2. Materials and Methods

Ripe banana was purchased from Fruit Garden market, Port Harcourt in Rivers State, Nigeria. The other materials and ingredients such as ginger and teabags were purchased from Mile 3 market also in Port Harcourt, Rivers State, Nigeria. The chemicals and equipment used were of analytical grade and was obtained from the Food Analytical/Food Chemistry Laboratory, Department of Food Science and Technology, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria.

Processing of ginger

Ginger roots were sorted and washed to get rid of soil, dirt and then drained as in the method used by Eke *et al.,* (2022). After washing a knife was used to peel the skin after which the ginger roots were sliced thinly. It was then dried at 55ºC for 6 h in an oven. The dehydration process was stopped when then pieces of the ginger became brittle. The dehydrated ginger was then blended coarsely and packaged. The process is shown in Figure 1.

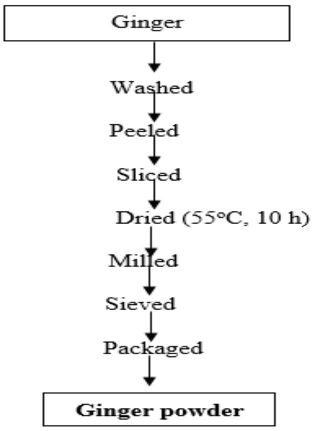

Figure 1: Production of ginger powder
Source: Eke *et al.* (2022).

Processing of banana peel

As described by Mittal *et al.* (2021) with slight modification, banana peel was prepared from mature and ripe banana peels. The peels were cleaned to remove contaminants. The inner pith (the white path) of the peels were scrapped off and the peels cut into smaller sizes and washed. The washed banana peels were placed in a dehydrator at a temperature of 55ºC for 10 h. The dried peels were coarsely blended using a Buchymix blender (Turbocrush Digital BM0421DL) as illustrated in Fig. 2.

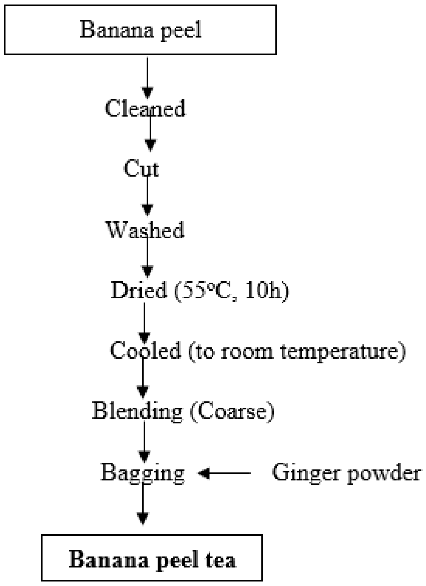

Figure 2: Production of banana peel tea
Source: Mittal *et al.* (2021) with slight modification

Table 1: Formulation Blends for Banana peel-ginger tea

Sample	Banana Peel (g)	Ginger (g)
A	2	-
B	1.8	0.2
C	1.7	0.3
D	1.6	0.4
E	1.5	0.5

Key:
A = 100% banana peel
B = 90% banana peel, 10% ginger
C = 85% banana peel, 15% ginger
D = 80% banana peel, 20% ginger
E = 75% banana peel, 25% ginger

Banana peel tea extraction

As described by Mittal *et al.* (2021) with modification. Two grams (2 g) of the tea containing 0, 10, 15, 20 and 25% of ginger powder and already weighed into a tea bag was placed in 100 ml of distilled water for 5 min at 100ºC. After brewing, the extract was allowed to cool for further analysis.

pH determination

pH of the tea samples was determined using the Association of Official Analytical Chemists (AOAC, 2012) standard method. The samples (10 ml) were measured into a beaker. The pH meter (Jenco 6177) after calibration and stabilization with standard buffer of pH 4.0 and 7.0, was used to determine the sample pH.

Crude protein and ash determination

The crude protein and ash contents of samples were analysed using the standard analytical method described by AOAC (2012). Kjeldahl method and a nitrogen conversion factor of 6.25 was used for crude protein determination. Ash content was determined gravimetrically after the incineration of the samples in a muffle Furnace (Model SXL) at 550ºC for 2 h.

