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Original Article

Evaluation of Nutritional composition of Roselle (*Hibiscus sabdariffa*) herbal Tea infused with Ginger (*Zingiber officinale*) and Lemon (*Citrus limon*) Peel

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ABSTRACT

Roselle calyces (*Hibiscus sabdariffa*), lemon (*Citrus limon*), and ginger (*Zingiber officinale*) are nutrient-dense crops that could be combined for herbal tea. Five herbal tea samples were prepared, namely, roselle without spice (RWS), roselle with ginger (RG1 and RG2), or with lemon peel (RL1 and RL2) at 25% and 50% inclusion. Microbial load, physicochemical, nutritional, antioxidant contents, and sensory analyses of the samples were performed using standard methods. Microbial load ranged from 2.7 to 3.5×10^6 colony-forming unit (CFU)/g; 2.9×10^5 to 1.1×10^6 CFU/g, and 5.1 to 7.2×10^5 CFU/g for total viable, *Salmonella-Shigella,* and fungal count, respectively. Values for pH ranged from 2.7 to 3.5; protein content ranged from 7.3% to 8.5%; and fiber ranged from 8.7% to 10.3%. Mineral content ranged from 3.05 to 3.75 mg/100 g, 869 to 911 mg/100 g, 20.3 to 22.5 mg/100 g, and 274 to 286.7 mg/100 g for iron, calcium, potassium, and magnesium, respectively. Ascorbic acid content of roselle tea samples ranged from 121.1 ± 2.4 mg/100 g to 138.01 ± 0.8 mg/100 g. Lycopene content ranged from 1.9 to 2.2 mg/100 g, while polyphenol content ranged from 31.2 to 41.3 mg/gallic acid equivalents/g and alkaloid content reduced with the addition of spice (1.8 to 2.8%). Panelists scored ROS higher than other infused teas in aroma (3.8) and general acceptability while roselle with 25% ginger (RG1) scored higher in color (4.3) and taste (3.9). In conclusion, the inclusion of ginger and lemon peels as spices could be an effective means of improving the nutrients and health benefits of roselle herbal tea.

Keywords: Ginger, herbal tea, lemon powder, roselle

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INTRODUCTION

Tea is a beverage consumed worldwide, either hot or cold depending on the consumer's preference.[1] It is generally accepted that next to water, tea is the most consumed beverage in the world,[2] and tea is majorly from the leaves of *Camellia sinensis* plant.[3] Recently, there is renewed interest in herbal teas which are considered to be caffeine free.

Herbal tea is an another important type of tea made from different raw materials such as spices, herbs, dried calyces, and dried fruit.[4] Roselle (*Hibiscus sabdariffa*) tea is an example of herbal tea. The red calyces of roselle contain antioxidants including flavonoids, hibiscetine, and sabdaretine[5] and also rich in riboflavin, ascorbic acid, niacin, carotene, calcium, and iron which are nutritionally important components.[6,7] Many polyphenols, particularly the flavonoids, have been documented to possess potent anti-inflammatory and antiviral activities.[7]

The health benefits of plant foods appear not to be simply attributable to their macro and/or micronutrient content alone but also to the presence of phytochemicals.[8] Furthermore, studies have shown that diets high in plant foods are associated with a lower risk of chronic diseases, such as cardiovascular disease.[5]

Ginger is the rhizome of the plant (*Zingiber officinale)* consumed as a delicacy, medicine, and spice. It is widely grown in Asia, Africa, India, Jamaica, Mexico, and Hawaii.[9] Ginger has beneficial effects toward cardiovascular disease through its

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multiple actions counteracting inflammation, hyperlipidemia, platelet aggregation, and hypertension.[10] It is also known for the alleviation of rheumatoid arthritis, osteoarthritis, joint, and muscle pain.[11]

