



Quality Evaluation of Herbal Tea Blends from Ginger and *Pavetta crassipes*

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Authors' contributions

This work was carried out in collaboration between all authors. Author JSA was the supervisor and authors ARI and TAY carried out the project work including design of the study and the draft of the manuscript. Author JF performed the statistical analysis while author ICA managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Tea-like product (green tea) was developed using ginger (*Zingiber officinale*, Rose) and *Pavetta crassipes* k. schum blends. Samples were blended in the following ratios (ginger/pavetta): 100/0 (sample A), 80/ 20 (sample B), 60/40 (sample C), 40/60 (sample D) and 20/80 (sample E). The physicochemical, phytochemical, antinutritional and sensory properties of the formulations were investigated. Results showed that increase in *Pavetta crassipes* level in the formulation significantly ($P < 0.05$) increased protein (8.35 - 10.67), fat (4.6 - 6.31) and carbohydrate (17.99 - 47.38) contents. However, moisture content, ash content and crude fibre significantly decreased ($p \leq 0.05$) from 8.72 - 7.54, 1.96 - 1.67 and 58.13 - 26.43 respectively. The micronutrients including Ca increased significantly while Mg decreased with increased *Pavetta crassipes*. Vitamin C content also increases significantly. The supplementation of *Pavetta crassipes* leaf powder also decreased significantly ($P < 0.05$) the level of anti-nutrients including oxalates, total phenol and alkaloids while phytates content increased significantly ($P < 0.05$). Na_2CO_3 , K_2CO_3 alkalinity and acid insoluble ash decreased significantly from 7.66 - 6.21, 11.23 - 8.32 and 57.93 - 27.36 respectively. There was

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no significant difference ($p \leq 0.05$) between all the samples and Lipton tea (sample F). Sample C were generally more accepted.

Keywords: *Ginger; Pavetta crassipes; tea-like product; phytochemical and physicochemical.*

1. INTRODUCTION

Tea is an aromatic beverage commonly prepared by pouring hot or boiling water over leaves of the tea plant (*Camelia sinensis*) [1]. After water, tea is the most widely consumed beverage in the world [2]. It has a cooling, slightly bitter, and astringent flavour that many people enjoy [3]. Tea has historically been promoted for having a variety of positive health benefits and recent human studies suggest that green tea may help reduce the risk of cardiovascular disease and some forms of cancer [4]. Tea also promote oral health, reduce blood pressure, helps with weight control, improve antibacterial and antivirasic activity, provide protection from solar ultraviolet light [5], increase bone mineral density and have "anti-fibrotic properties and neuro-protective power [6].

Herbal tea is a term used for any non-caffeinated beverage made from the infusion or decoction of herbs, spices or other plant material in water. These drinks are distinguished from caffeinated beverages like coffee and the true tea (black, green, white, yellow, oolong, etc.) or from a decaffeinated tea, in which the caffeine has been removed. In addition to serving as a beverage many are also consumed due to a perceived medicinal benefit [7].

Pavetta crassipes is a low shrub of the savannah [8]. In Nigeria, the leaves are eaten by some native tribes pounded with other foods, or boiled in the slightly fermented water in which cereals have been left to steep, and mixed with pap. The leaves of this plant are used medicinally in the management of respiratory infections and abdominal disorders [9]. In Central Africa, the acid infusion of the leaves is taken as a cough remedy [10,9]. The *P. crassipes* leaves extract are effective agents against infectious diseases and other diseases such as cancers, diabetes, cardio-vascular, neurological, respiratory disorders [11]. The leaves have content of selected minerals, vitamins and essential amino acids which are used as a preventive measure against diseases and other infection as well as nourishment of the body. Extract of Alkaloids from the leaves has been shown to have significant anti-malaria activities [12,13]. [8] reported that *Pavetta crassipes* leaves showed

activity against some pathogenic microorganisms which included *Streptococcus pyogenes*, *Corynebacterium ulcerans*, *Klebsiella pneumoniae*, *Neisseria gonorrhoeae*, *Pseudomonas aeruginosa*, and *Escherichia coli* at a concentration < 50 mg/mL.

Ginger (*Zingiber officinale*, Rose) is a major crop grown primarily in central Asia, China and Pakistan and exported worldwide. Ginger is a well-known plant and is widely used as a spice and medical treatment for certain ailments in traditional medicine. Ginger is usually available in three different forms: fresh (green), root ginger, preserved ginger spice. Ginger contains gingerol- an oleoresin (combination of volatile oils and resin) that accounts for the characteristic aroma and therapeutic properties [14,15].