Mineral content determination

APHA 3030 F (Nitric acid -Hydrochloric acid digestion) was used in the digestion of the samples. One gram (1 g) of each sample was digested with 10 ml of HNO_3 after ashing. The samples were cautiously evaporated to less than 5ml. It was cooled and 10 ml of 1 + 1 HCL was added. The sample was heated to dissolve any precipitate or residue and filtered to remove insoluble material that could clog the nebulizer. The filtrate was transferred to a 100 ml volumetric flask with rinsing (with deionized water) and diluted to 100 ml mark. Atomic absorption spectrophotometer (Buck scientific, model 210) was used to determine the magnesium, manganese, copper and potassium content of the samples.

Antioxidant determination

The methods described by Nbaeyi-Nwaoha and Onwuka (2014), was used to determine the tannin, phenol and flavonoid content of the tea samples. The tannin and phenol content were determined by the Folin-Ciocalteu method, while the flavonoid content of the cookies samples was determined by gravimetric method after evaporation.

Sensory evaluation

A twenty-member panelits consisting of students of the Rivers State University community, Port Harcourt, Nigeria was used for the sensory evaluation. The panelists were above 18 years of age and regular consumers of tea. They were neither sick nor allergic to the tea. The samples were evaluated for aroma, appearance, colour, mouthfeel and overall acceptability, using a 9-point hedonic scale of 1 to 9 as described by (Iwe, 2010), where 1= dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly 5 = nether like or dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely.

Statistical analysis

Data obtained for all the analysis carried out was subjected to statistical analysis using IBM SPSS Statistics (version 26). Statistical differences and relationship among variables were evaluated by analysis of variance under general linear model and Tukey pairwise comparison at 95% confidence level.

3. Results and Discussion

Nutrient composition of brews from commercially sold tea and banana peel tea substituted with ginger

The protein, ash, magnesium, manganese, copper and potassium composition of brews from commercially sold tea, and infusion tea produced from banana peel is presented in Table 2.0.

The protein content ranged from 0.24-0.94%, with sample F (control) recording the lowest, while the highest was recorded in sample A (100% banana peel). There was significant difference ($p<0.05$) between the control and the ginger substituted samples in their protein content. The protein content of the samples increased with increase in substitution ratio of ginger. The protein content from this study (0.56-0.94%) was higher than 0.475-0.783% reported by Mittal *et al.* (2021) for Indian kangra green tea infused with different local fruit peels. Protein serves as the major structural components of all cells in the body, and functions as enzymes, transport carriers, and some hormones (Orisa *et al*., 2024).

The ash content ranged from 0.14-0.31% sample B (90% banana peel: 10% ginger) recording the lowest, and the highest recorded in sample A. The ash content of the tea samples here (0.22-0.31%) showed that tea infusions typically have low ash content, as the result obtained were similar to 0.20-0.40% ash content of 0.20-0.30% reported by Sanchez *et al.* (2018) for green tea. Also, Ogunwande *et al.* (2019) and Al-Mamun *et al.* (2017) have reported ash contents of 0.20-0.50% and 0.5-1.5% for black and herbal teas respectively. These low ash contents maybe because the soluble compounds in tea leaves, such as polyphenols, carbohydrates, and amino acids (Mittal *et al.*, 2021) are extracted into the liquid, while the insoluble ash components like minerals and other inorganic compounds, remain largely in the tea leaves.

The magnesium content ranged from 0.84-6.12 mg/100g. Sample F recorded the lowest while sample A recorded the highest. Magnesium helps in the proper functioning of the muscles (Orisa *et al*., 2023). It also serves as an activator in many enzymes systems (Okoye and Egbujie, 2018). There was significant difference ($p<0.05$) between samples, in their magnesium content. The magnesium content reduced with increase in the quantity of ginger. Kumar *et al.* (2018) also found that the addition of ginger to tea infusions reduced the magnesium content by 12.60% compared to tea infusions without ginger. Due to its chelating properties, ginger can reduce magnesium content in food products (Srinivasan *et al.*, 2019). The magnesium content reported in this study (0.84-6.12 mg/100 ml) were higher than 0.86-1.63 mg/kg reported by Dlugaszek and Mierczyk (2024) for green tea infused at different time intervals.

