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Original Article

Phytochemical and sensory evaluation of functional tea produced from Lemongrass, Turmeric bud and Moringa leaf

OPEN ACCESS

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ABSTRACT

The study was done to determine the phytochemical and sensory properties of functional tea produced from blends of lemongrass (Cymbopogon citratus), turmeric (Curcuma longa), and Moringa (Moringa oleifera) leaves (LTM). Lemongrass and moringa leaves were sorted, washed, and dried using a dehydrator at 60°C for 8 h, while the turmeric rhizome was oven-dried at 90°C for 8 h, ground, sieved, and packaged. The functional tea was divided into 5 samples containing different ratios of lemongrass, turmeric, and moringa: (LTM1) 70:20:10, (LTM2) 67:28:5, (LTM3) 63:30:7, (LTM4) 60:30:10, and (LTM5) 70:23:7. Tea from 100 % lemongrass served as the control. Phytochemical and sensory analysis were carried out on the functional tea samples. From the results obtained, sample LTM4 recorded the highest concentration of tannins (1.30%), saponins (1.40%), flavonoids (0.92%), and total phenols (0.43 mgGAE/g). The combination of the plants was shown to improve all the phytochemical parameters measured when compared to the control sample. The functional tea samples were also generally accepted by the panelists, as they all had a mean score above 5, with sample LTM1 (70:20:10) being the most preferred sample. This study has shown that functional tea can be produced from a combination of lemongrass, turmeric, and moringa.

KEYWORDS: *Flavonoids, Herbal tea, Indigenous plants, Tannins, Phenols, Saponins*

INTRODUCTION

Tea has a rich history, having been used for thousands of years in China. Non-*camellia* tea (herbal tea) can be traced back to the Tang Dynasty (Zhu, 2018). Herbal teas vary widely in their composition. They are made from natural products, mainly a variety of herbs, and have a variety of benefits for human health. Plant materials used in herbal teas include fresh or dried roots, stems, leaves, fruits, flowers, seeds, bark, or whole plants from one or more herbal tea plant species (Liu *et al*., 2013).

Tea is a component of the quickly growing industry for wellness beverages (Byun & Han, 2004). It has now become an indispensable aspect of modern life. People take tea because of its flavour and scent as well as the distinctive place it has in the culture of so many different societies. According to the

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production processes used, teas are typically categorized as green, oolong, or black. However, a fourth type known as functional teas are being made from plants other than the tea plant, *Camellia sinensis* (Da Silva, 2020). Despite having enormous dietary potential, indigenous plants like lemongrass, turmeric, and *moringa* leaves are typically underutilized. These plants have been reported to have high content of antioxidants and important phytochemicals (Abbey and Timpo, 2020). Therefore, it is crucial to investigate the potential of locally available plant materials like *moringa* leaves, lemongrass, and turmeric in the creation of functional tea.

Functional teas are widely consumed for their healing and energizing properties since they can help people relax, having the capacity to assist with digestive and stomach disorders (Khan and Mukhtar *et al*., 2013). They can aid the body by having cleansing properties and by boosting the immune system (Kochman *et al*., 2020). It is vital to keep in mind that various herbs may have various therapeutic properties, allowing us to create our own infusions depending on how we want the tea to function.

MATERIALS AND METHOD

Source of Materials

The lemongrass, turmeric and *moringa* leaves were purchased from sellers at Eke Awka market, Awka, Anambra state Nigeria. The samples were purchased when freshly harvested and were transferred under aseptic condition to the Department of Food Science and Technology Laboratory, Nnamdi Azikiwe University, Awka, Anambra state, Nigeria, for processing. All chemicals and equipment used were of analytical grade.

Experimental Design

The experimental design was a D- optimal mixture design, from Design expert (13) as shown in Table 1. All determinations were done in triplicates.

Table 1: Experimental design

Sample	Lemongrass (g)	Turmeric (g)	Moringa leaf (g)
CTRL (control)	100	0	0
LMT1	70	20	10
LMT2	67	28	05
LMT3	63	30	07
LMT4	60	30	10
LMT5	70	23	07

Sample Preparation

Production of lemongrass powder

Freshly harvested Lemongrass was sorted, washed under running tap water and then steam blanched for 60 secs as shown in Figure 1. The blanched leaves were drained in plastic sieve and dried using hot air oven at a predetermined temperature of 60˚C for 8 h. Thereafter, the dried leaves were ground with electric blender (Panasonic) and sieved through a 250 mm mesh sieve to obtain fine powder. The powder was packaged in an air-tight bag and stored at ambient temperature (23˚C) for further use.