Due to the high content of micronutrients and important phytochemicals, ginger and *Pavetta crassipes* are good candidates for production of composite tea. According to [16], indigenous herbs are in general heavily under-exploited in spite of their huge dietary potential. It is therefore imperative to explore the potential of indigenous plant materials in the development of new herb tea. It is therefore necessary to combine *Pavetta crassipes* with other herbs such as ginger in developing herb tea with an improved mouth feel and sensory appeal. This is crucial because consumers are generally unwilling to buy food with poor sensory appeal, irrespective of health or nutritional benefits. In view of this, this paper aims at investigating the quality attributes and aesthetic appeal of green tea produced from the blends of ginger and *Pavetta crassipes*

2. MATERIALS AND METHODS

2.1 Sources of Material

The leaves of *Pavetta crassipes* were obtained from Ukum Local Government Area of Benue State, and the Ginger rhizomes were purchased from North Bank market Makurdi.

2.2 Sample Preparation

The *Pavetta crassipes* leaves and ginger rhizomes were washed thoroughly, steamed and sundried. Thereafter, milled and stored in an air

tight container until ready for analysis. Samples were further blended in the following ratios (ginger/pavetta): 100/0 (sample A), 80/ 20 (sample B), 60/40 (sample C), 40/60 (sample D) and 20/80 (sample E).

2.3 Proximate Composition

The proximate composition was determined after sun drying. Moisture, ash content, protein, fat, fibre, carbohydrate were determined using [17].

2.4 Determination of Chemical Properties of Tea

2.4.1 Determination of water soluble ash

The ash contained in the dish was boiled with 25 cm³ distill water and the liquid filtered through an

ash-less filter paper and thoroughly washed with hot distill water. The filter paper was then ignited in the original dish, cooled and the water insoluble ash weighed.

$$\begin{aligned} \text{Water soluble ash (\%)} \\ = \text{total ash (\%)} - \text{water insoluble ash (\%)} \end{aligned}$$

2.4.2 Determination of acid insoluble ash

The ash was boiled with 25 cm³ dilute hydrochloric acid (10% v/v HCL) for 5 minutes; the liquid was filtered with hot water. The filter paper was then ignited in the original crucible, cooled and weighed [18].

$$\text{Acid insoluble ash (\%)} = \frac{\text{Acid insoluble ash} \times 100}{\text{weight of sample}}$$