Lemon (*Citrus limon*) peels are rich in nutrients such as dietary fiber and also contain many phytochemicals including β- and γ-sitosterol and glycosides.[12,13] Lemon peel is known for its anticancer properties due to its alkaloid content and also has antimicrobial properties.[14] Furthermore, it has high flavonoid content, which functions as direct antioxidant and free radical scavengers and also has the capacity to modulate enzymatic activities and inhibit cell proliferation.[15]

In developed countries, roselle calyces are used to produce several food (jams, jellies, syrup, and tea) products. In Nigeria, roselle, ginger, and lemon peels are underutilized plant materials in spite of the high micronutrient and phytochemical contents. Therefore, the objective of this study was to develop herbal teas with ginger or lemon peels and to analyze the nutritional composition of said herbal teas.

MATERIALS AND METHODS

Materials

Dry calyces of roselle (*H. sabdariffa*), fresh ginger rhizomes (*Z. officinale*), and ripe fresh lemon fruits (*C. limon*) were obtained form Odo-Ori market in Iwo, Osun state, Nigeria, and immediately transported to the Food Science Laboratory at Bowen University. The raw materials were manually sorted to get rid of unhealthy fruits and rhizomes. The samples were cleaned to remove dirt and unwanted materials and washed thoroughly with potable water. The samples were all air-dried at room temperature (32 ± 2°C) for 12 h.

Methods

Preparation of roselle, ginger, and lemon peel powder

Shade dried roselle calyces, ginger, and lemon peels were separately milled with a grinder (Binatone grinder BLG-450/451, Nigeria) until a smooth powder was obtained. The powders were sieved with a mesh size of 200 μ according to Joseph and Adogbo.[4] The resulting powders were stored in a zip lock bag in the laboratory at room temperature (32 ± 2°C) until used.

Preparation of roselle (H. sabdariffa) herbal tea

After milling and sieving, five variations of roselle herbal tea samples were prepared. Details of the various sample formulations are presented in Table 1. All samples were packaged in tea bags and stored at ambient temperature.

Table 1: Formulation for infused roselle herbal tea production

Herbal tea samples	Roselle powder	Ginger powder	Lemon peel powder
ROS (control)	100	0	0
RG1	75	25	0
RG2	50	50	0
RL1	75	0	25
RL2	50	0	50

ROS: 100% roselle tea, RG1: 75% roselle and 25% ginger powder, RG2: 50% roselle and 50% ginger powder, RL1: 75% roselle and 25% lemon peel powder, RL2: 50% roselle and 50% lemon peel powder

Microbiological Analysis

Microbial analysis was carried out on the raw materials: Roselle calyces (*H. sabdariffa*), ginger (*Z. officinale*), and lemon (*C. limon*) peels. About 1 g of each raw material was weighed into 9 mL of peptone water (HiMedia Lab., India) and further diluted up to 10^{-4} as described by Ogbuile *et al*.[16] Using the pour plate method, 1 mL from the last dilution of each sample was plated in plate count, *Salmonella-Shigella,* and potato dextrose agar and was incubated at 37°C for 24 h. Potato dextrose agar plates were incubated at 28°C for 72–96 h. The numbers of colonies were observed and enumerated.

Physicochemical Analyses

Tea samples were prepared using approximately 100 mL of boiled water (100°C) and a tea bag for each sample. It was allowed to extract for about 3 min and allowed to cool for 10 min before analyses. About 10 mL of each sample in triplicate was used for pH (PHS-98108, Hanna) analysis following Adelekan *et al*.[17] Total titratable acidity (TTA) was carried out according to Akanbi *et al.*[18] and was expressed as percentage malic acid according to Jabeur *et al.*[19] who reported that malic acid is the predominant acid in roselle calyces. Total soluble solids (TSSs) of the unsweetened herbal teas were determined according to the Association of Official Analytical Chemist,[20] using a handheld refractometer (Erma Handheld Refractometer, China), and reported as °Brix.