Manganese content of the samples ranged from 0.097-0.210 mg/100 ml with sample A recording the lowest, and sample F, the highest. There was significant difference ($p<0.05$) between samples in their manganese content. The inclusion of ginger showed to increase the manganese content of the samples, with increase in ginger. As reported by Kumar *et al*. (2018), the addition of ginger to tea infusions increased the manganese content by 15.10%. This increase maybe due to the ability of ginger as reported by Srinivasan *et al.* (2019) to enhance mineral bioavailability.

The copper content ranged from 0.013-0.899 mg/100 ml. Sample F recorded the lowest, while sample A recorded the highest. Copper content of the tea sample reduced with increase in the quantity of ginger added. There was no significant difference ($p<0.05$) among samples. Ginger can reduce copper content in food products due to its chelating properties, which can bind to copper ions and reduce their availability (Srinivasan *et al*., 2019). Singh *et al.* (2015) reported significant reduction in copper content (18.20%) in cooked vegetables with added ginger compared to those without ginger. The copper content from this study (0.013-0.899 mg/100g) differs from 0.00037-0.00989 mg/100 ml for 33 various types of tea without additives reported by Klepacka *et al*. (2021).

Potassium content of the samples ranged from 11.16-88.26 mg/100 ml with sample A recording the lowest value, while sample B recorded the highest. The potassium content of the samples reduced with increase in the quantity of ginger added. Significant difference ($p<0.05$) existed among the samples. Potassium is an electrolyte essential in the homeostatic balance of body fluids. It is needed in fluid balance and regulation of nerve impulse conduction, regular heart beat and cell metabolism (Whittaker, 2017). The result here (11.16-88.26 mg/100 ml) was similar to 15.506-45.535 mg/100 ml potassium content reported by Klepacka *et al.* (2021), but higher than 5.411-7.960 mg/100g reported by Dlugaszek and Mierczyk (2024).

Table 2: Nutrient composition of brews from commercially sold tea, and banana peel tea infusion substituted with ginger

Sample	Protein (%)	Ash (%)	Magnesium (mg/100 ml)	Manganese (mg/100 ml)	Copper (mg/100 ml)	Potassium (mg/100 ml)
A	$0.94^{a}\pm0.03$	$0.31^{a}\pm0.00$	$6.12^{a}\pm0.01$	$0.097^{f}\pm0.00$	$0.899^{a}\pm0.00$	$11.16^{f}\pm0.00$
B	$0.56^{d}\pm0.02$	$0.14^{d}\pm0.00$	$5.42^{b}\pm0.00$	$0.103^{e}\pm0.00$	$0.459^{b}\pm0.00$	$88.26^{a}\pm0.00$
C	$0.65^{cd}\pm0.02$	$0.28^{b}\pm0.01$	$5.33^{c}\pm0.00$	$0.109^{d}\pm0.00$	$0.336^{c}\pm0.00$	$60.55^{b}\pm0.00$
D	$0.70^{bc}\pm0.01$	$0.22^{c}\pm0.01$	$5.02^{d}\pm0.01$	$0.137^{c}\pm0.00$	$0.161^{d}\pm0.00$	$54.46^{c}\pm0.00$
E	$0.75^{b}\pm0.03$	$0.24^{c}\pm0.00$	$4.02^{e}\pm0.00$	$0.142^{b}\pm0.00$	$0.140^{e}\pm0.00$	$50.46^{d}\pm0.00$
F	$0.24^{e}\pm0.00$	$0.30^{a}\pm0.02$	$0.84^{f}\pm0.04$	$0.210^{a}\pm0.01$	$0.013^{f}\pm0.01$	$15.61^{e}\pm0.00$

Values are means ± Standard Deviation of duplicate determinations. Means in the same column with different superscript are significantly different at $p<0.05$.

Keys:
A = 100% banana peel
B = 90% banana peel, 10% ginger
C = 85% banana peel, 15% ginger
D = 80% banana peel, 20% ginger
E = 75% banana peel, 25% ginger
F = Control (Commercially sold tea)

Antioxidant properties and pH of brews from commercially sold tea, and banana peel tea infusion substituted with ginger

The total phenol, tannin, flavonoid and pH of the samples is as shown in Table 3.0.