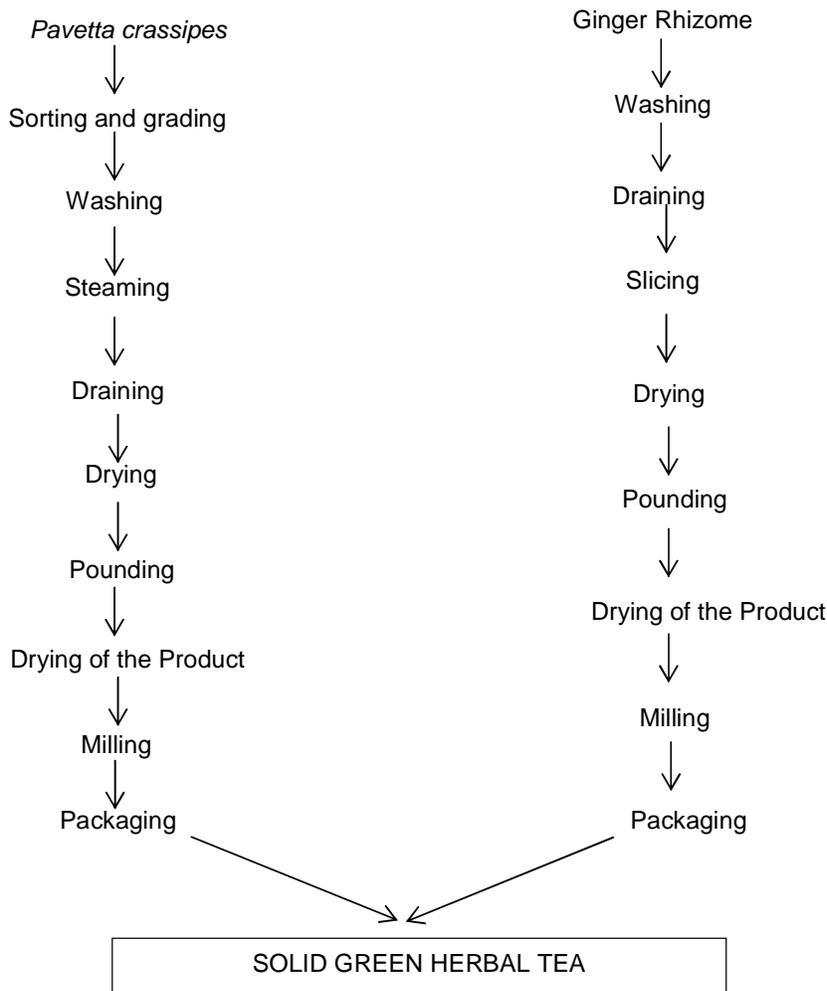


Fig. 1. Production flowcharts for *Pavetta crassipes* and ginger

2.4.3 Determination of alkalinity of soluble ash

The filtrate obtained from the water soluble ash was cooled and filtrated with 0.1 M hydrochloric acid using methyl orange indicator, the alkalinity of the soluble ash was determined by the method described by [19]. The alkalinity was expressed as cm^3 molar acid/100 g sample

i. Potassium trioxocarbonate(iv), K_2CO_3 alkalinity

The alkalinity, cm^3 M acid/100 g sample value as obtained in alkalinity soluble ash determination was multiplied by 0.053 to get the Na_2CO_3 alkalinity.

ii. Sodium trioxocarbonate(iv), Na_2CO_3 alkalinity

The alkalinity cm^3 M acid/100 g sample value as obtained in alkalinity soluble ash determination was multiplied by 0.53 to get the Na_2CO_3 alkalinity.

2.5 Anti-nutrients

2.5.1 Phytate determination

The phytate content of the sample was determined using the method described by [20]. 2 g of sample was dissolved in 40 ml of 0.5 M of nitric acid for 1hr. It was filtered and 0.5 M of standard ferric chloride solution (2 ml/L) was added to the filtrate and incubated for 20 minutes at 100°C. This was again filtered with 3 ml of 0.004 M Ammonia thiocyanate added to the filtrate. The filtrate remains in the solution were read on a spectrophotometer at 600 nm.

2.5.2 Determination of oxalate

Oxalate was estimated according to the procedure of [21]. 1 g of sample was added into 75 ml of 1.5 N H_2SO_4 . The solution was carefully stirred intermittently with a magnetic stirrer for about 1 hour and filtered using Whatman No 1 filter paper. A 25 ml volume of the filtered extract was collected and titrated while hot (80 - 90°C) against 0.1 N KMnO_4 solution to the point where a faint pink colour appeared that persist for at least 30 secs.

3. SENSORY EVALUATION

Solid Herbal tea blend will be subjected to hot water treatment in a clean container for 6mins to

soften the leaves for adequate infusion and release of flavors. Stir for even circulation of the flavor. Sensory evaluation on the infusion was conducted. Fifty (50) panelists (32 female; 18 male) students were recruited for the tests. Panelists were mostly students aged between 18 and 24 years with few university staff. The number of panelists was decided based on sensory evaluation guidelines [22]. Specific sensory characteristics of each recipe (Color, Bitterness, Astringency, Aroma and Overall acceptability) were rated separately on a scale of 1 to 5. Scores were defined as follows: (1) dislike very much; (2) dislike slightly; (3) like slightly (4) like; (5) like very much. Numerical averages were then calculated for a composite test score.

3.1 Statistical Analyses

Data obtained was analyzed by analysis of variance (ANOVA) using a split-split plot model according to the methods of [23] When significant is ($P < 0.05$).

4. RESULTS AND DISCUSSION

4.1 Proximate Analysis

Table 1 showed the proximate composition of green tea produced from ginger and *Pavetta crassipes*. Crude protein increased from 8.82 – 10.67% with increase in percentage of pavetta from 20 to 80% (samples B to E) and higher than 8.35% for sample A (control, 100% ginger). [24] also reported that *Pavetta crassipes* contains high amount of protein of up to 15% and with a range of amino-acids most especially Aspartic acid, Glutamic acid and Leucine. Proteins play many vital roles in the human body, including providing structure and strength to cells and tissues, controlling biochemical reactions and aiding the immune system, it also regulate cell division, which acts to slow ageing and replace damaged cells to ensure a constant supply of healthy cells. Increase in protein due to pavetta addition improves the nutritive value of ginger tea already in the market. The crude fat content of the formulation increased with additions of the *Pavetta crassipes* leaf powder. Whereas sample A (control) with 100% ginger powder contained 4.86% fat, that of sample B to E increased from 4.93 to 6.31%. The increment in crude fat of the formulation may be due to its high content in *Pavetta crassipes*. [25] also reported moderate presence of crude fat in *P. crassipes* proximate. Fat helps the body maintains its core temperature, absorbs nutrients and provides human with energy.