Nutritional Content of Infused Roselle Herbal Teas

Proximate analysis

Moisture, ash, crude protein, crude fiber, and fat contents were determined according to the Association of Official Analytical Chemists.[21]

Determination of mineral content

The mineral content (Ca, K, Mg, and Fe) was determined following the method of Association of Official Analytical Chemists.[21] Using atomic absorption spectrophotometer (PG 990, United Kingdom), the sample for calcium (Ca), magnesium (Mg), and iron (Fe) was read at wavelengths of 422.7 nm, 285.2 nm, and 510 nm, respectively. The potassium content (K) was determined by flame photometry method using a flame photometer (Jenway PFP7, United Kingdom) at a wavelength of 766.4 nm.

Determination of Phytochemical Content

Lycopene content

Lycopene content was determined according to the Association of Official Analytical Chemists.[21] Briefly, about 0.6 g of the sample was weighed into a 50 mL centrifuge tube and was covered with aluminum foil. Approximately 5 mL of 0.05% of butylated hydroxytoluene was added. Then, 5 mL of 95% ethanol was added, followed by the addition of 10 mL hexane and thoroughly mixed. After mixing, 3 mL of cold distilled water was added. The solution was read at an absorbance of 503 nm using a spectrophotometer (PG 990, United Kingdom). Lycopene content was calculated:

$$\text{Lycopene}\left(\text{mg}/100\,\text{g}\right)=\frac{A_{503}\times 31.2}{\text{Weight of sample}}\times\frac{100}{1}$$

Where, A=Absorbance
31.2=Absorption coefficient of lycopene.

Ascorbic acid content

The standard solution was prepared by dissolving about 0.05 g of ascorbic acid in 50 mL of oxalic acid. The solution was thoroughly mixed and 1 mL, 2 mL, 3 mL, 4 mL, and 5 mL aliquot were pipetted into a test tube, respectively. About 1 mL of dye (2,2-dichloroindophenol) was also measured into the test tube. Each solution was made up to 9 mL with distilled water and was read at absorbance wavelength of 515 nm. Ascorbic acid was calculated using ascorbic acid standard curve. Ascorbic acid content was determined according to Junior and Malavolta.[22] About 0.5 g of sample was weighed and dissolved in 10 mL of oxalic acid. About 1 mL of the solution (extract) was further dissolved in 8 mL of distilled water and 1 mL of dye was added. It was read on a spectrophotometer (PG 990, United Kingdom) at absorbance wavelength of 515 nm.

Alkaloid content

Alkaloid content was determined as described by Harbone.[23] About 5 g of sample was weighed in a volumetric flask and 200 mL of 10% acetic acid in ethanol was added. The solution was covered and allowed to stand for 4 h at room (32 ± 2°C) temperature. Solution was filtered using Whatman 110 mm filter paper. The filtrate was concentrated by heating to about one-quarter of the original volume. Then, few drops of concentrated ammonium hydroxide were added to precipitate the alkaloid. The precipitate was filtered through a weighed filter paper (W_1), which was placed in the oven (Universal Hot Air Oven, England) with its temperature at 60–80°C and allowed to dry for 1 h. The filter paper was removed and placed in the desiccator to cool. It was weighed and recorded as W_2 and the percentage alkaloid was calculated:

$$\%\ \text{Alkaloid}=\frac{W_2-W_1}{W_1}\times\frac{100}{1}$$

Where, W_1=Initial weight of filter paper
W_2=Weight of filter paper after drying.

Total Polyphenol Content (TPC)

TPC was determined according to Singleton and Rossi, 1965.[24] About 2 mL of each sample, in triplicate, were pipetted into test tubes and 1 mL of 0.2N Folin–Ciocalteu reagent and 0.8 mL of 7.5% sodium carbonate solution were added. The solution was thoroughly mixed and allowed to stand for 30 min in the dark at room (32 ± 2°C) temperature. Absorption was measured on an ultraviolet–visible spectrophotometer (PG 990, United Kingdom) at 765 nm. The total phenolic content was expressed as gallic acid equivalents (GAEs) in milligrams per gram dry material.