The total phenol content ranged from 2.03-3.58 mg/100g. Sample F recorded the lowest, while sample A recorded the highest. The total phenol (TP) content of the samples infused with ginger increased with increase as the quantity of ginger increased. The 100% banana tea sample (sample A) however recorded the highest TP content, and varied significantly ($p<0.05$) with other samples, apart from sample E (75% banana peel: 25% ginger). Total phenol content from this study (2.03-3.58 mg/100g) was lower than 43.38 and 46.03 mg/100 ml reported by Klepacka *et al*. (2021) for black tea and pu-erh tea infusions respectively. The variation in polyphenol levels in various tea infusions is also indicated among other things, by studies by Almeida *et al*. (2019) and Samadi and Fard (2020), who also demonstrated that the best source of these compounds were green tea leaves.

Tannin content of the samples ranged 3.62-21.98 mg/kg with sample E recording the lowest value, and sample F recording the highest. Ginger inclusion reduced the tannin content of the banana peel teas, as samples with higher amount of ginger recorded lower tannin content. This might be as a result of low tannin content (0.12-0.26 mg/kg) of ginger as reported by Ajayi *et al*. (2013). The tannin content of the samples (3.62-4.81 mg/kg) were lower than 74.55mg AAE/g of banana infused green tea as reported by Mittal *et al*. (2021).

The flavonoid content ranged from 1.20-1.43%. Sample F recorded the lowest value, while sample E recorded the highest. Flavonoids are also powerful antioxidants that can reduce free radicals (Middleton *et al*., 2000), as free radicals damage the tissues of organs and cause various diseases. The inclusion of ginger to banana peel tea infusion increased the flavonoid content of the samples as the flavonoid content increased with increase in the quantity of ginger. Ariani and Akhmad (2018) have reported that flavonoids as antioxidants are necessary to counteract the effects of free radicals in the body. Additionally, flavonoids affect the neurological system and may be used to treat cancer **(**Achmad and Putri, 2021**)**. According to research, banana peel contains flavones that have enormous potential in the food industry (Guerrero-Alva, 2019). Banana peel extract contain flavonoid leucocyanidin that promote healing (Novak *et al*., 2003).

pH value of the tea samples ranged from 6.63-7.42. The lowest value was recorded in sample F, while the highest value was observed in sample A. There was significant difference ($p<0.05$) between the control (sample A) and the other samples in their pH value. The inclusion of ginger reduced the pH value of the samples. The pH of samples from this research (7.35-7.42) were a bit higher than the pH of green tea infusion (6.00) reported by Dlugaszek and Mierczyk (2024), and were similar to pH of brewed tea (6.75-7.89) reported by Lunkes and Hashizume (2014). The pH values from this study were all close to neutrality, and showed no sign of erosive potential to teeth. This finding can be explained through the Stephan's report (Stephan, 1996), which did not observe loss of superficial hardness of teeth when they were in contact with teas without an acid component.

Table 3: Antioxidant properties and pH of brews from commercially sold tea, and banana peel tea infusion substituted with ginger

Sample	Total Phenol (mg/100g)	Tannin (mg/kg)	Flavonoid (%)	pH
A	$3.58^{a}\pm0.08$	$4.81^{b}\pm0.04$	$1.23^{c}\pm0.01$	$7.42^{a}\pm0.01$
B	$3.00^{d}\pm0.03$	$4.20^{bc}\pm0.28$	$1.26^{c}\pm0.00$	$7.38^{b}\pm0.01$
C	$3.14^{cd}\pm0.04$	$4.27^{bc}\pm0.14$	$1.30^{bc}\pm0.01$	$7.35^{b}\pm0.00$
D	$3.24^{bc}\pm0.04$	$3.93^{bc}\pm0.08$	$1.36^{ab}\pm0.04$	$7.37^{b}\pm0.01$
E	$3.40^{ab}\pm0.06$	$3.62^{c}\pm0.37$	$1.43^{a}\pm0.04$	$7.36^{b}\pm0.01$
F	$2.03^{e}\pm0.03$	$21.98^{a}\pm0.22$	$1.20^{d}\pm0.08$	$6.63^{c}\pm0.00$

Values are means ± Standard Deviation of duplicate determinations. Means in the same column with different superscript are significantly different at $p<0.05$.

Sensory properties of brews from commercially sold tea, and banana peel tea infusion substituted with ginger

The sensory properties of brews from commercially sold tea, and infusion tea produced from banana peel is presented in Table 4.0.