The level of crude fibre in the sample decrease significantly with increase addition of the *P. crassipes* leaf powder from 58.13% to 26.43%. This can be attributed to lower content of crude fiber in *P. crassipes*. [25] showed that *P. crassipes* has a lower content of crude fibre. Fiber binds water in the intestine in the form of a gel and ensures that the stool is bulky and its passage through the intestine is not delayed. Ash content also followed the same trend as crude fibre decreasing from 1.95 to 1.69% with increase in *P. crassipes*. Similarly, the moisture content of the formulation also decreased from 8.7 to 7.54 with an increase in *P. crassipes*. This gives positive indication of improved storability. Carbohydrate profile of the formulation showed an increase from 17.99 to 47.38% with an increase in *P. crassipes* concentration. This may be to high carbohydrate content in *P. crassipes*. [24,25] reported that *P. crassipes* has a high content of carbohydrate. Carbohydrate are needed for the central nervous system, kidneys, brain, muscles and including the heart to function properly and as source of energy for the body.

4.2 Vitamin C, Magnesium and Calcium

Minerals and vitamin C content of the samples are shown in Table 2. There was significant difference ($P < 0.05$) in Vitamin C content among

the samples, showing increases with increase in *P. crassipes* percentage in the formulation. Sample E has the highest value of Vitamin C of value 172.65 mg/100 g while sample A has the lowest value of 136.26 mg/100 g. *P. crassipes* has high Vitamin C [24] and therefore responsible for observed trend. The tea can therefore serve as antioxidant due to its high vitamin C and improvement on the health of its consumers. Virtually all the samples formulations showed significant difference ($P < 0.05$) in micronutrients tested. The Calcium content increased from 215.77 to 255.85 mg/100g due to addition of pavetta. However, this increase falls below Recommended Daily Allowance (RDA) of 1,000 mg for adults and children aged 4 years and older. Magnesium of the sample decreases with increase in *P. crassipes*, ranging from 111.64 to 51.65 with highest value in sample A and the lowest was in sample E. The magnesium falls below the Recommended Daily Allowance (RDA) of 420 mg/day for men and 310 mg/day for women.

4.3 Antinutrient

Table 3 showed significant difference in the phytochemical composition of the samples. The oxalates level decreased with increased level of *P. crassipes* leaf powder. This is because ginger has higher level of oxalates. Dietary oxalates

Table 1. The proximate composition of herbal produced from ginger and *Pavetta crassipes*

Parameter	Samples (%)					LSD
	A	B	C	D	E	
Crude protein	8.35±0.01 ^e	8.82±0.01 ^d	9.75±0.01 ^c	10.07±0.02 ^b	10.67±0.01 ^a	0.02
Fat	4.86±0.02 ^e	4.93±0.01 ^d	5.14±0.02 ^c	5.62±0.01 ^b	6.31±0.02 ^a	0.02
Crude fibre	58.13±0.02 ^a	41.65±0.02 ^b	35.82±0.02 ^c	28.76±0.02 ^d	26.43±0.02 ^e	0.03
Ash	1.95±0.01 ^a	1.84±0.02 ^b	1.77±0.01 ^c	1.73±0.01 ^d	1.67±0.02 ^e	0.02
Moisture	8.72±0.02 ^a	8.27±0.02 ^b	8.15±0.02 ^c	7.87±0.02 ^d	7.54±0.01 ^e	0.03
CHO	17.99±0.03 ^e	34.49±0.04 ^d	39.27±0.19 ^c	46.64±1.18 ^b	47.38±0.04 ^a	0.97

Values are means + S. D mean values within the same row with same superscript are not significantly different ($P < 0.05$).