Sensory Evaluation

Roselle tea samples were scored by 15 member panel, comprising young adults (20–27 years) and older adults (40–68 years). Each tea bag was extracted in 100 mL of hot boiling (100°C) water for 3 min. Then, 5 g of sugar was added to taste and the samples were coded. Approximately 40 mL of each herbal tea sample was served randomly and panelists were instructed to score on a 5-point Hedonic scale, where 1 = Dislike extremely, 2 = Dislike moderately, 3 = Neither like nor dislike, 4 = Like moderately, and 5 = Like very much.[25] The attributes for scoring included color, taste, aroma, and general acceptability of the product.

Statistical Analysis

Data from microbial load, physicochemical, proximate, antioxidants, and sensory analyses were analyzed using descriptive statistics, Analysis of variance with a *post hoc* Duncan new multiple range test in IBM SPSS Statistics[26] 20.0 version at $P < 0.05$ significant level.

Table 2: Microbial load (CFU/g) of raw materials used in roselle herbal tea production

Sample	Total viable	*Salmonella/Shigella*	Total fungi
Dried roselle calyces	$3.5\pm0.06\times10^6$	$1.5\pm0.02\times10^5$	$5.1\pm0.13\times10^5$
Dried lemon peels	$3.5\pm0.01\times10^6$	$1.3\pm0.01\times10^6$	$5.4\pm0.2\times10^5$
Dried ginger	$2.7\pm0.04\times10^6$	$5.9\pm0.1\times10^5$	$7.2\pm0.04\times10^5$

Values are mean of duplicate, Duncan separation of means with same alphabets is not different (P<0.05) in each row.
CFU/g: Colony-forming unit/g

RESULTS AND DISCUSSION

Microbial Load (Colony-Forming Unit [CFU]/g) of Raw Materials Used for Tea Samples

The microbial load of the individual raw materials before bagging into teas is presented in Table 2. Overall, there was growth on the different agars used. Total viable count ranged from 2.7 to 3.5 × 10^6 CFU/g. *Salmonella-Shigella* count ranged from 1.5 × 10^5 to 1.3 × 10^6 CFU/g, and total fungal ranged from 5.1 to 7.2 × 10^5 CFU/g. Dried roselle calyces had the lowest *Salmonella-Shigella* and fungal counts compared to dried ginger and lemon peels. Contamination of the materials could be due to the exposure to air, soil, and debris at the market.[27,28] The microbial load is within allowable limit for tea (*C. sinensis*) (aerobic plate count – ≤10^7/g; yeast/mold ≤10^4/10^5/g; *Escherichia coli* ≤10^2/g and *Salmonella* absent in 125 g) (European Tea Committee, 2018).[29]

Physicochemical Properties of Roselle Herbal Tea

The results of pH, TTA, and TSS (°Brix) of the tea samples are presented in Table 3. The pH values ranged from 2.7 ± 0.01 to 3.6 ± 0.07. The roselle tea without spice (reactive oxygen species [ROS]) had the lowest pH value. However, it was observed that the addition of the spices (ginger and lemon peels) at different variations increased the pH value slightly.

Table 3: Total titratable acidity and total soluble solids of roselle herbal tea samples

Tea sample	pH	TTA (%)	TSS (°Brix)
ROS	2.7±0.01	0.01±0.00	7.00±0.00
RG1	3.4±0.01	0.007±0.00	7.00±0.00
RG2	3.3±0.01	0.004±0.00	7.00±0.00
RL1	3.5±0.02	0.004±0.01	7.00±0.00
RL2	3.6±0.01	0.007±0.00	7.00±0.00