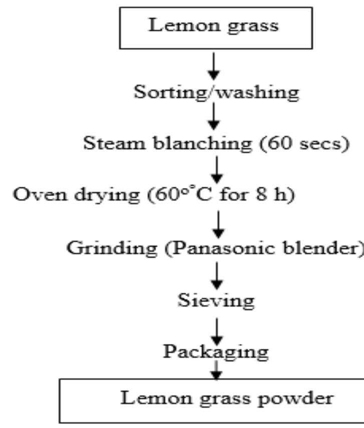

Fig. 1: Production of Lemongrass powder
Source: Mozumder *et al.* (2012) with slight modification

Production of turmeric powder

Prior to drying, individual turmeric rhizomes were sorted, washed, measured with callipers and sliced into 5 mm thickness using sharp stainless-steel knife (Jayathunge *et al*., 2019) as shown in Figure 2. To get uniform drying, turmeric slices were placed in single layer for drying in hot air oven at a predetermined temperature of 90℃ for 8 h. Dried turmeric slices were cooled for about an hour inside desiccators to prevent reabsorption of moisture and then packed in air-tight bag.

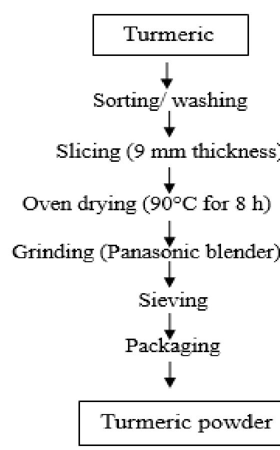

Figure 2: Production of turmeric powder
Source: Mozumder *et al.* (2012) with slight modification

Production of *Moringa oleifera* leave powder

Moringa oleifera leaves were sorted to remove extraneous materials and decaying leaves, washed under running potable water, drained and then placed in single layer trays for drying in hot air oven at 60℃ for 8 h as shown in Figure 3. Thereafter, the dried *Moringa* leaves were ground with electric blender (Panasonic) and sieved through 250 mm mesh sieve to obtain fine powder. The powder was packaged in a transparent polyethylene bag at ambient temperature (23℃) for further use.

Tea Extract Preparation

The raw materials were mixed according to the formulations in Table 1 and homogenized to form tea. Two hundred milliliter of de-ionized water was heated to 100 ℃. One gram of dried tea was added to the cooling water and left to infuse for 10 min, being stirred every two minutes. The infusion was filtered with paper filters (Whatman filter papers) and then with polytetrafluoroethylene filters, with a 25 mm diameter and 0.45 μm pore size. All infusions were diluted with de-ionized water to obtain the working solution and maintained at −20◦C for the phytochemical analyses.

Phytochemicals Analyses

Determination of total tannins by titration

The method of Pearson (2018) was used for the determination of tannins. Approximately 10 grams of sample was weighed in a conical flask and 100 ml of petroleum ether was added and covered for 24 h. The sample was filtered and allowed to stand for 15 min for the solvent to evaporate. It was re-extracted by soaking 100 ml of 1 % acetic acid in ethanol for 4 hours. The sample was then filtered and the filtrate collected. Then 25 ml of ammonium hydroxide was added to the filtrate to precipitate the alkaloids. The alkaloid was heated with electric hot plate to remove some of the ammonium hydroxide still in solution. The remaining volume was measured and 5 ml of this was taken and 20 ml of ethanol was added to it. It was titrated with 0.1 M NaOH using 1 ml of phenolphthalein as indicator until a pink end point was reached. Tannin content was calculated in percentage ($C^1V^1 = C^2V^2$) molarity.

Determination of total saponins

Saponins were determined using AOAC (2010). Briefly, 10 grams of the ground sample was weighed into a thimble and transferred into the Soxhlet extractor chamber fitted with a condenser and flask. Methanol (250 ml) was poured into the flask. Extraction continued for 1 h, the saponin was exhaustively extracted by heating the flask on a heating mantle. After the thimble and its content was removed and the methanol recovered leaving the saponin and little quantity of methanol in the flask. It was taken to an oven and kept at slanting position at a temperature of 70˚C to evaporate the residual methanol. The flask and content were weighed and the difference between the flask plus saponins and flask alone was the mass of saponins extracted. The saponins content was weighed and calculated in percentage.