Key: 100% Ginger and 0% *Pavetta crassipes* for sample A; 80% Ginger and 20% *Pavetta crassipes* for sample B; 60% Ginger and 40% *Pavetta crassipes* for sample C; 40% Ginger and 60% *Pavetta crassipes* for sample D; 20% Ginger and 80% *Pavetta crassipes* for sample E; LSD: Least Significant Difference

Table 2. Vitamin C and minerals in the herbal produced from ginger and *Pavetta crassipes*

Nutrients (mg/100 g)	Samples					LSD
	A	B	C	D	E	
Vitamin C	136.26±0.02 ^e	144.24±0.02 ^d	151.64±0.02 ^c	163.74±0.02 ^b	172.65±0.03 ^a	0.04
Ca	215.77±0.02 ^e	226.15±0.04 ^d	236.24±0.03 ^c	245.66±0.04 ^b	255.85±0.03 ^a	0.06
Mg	111.64±0.03 ^a	81.64±0.03 ^b	62.75±0.04 ^c	57.16±0.03 ^d	51.65±0.04 ^e	0.06

Values are means + S. D mean values within the same row with same superscript are not significantly different ($P < 0.05$)

Key: 100% Ginger and 0% *Pavetta crassipes* for sample A; 80% Ginger and 20% *Pavetta crassipes* for sample B; 60% Ginger and 40% *Pavetta crassipes* for sample C; 40% Ginger and 60% *Pavetta crassipes* for sample D; 20% Ginger and 80% *Pavetta crassipes* for sample E; LSD: Least Significant Difference

have been known to form complexes with calcium, magnesium and iron leading to the formation of insoluble oxalate salt and resulting on oxalate stone resulting to reduction in absorption of important nutrients. Reduced oxalate in the tea due to increase in percentage of pavetta is positive indication of the nutritional quality of the tea. The phytate content in the samples was significantly differed ($P < 0.05$) across board, increasing with increase in concentration of *P. crassipes*. The highest concentration was observed in sample E, having the value of 3.71 mg/100 g. Bioavailability of nutrients such as iron, zinc and calcium in the green tea can be high if phytate level is lower than 2%. The result of this work show phytates values slightly above 2%.

A significant difference ($P < 0.05$) in phenolics was observed among the samples. The values ranged from 4.53 – 0.53 mg/100 g and decreased in samples as more *P. crassipes* leaf powder was added to ginger. However, concentrations of the total phenol in the green tea were lower than the range (23 – 40 mg/100 g) required in complementary foods [26]. Total phenol binds both protein and carbohydrate, which has several implications for food containing high total phenol. The presence of total phenol can cause browning or other pigmentation problems in both fresh and processed foods [27]. Total phenols act as anti-nutritional factors by causing astringent reaction in the mouth and make the food unpalatable. Secondly, by precipitating proteins in the gut, thus reducing digestibility or inhibiting digestive enzymes such as trypsin, chymotrypsin, amylases and lipases [28]. Therefore, decrease in phenol content of the tea due to increased percentage of pavetta is desirable. There was also significant difference between the tea samples in terms of alkaloids levels. The alkaloids decreased from 6.23 – 1.65 mg/100 g with increase in *Pavetta crassipes* leaf powder.

Sample E showed the least value of alkaloid content in the formulation.

4.4 Water Soluble Ash

Table 4 showed the result for water soluble ash, alkalinity and the acid soluble ash. The water soluble ash content of the sample increases as the *Pavetta crassipes* concentration increases. The value ranged from 1.56±0.02 to 1.84±0.01 which is lower than 3.40% as reported by [29]. Water soluble ash is largely made up of mineral element e.g calcium, magnesium and sodium. It is often important to know the mineral content of foods during processing because this affects the physicochemical properties. The K_2CO_3 indicated the alkalinity of the tea-like sample which increases with increase *P. crassipes* concentrations. However, there is no significant difference in the level of Na_2CO_3 and acid insoluble ash of the green tea. The presence of Na_2CO_3 in the tea sample indicates the alkalinity level of the tea. Acid insoluble ash decreases as concentration of *P. crassipes* increases; this gives information about the presence of remaining organic materials present in the acid and those that were totally removed after water soluble ash was recovered.

4.5 Sensory Evaluation

Table 5 showed the sensory evaluation of the tea-like product. In term of colour, all the samples were not significantly ($p > 0.05$) different. Sample E colour is mostly preferred to all other samples. There was no significant difference ($p < 0.05$) in the level of bitterness. The astringency of the product also showed no significant different in all samples. In term of aroma, sample A was the most preferred and this could be as a result of the present of oil and oleoresin in the ginger. [30] also reported that it is used as a spice because it has distinctive flavours and aromas. There were no significant differences in term of