Sensory analysis is an important criterion for assessing quality in the development of new products and for meeting consumer requirements (Obinna-Echem *et al*., 2023).

The aroma scores ranged from 6.20 (samples B, D, and E) to 7.00 (Sample F). There was no significant difference ($p<0.05$) among samples in their aroma scores. The aroma scores in this study (6.20-7.00) were similar to 6.24 and 6.42 reported by Hussain *et al*. (2019) for the aroma of France rose and osmanthus flower extract respectively.

Colour scores ranged from 5.60-8.01 with samples D and F having the lowest and highest scores respectively. Inclusion of ginger to banana peel brew reduced the colour score of the samples. The colour scores differed from 8.19-8.39 reported by Sazon (2022), for colour of herbal tea from malunggay leaves of different maturity.

The appearance scores ranged from 5.60-7.21. Sample D recorded the lowest, while sample F recorded the highest score. Inclusion of ginger to banana peel brew reduced the astringency score of the samples.

The mouthfeel scores ranged from 6.40 (sample D) to 7.80 (sample A), while the astringency scores ranged from 6.60 (samples B, C and) to 7.60 (sample A). Sample A (100% banana peel) recorded the highest mouthfeel score (7.80), but did not differ significantly (p<0.05) from sample E (7.00) and F (7.63), indicating the samples were both liked moderately (Iwe, 2010).

The overall acceptability scores of the samples ranged from 6.08-7.29 with sample D recording the lowest, while sample F recorded the highest. The overall acceptability score of the samples showed that sample F (commercially sold tea) was liked best by the panelists, but did not differ significantly (p<0.05) from the other samples, apart from sample D. The overall acceptability score of the control sample (7.29) and the 100% banana peel brew (7.08) were similar to 7.83-7.99 reported by Sazon (2022) for guava leaves extract of different maturity. There were however higher than 4.96-6.16 overall acceptability scores of France rose buds, jasmine flower, and Osmanthus flower reported by Hussain *et al.* (2019).

Table 4: Sensory properties of brews from commercially sold tea, and banana peel tea infusion substituted with ginger

Sample	Aroma	Colour	Appearance	Mouthfeel	Astringency	Overall Acceptability
A	$6.40^{ab}\pm1.90$	$6.80^{b}\pm1.01$	$6.80^{a}\pm1.36$	$7.80^{a}\pm1.20$	$7.60^{a}\pm1.05$	$7.08^{a}\pm0.96$
B	$6.20^{b}\pm1.77$	$6.20^{bc}\pm0.77$	$6.80^{a}\pm1.20$	$6.80^{b}\pm0.77$	$6.60^{b}\pm1.67$	$6.52^{ab}\pm1.00$
C	$6.40^{b}\pm1.67$	$6.60^{b}\pm0.82$	$7.00^{a}\pm1.12$	$6.60^{b}\pm0.82$	$6.60^{b}\pm0.82$	$6.64^{ab}\pm0.61$
D	$6.20^{b}\pm0.77$	$5.60^{c}\pm0.50$	$5.60^{c}\pm0.50$	$6.40^{b}\pm0.50$	$6.60^{b}\pm0.82$	$6.08^{b}\pm0.25$
E	$6.20^{b}\pm0.41$	$6.00^{bc}\pm1.45$	$6.60^{b}\pm1.04$	$7.00^{ab}\pm1.12$	$6.80^{ab}\pm0.77$	$6.52^{ab}\pm0.56$
F	$7.00^{a}\pm0.88$	$8.01^{a}\pm1.11$	$7.21^{a}\pm1.17$	$7.63^{a}\pm0.82$	$6.60^{b}\pm0.63$	$7.29^{a}\pm0.94$

Values are means ± Standard Deviation of duplicate determinations. Means in the same column with different superscript are significantly different at p<0.05.

4. Conclusion and Recommendation

This study demonstrates the feasibility of producing infusion tea from banana peel, a waste product generated in large quantities (over 36 million tons annually). Our findings show that banana peel tea is rich in essential micronutrients like magnesium, copper, manganese, and potassium, particularly when combined with ginger. The brew's antioxidant properties, attributed to its flavonoid content, are enhanced by ginger addition. A 25% substitution of banana peel with ginger is recommended for optimal benefits. The results from this study also highlight the potential of banana peel tea as a sustainable and nutritious beverage option.

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