Values are mean±standard deviation of triplicate, Duncan separation of means with same alphabets is not different (P<0.05) in each row. ROS: Roselle powder (100%), RG1: Roselle:ginger powder (75%:25%), RG2: Roselle:ginger powder (50%:50%), RL1: Roselle:lemon peel powder (75%–25%), and RL2: Roselle:lemon peel powder (50%:50%)

The pH of spiced roselle teas is within the range of each other (3.3–3.6) but significantly different (P < 0.05) from roselle without spice (ROS). The pH values of roselle tea from this study agree with Babalola *et al*.[6] who reported that roselle drink is a high acid food. *H. sabdariffa* is a rich organic plant, rich in oxalic and malic acid.[30] Furthermore, Zobo drink another product from roselle has been reported to have acidic pH. For example, it was observed that the pH of the fruit-flavored Zobo drinks had a low pH value of 2.19 and 3.64.[30,31] Adesokan *et al*.[32] also reported that roselle juice is slightly acidic and should not be consumed without snack or on an empty stomach. The TTA ranged from 0.004 ± 0.00 to 0.01 ± 0.00% and was not significantly different at P < 0.05. This agrees with the report of Bolade *et al*.,[33] which states that the TTA of roselle drink is relatively low and it is a reflection of low pH values. The TSS for all unsweetened tea samples was 7°Brix. The values from the study contradict Fasoyiro *et al*.[30] who reported that roselle drink has a soluble solid of 3.20°Brix and Omemu *et al*.[34] reported 11.2–13.3°Brix after the addition of varied amount of sugar. However, this study did not add any sweetener to the samples for this analysis.

Proximate Composition of Roselle Herbal Tea Samples

Results of the nutritional composition of roselle herbal tea samples are presented in Table 4. Roselle tea without spice (ROS) had a slightly higher moisture content of 8.12% and all the values were significantly different (P < 0.05). The values from this study contradict the result of Mohamed *et al*.[35] who reported that roselle tea leaves contain a maximum moisture content of 15%. The ash content ranged from 10.0 ± 0.02 to 10.3 ± 0.06%. Babalola[6] reported that roselle calyces contain a high amount of minerals such as iron, calcium, potassium, and magnesium, which contributed to the high ash content.

The protein content ranged from 7.3 ± 0.05 to 8.5 ± 0.1%. RL2 had the highest protein content while RG2 had the lowest. There were significant differences (P < 0.05) between RL2 sample and other herbal teas. Mohammed *et al*.[36] observed that protein content of roselle calyces was 7.44%, the result obtained in this study is within range of that report. The result indicates

Table 4: Proximate composition (%) of roselle herbal tea and roselle composite tea samples

Sample	Moisture	Ash	Protein	Fat	Fiber
ROS	8.12±0.03	10.2±0.05	8.3±0.06	0.54±0.04	9.7±0.03
RG1	7.92±0.03	10.2±0.05	7.6±0.3	0.46±0.04	8.7±0.04
RG2	8.02±0.03	10.3±0.06	7.3±0.50	ND	10.3±0.02
RL1	8.00±0.03	10.0±0.02	8.0±0.1	0.50±0.02	9.0±0.04
RL2	8.06±0.02	10.1±0.02	8.5±0.1	ND	9.3±0.04

Values are mean±standard deviation of triplicate, Duncan separation of means with same alphabets is not different (P<0.05) in each row. ROS: Roselle powder (100%), RG1: Roselle:ginger powder (75%:25%), RG2: Roselle:ginger powder (50%:50%), RL1: Roselle:lemon peel powder (75%–25%), RL2: Roselle:lemon peel powder (50%:50%), ND: Not determined that roselle tea samples are a good source of plant protein. According to Berrazaga *et al*.,[37] plant-sourced proteins offer environmental and health benefits. The fat content of roselle tea samples ranged from 0.46 ± 0.04 to 0.54 ± 0.04%. The control (ROS) had the highest fat content with value (0.54 ± 0.04%), while sample RG2 had the lowest fat content. Plant foods are not significant sources of fat in human diet. The values for fiber content ranged from 8.7 ± 0.04 to 10.3 ± 0.03%.