$$\%\text{ Saponins} = \frac{(Weight\ of\ beaker + sample) - (Weight\ of\ empty\ beaker)}{Weight\ of\ sample\ analyzed} \times 100 \quad (1)$$

Determination of total flavonoids

Total flavonoids was determined by AOAC (2010). Ten (10) grams of the functional tea sample was put in a beaker with 100 ml of 80% aqueous methanol at room temperature. The whole solution was filtered through Whatman filter paper. The filtrate was later transferred into a crucible and evaporated into dryness over a water bath and weighed to a constant weight.

$$\%\text{ Flavonoids} = \frac{(Weight\ of\ crucible + residue) - (Weight\ of\ crucible)}{Weight\ of\ sample\ analyzed} \times 100 \quad (2)$$

Determination of total phenolics of the extracts

The total phenolic content of the extracts was determined using the Folin-Ciocalteu method as described by Oluwaseun *et al*. (2021). A sample of 0.2 ml of extract solution (1 mg/ml) was mixed with 1 ml Folin-Ciocalteu reagent and 2 ml Na_2CO_3 (7.5 %). The final volume was brought up to 7 ml with deionized water. After 2 h of incubation at room temperature, the absorbance was measured at 765 nm using a spectrophotometer (Shimadzu, UV-1800). Gallic acid was used as a standard for calibration curve. The total phenolic content was expressed as gallic acid equivalents (mgGAE/g extract).

Sensory Evaluation of the Functional Tea

A semi-trained panel of 25 judges made up of male and female staff and students of the department of Food Science and Technology, Nnamdi Azikiwe University, Awka were used. The functional tea samples packaged in their respective tea bags were presented to the panelists with tea cups and hot water for infusion. The panelists were educated on the respective descriptive terms of the sensory scales and requested to evaluate the various samples for appearance, taste, aroma, aftertaste and overall acceptability using a 9-point Hedonic scale, where 9 was equivalent to like extremely and 1 equivalent to dislike extremely. Presentation of coded samples were done randomly and potable water was provided for rinsing of mouth in between the respective evaluations (Duncan, 2019).

Data Analysis

Data generated from analysis was compiled and subjected to One-way Analysis of Variance (ANOVA). The significant difference between means and separate means respectively at $p < 0.05$ levels was determined using the Duncan Multiple Range Tests (SPSS, Statistical Product for Service Solutions, Version 25.0).

RESULTS AND DISCUSSION

Phytochemicals Evaluation

The results of the phytochemical analysis of the functional tea produced from lemon grass, turmeric rhizome and *moringa* leaves are presented in Table 2. The functional tea not only showed the presence of tannins, saponins, flavonoids, and total phenols, but also revealed a variation in their concentration. The presence of these phytochemicals in these tea formulations may contribute to its medicinal value (Uborr *et al*., 2022). The results showed significant differences ($p < 0.05$) in the different samples and variations in the proportion of the different components used in the functional tea formulations.

Table 2: Phytochemical properties of the functional tea

Sample	Tannins (%)	Saponins (%)	Flavonoids (%)	Total phenols (mgGAE/g)
LTM1	$1.21^{b} \pm 0.01$	$1.32^{b} \pm 0.00$	$0.83^{b} \pm 0.00$	$0.37^{b} \pm 0.00$
LTM2	$1.12^{e} \pm 0.00$	$1.19^{d} \pm 0.01$	$0.64^{f} \pm 0.00$	$0.21^{f} \pm 0.00$
LTM3	$1.15^{d} \pm 0.00$	$1.20^{d} \pm 0.00$	$0.81^{c} \pm 0.00$	$0.25^{e} \pm 0.00$
LTM4	$1.30^{a} \pm 0.00$	$1.40^{a} \pm 0.00$	$0.92^{a} \pm 0.01$	$0.43^{a} \pm 0.00$
LTM5	$1.17^{c} \pm 0.00$	$1.23^{c} \pm 0.01$	$0.79^{d} \pm 0.00$	$0.28^{d} \pm 0.00$
CTRL	$0.72^{f} \pm 0.01$	$1.10^{e} \pm 0.00$	$0.72^{e} \pm 0.00$	$0.31^{c} \pm 0.00$

Values are mean ± standard deviation of triplicate determinations. Any value in each column not followed by the same superscript show significant difference (p < 0.05). LTM1 = (Lemongrass 70%,Turmeric 20%, Moringa 10 %), LTM2 = (Lemongrass 67%, Turmeric 28%, Moringa 5%,), LTM3= (Lemongrass 63%, Turmeric 30%, Moringa 7%,), TM4= (Lemongrass 60%, Turmeric 30%, Moringa 10%), LTM5= (Lemongrass 70%, Turmeric 23%, Moringa 7%,), CTRL (Lemongrass 100%).