Table 3. Anti-nutrient in “herbal” produced from ginger and *Pavetta crassipes*

Parameters	Samples (mg/100 g)					LSD
	A	B	C	D	E	
Oxalates	3.74±0.03 ^a	3.15±0.03 ^b	2.34±0.02 ^c	1.94±0.02 ^d	0.83±0.02 ^e	0.04
Phytates	2.16±0.02 ^e	2.44±0.02 ^d	2.82±0.02 ^c	3.33±0.02 ^b	3.71±0.02 ^a	0.03
Total phenols	4.53±0.03 ^a	4.25±0.02 ^b	3.72±0.01 ^c	2.34±0.02 ^d	1.05±0.02 ^e	0.03
Alkaloids	6.23±0.02 ^a	5.85±0.02 ^b	4.23±0.02 ^c	3.13±0.03 ^d	1.65±0.02 ^e	0.04

Values are means + S. D mean values within the same row with same superscript are not significantly different ($P < 0.05$)

Key: 100% Ginger and 0% *Pavetta crassipes* for sample A; 80% Ginger and 20% *Pavetta crassipes* for sample B;

60% Ginger and 40% *Pavetta crassipes* for sample C; 40% Ginger and 60% *Pavetta crassipes* for sample D;

20% Ginger and 80% *Pavetta crassipes* for sample E; LSD: Least Significant Difference

Table 4. Chemical properties of herbal produced from ginger and *Pavetta crassipes*

Parameters	Samples					LSD
	A	B	C	D	E	
Water soluble ASH	1.56±0.02 ^e	1.62±0.01 ^d	1.66±0.01 ^c	1.72±0.01 ^b	1.84±0.01 ^a	0.02
K ₂ CO ₃ Alkalinity	11.23±0.02 ^a	10.35±0.02 ^b	10.05±0.03 ^c	9.25±0.02 ^d	8.32±0.02 ^e	0.04
Na ₂ CO ₃ Alkalinity	7.66±0.02 ^a	7.26±0.02 ^b	6.83±0.02 ^b	6.42±0.01 ^b	6.21±0.01 ^b	0.03
Acid insoluble Ash	57.93±0.02 ^a	44.63±0.02 ^b	34.76±0.01 ^c	31.92±0.02 ^d	27.36±0.02 ^e	0.03

Values are means + S. D mean values within the same row with same superscript are not significantly different ($P < 0.05$)

Key: 100% Ginger and 0% *Pavetta crassipes* for sample A; 80% Ginger and 20% *Pavetta crassipes* for sample B; 60% Ginger and 40% *Pavetta crassipes* for sample C; 40% Ginger and 60% *Pavetta crassipes* for sample D; 20% Ginger and 80% *Pavetta crassipes* for sample E; LSD: Least Significant Difference

Table 5. Sensory properties of herbal tea

Parameters	Samples (%)					LSD	
	A	B	C	D	E		
Colour	4.00 ^a	4.00 ^a	3.90 ^a	4.30 ^a	4.40 ^a	4.70 ^a	1.56
Bitterness	4.10 ^a	3.90 ^a	3.20 ^a	3.90 ^a	4.20 ^a	4.00 ^a	1.13
Astringency	3.60 ^a	3.30 ^a	3.80 ^a	3.70 ^a	4.50 ^a	4.30 ^a	1.54
Aroma	4.90 ^a	4.30 ^{ab}	4.30 ^{ab}	4.20 ^{ab}	3.90 ^{bc}	4.90 ^a	1.19
General acceptance	4.90 ^a	4.80 ^a	4.90 ^a	4.00 ^{ab}	4.60 ^a	4.70 ^a	1.44

Values are means + S. D mean values within the same row with same superscript are not significantly different ($P < 0.05$)

Key: 100% Ginger and 0% *Pavetta crassipes* for sample A; 80% Ginger and 20% *Pavetta crassipes* for sample B; 60% Ginger and 40% *Pavetta crassipes* for sample C; 40% Ginger and 60% *Pavetta crassipes* for sample D; 20% Ginger and 80% *Pavetta crassipes* for sample E; Sample F is Lipton; LSD: Least Significant Difference

general acceptability except in sample D where the value read 4.00. Sample C was most generally acceptable and the table also showed that sample D was the least acceptable product with score value lowers than other samples. Samples did not show significant difference in sensory attributes when compared with Lipton Tea (sample F).

5. CONCLUSION

The addition of *P. crassipes* leaf powder to ginger powder resulted in significant increase in protein and carbohydrate. Magnesium and calcium also increase including vitamin C content of the blend. However, the phytochemicals decreases with more addition of *P. crassipes* excluding phytates. Sensory analysis indicated that there was no significant difference between the herbal product (green tea) and Lipton tea and the ginger/*Pavetta crassipes* blend sample C was the most preferred.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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