Mineral Content of Roselle Herbal Tea Samples

Overall, all the roselle tea samples had high mineral (iron, calcium, potassium, and magnesium) content. However, the mineral contents of roselle herbal teas with the inclusion of spice were observed to be higher and significantly different (P < 0.05) from plain roselle tea, as shown in Table 5. The mineral content ranged from 3.1 ± 0.04 to 3.8 ± 0.01 mg/100 g, 869.4 ± 2.7 to 911.0 ± 0.4 mg/100 g, 20.3 ± 0.03 to 22.5 ± 0.03 mg/100 g, and 274.2 ± 1.1 to 286.7 ± 0.4 mg/100 g for iron, calcium, potassium, and magnesium, respectively. Herbal tea with ginger infusion has high iron content compared to the tea with lemon peel in this study. Furthermore, Morton[38] previously reported that ginger could be used as a supplement for anemia because it contains a substantial amount of iron.

Table 5: Mineral content (mg/100 g) of roselle herbal tea and roselle composite tea samples

Sample	Iron	Calcium	Potassium	Magnesium
ROS	3.75±0.08	869.4±2.73	20.3±0.03	278.3±1.23
RG1	3.79±0.01	901.5±1.01	21.9±0.03	274.2±1.09
RG2	3.6±0.05	874.2±1.94	21.8±0.03	286.0±0.57
RL1	3.05±0.04	911.0±0.37	21.4±0.15	275.6±1.04
RL2	3.14±0.02	906.6±1.08	22.5±0.03	286.7±0.42

Values are mean±standard deviation of triplicate, Duncan separation of means with same alphabets is not different (P<0.05) in each row. ROS: Roselle powder (100%), RG1: Roselle:ginger powder (75%:25%), RG2: Roselle:ginger powder (50%:50%), RL1: Roselle:lemon peel powder (75%–25%), RL2: Roselle:lemon peel powder (50%:50%)

Table 6: Antioxidant content of roselle herbal tea and roselle composite tea samples

Sample	Ascorbic acid (mg/100 g)	Lycopene (mg/100 g)	Alkaloid (%)	Polyphenol (mg/GAE/g)
ROS	133.8±1.82	1.9±0.03	2.8±0.05	41.3±0.39
RG1	135.0±0.20	2.1±0.06	2.54±0.4	38.7±0.65
RG2	138.0±0.78	2.1±0.03	2.36±0.01	39.9±0.44
RL1	121.1±0.46	2.2±0.02	1.83±0.04	31.2±0.95
RL2	126.1±1.16	2.1±0.01	2.58±0.2	34.6±0.21

Values are mean±standard deviation of triplicate, Duncan separation of means with same alphabets is not different (P<0.05) in each row. ROS: Roselle powder (100%), RG1 Roselle:ginger powder (75%:25%), RG2: Roselle:ginger powder (50%:50%), RL1: Roselle:lemon peel powder (75%–25%), RL2: Roselle:lemon peel powder (50%:50%)

All tea samples with spice inclusion at different variations had high calcium content as compared to the tea without spice. Roselle herbal tea infused with 25% lemon peels (RL1) had the highest calcium content (911.0 ± 0.4 mg/100 g) while the ROS had the lowest value of 869.4 ± 2.7 mg/100 g. This agrees with Adelekan *et al*.[17] who reported that calcium is the most abundant mineral in lemon juice and peel. Furthermore, Pourmorad *et al*.[39] also reported that calcium was the highest occurring mineral in citrus fruit. In this study, the inclusion of lemon peel powder resulted in an increase in calcium level.

Antioxidant Content of Roselle Tea Sample

The values for the antioxidant content ranged from 121.1 ± 0.5 to 138.01 ± 0.8 mg/100 g [Table 6]. Although sample RG2 had the highest ascorbic acid content, all the tea samples are also important sources of Vitamin C. The lycopene content ranged from 1.9 ± 0.0 to 2.2 ± 0.02 mg/100 g. It was observed that roselle tea samples with spice had higher lycopene content compared to the control roselle tea (ROS).

The polyphenol content ranged from 31.2 ± 1.0 to 41.3 ± 0.39 mg GAE/g. The control roselle tea (ROS) had the highest value (41.3 mg GAE/g), but herbal teas with ginger and lemon peels also were close in values to the control. The alkaloid content of the roselle tea samples ranged from 1.8 to 2.8%. ROS has the highest alkaloid content, while RL1 had the least. The alkaloid content of roselle calyces (ROS) in this study is within the range of 2.14% reported by Okereke *et al*.,[40] and alkaloids have been documented to have antioxidant activity.[41]

Sensory Evaluation of Roselle Tea

Using 5-point Hedonic scale, RG1 was scored the highest for color (4.3 ± 0.62) and taste (3.9 ± 0.74), as presented in Figure 1 and Table 7. Overall, there were significant differences (P < 0.05) in scores for color, taste, and general acceptability of the tea samples but not in aroma. For aroma, the score ranged from 3.3 ± 0.96 to 3.8 ± 0.87, while for the general acceptability,

Table 7: Spearman's ρ correlation coefficient between general acceptability and type of tea and other sensory attributes

	Color	Aroma	Taste	Treatment	Age
General acceptability	ρ(75)=0.298** (P<0.009)	ρ(75)=0.435** (P<0.000)	ρ(75)=0.747** (P<0.000)	ρ(75)=−0.314** (P<0.006)	ρ(75)=0.148 (P<0.204)

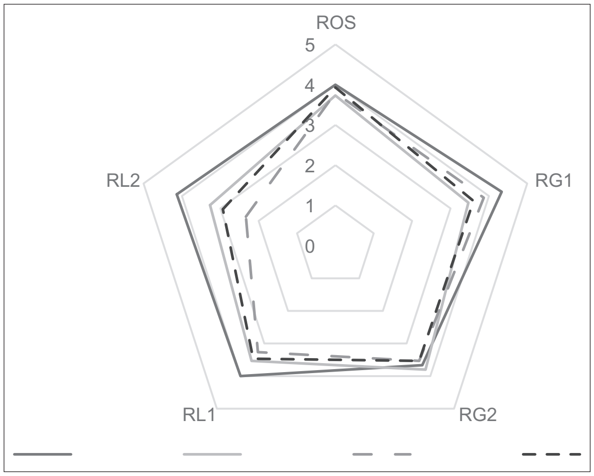

Figure 1: Sensory attributes of roselle herbal teas. ROS: Roselle powder (100%), RG1: Roselle: ginger powder (75%:25%), RG2: Roselle: ginger powder (50%:50%), RL1: Roselle: lemon peel powder (75%–25%), and RL2: Roselle: lemon peel powder (50%:50%)

control roselle tea (ROS) had the highest score (3.9 ± 0.88), while RL2 was scored low (2.9 ± 1.18).

Calculated Spearman correlation coefficient results show that there are relationships between the general acceptability and the sensory attributes such as type of herbal tea, color, aroma, and taste. A strong and significant correlation ($P < 0.01$) was found between these variables, while the relationship between general acceptability and age was weak.

CONCLUSION

The use of lemon and ginger in the enrichment of roselle herbal tea production is essential as it increases the macro- and micronutrient compositions of the teas. This study has shown that the use of spices at different variations increased the pH value, thereby reducing the acidic contents of the tea samples. Furthermore, results show that roselle tea is a great source of antioxidants such as ascorbic acid and minerals (iron, calcium, potassium, and magnesium). Sensory evaluation of the tea samples showed that ROS was more acceptable (3.93), roselle herbal tea with 25% ginger (RG1) scored higher in color and taste.

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