The tannin content ranged from 0.72 to 1.30% with sample LTM4 (60% lemongrass, 30% turmeric bud and 10% *moringa*) being the highest and the control (100% lemongrass), having the lowest value. These values were higher than those reported by Bako *et al*. (2023) for *Justicia secunda* tea (0.48 mg/g) and Arogbodo *et al.* (2020) (0.55 mg/g) respectively, but lower than those reported by Mgbemena *et al.* (2022) on *Ficus capensis* leave extract (4.62 mg/g). The combination of the raw materials had a positive effect on the tannin content of the tea extract because there was an increase in the value obtained. According to Njoku and Akumufula (2007), the tannin content of plants makes them an excellent choice for treating wounds resulting from hemorrhoids and varicose ulcer lacerations. Also, Saxena *et al*. (2013), added that plants containing tannins are used as astringents, diuretics, remedies for diarrhea, and defense against stomach and duodenal cancers.

The saponin content ranged from 1.10 to 1.40%. Sample LTM4 (60% lemongrass, 30% turmeric bud and 10% *moringa*) contained the highest amount of saponin and the control (100% lemon grass) had the lowest amount. There was no significant difference ($p > 0.05$) between samples LTM2 (67% lemongrass, 28% turmeric and 5% *moringa*) and LTM3 (63% lemongrass, 30% turmeric and 7% *moringa*) but the rest of the samples had significant difference ($p < 0.05$). Saponin helps in protecting the plant against microbes and fungi and may also enhance nutrient absorption and aid in animal digestion (Innocent-Ukachi, 2019). The presence of saponin has many health benefits which include; cancer prevention and improvement of immune system and reduction of blood cholesterol level (Hartmut, 2020).

In addition, the flavonoid content of the tea samples ranged from 0.64 to 0.92% with sample LTM4 (60% lemon grass, 30% turmeric bud and 10% *moringa*), having the highest concentration (0.92%) and sample LTM2 (67% lemon grass, 28% turmeric bud and 5% *moringa*), the lowest concentration (0.64%). The samples were all significantly different ($p < 0.05$) different from each other. It was observed that increased drying temperature led to corresponding decrease in the sample's flavonoid content, which could be due to loss of the macro-molecules (flavonoids) during vaporization. The result in this study was lower than the values obtained by Innocent-Ukachi (2019) for herbal tea formulation (3.6% to 7.34%). According to Panche *et al*. (2016), flavonoids are a large class of phytochemical substances that are generally associated with a particular role in reducing the risk of significant chronic diseases in people, such as heart, kidney, and diabetes problems. The medicinal benefits of this phytochemical include its anti-inflammatory, anti-arthritic, analgesic, immunomodulatory, and antioxidant qualities (Ain *et al*., 2024). According to epidemiological research, consuming a diet rich in flavonoids may shield people from illnesses linked to oxidative stress. It has been demonstrated *in vitro* that flavonoids derived from different plant sources have the ability to scavenge free radicals and provide protection against oxidative stress (Panche *et al*., 2016). As a result, the functional tea from the blends of lemon grass, turmeric and *moringa*, contains flavonoids, which may have biological effects like anti-oxidative and anti-tumour activities (Okoroh *et al*., 2019).

Polyphenols are complex secondary phenol metabolites that are widely distributed in plants, mainly in fruits, leaves, roots, and skins (Ren *et al*., 2019). The phenol content of the tea samples ranged from 0.21 to 0.43 mgGAE/g with sample LMT2 (67% lemon grass, 28% turmeric bud and 5% *moringa*) having the lowest concentration of 0.21 mgGAE/g and sample LMT4

(60% lemon grass, 30% turmeric bud and 10% *moringa*), the highest concentration (0.43 mgGAE/g). There was significant difference ($p < 0.05$) between all the samples. Innocent-Ukachi (2019) reported a decrease in phenol composition from 139.6 – 214.04 mg/100 ml due to difference in mixing ratio of tea brewed from blends of soursop (*Annona muricata*) and moringa (*Moringa oleifera*) leaves. Although the content of phenol in the formulated tea was slightly high, their presence in the dried samples would be beneficial as reported by Gosh (2015), that inclusion of foods containing phenol in one's daily diet helps in preventing and combating various types of health ailment due to their antioxidant potential and radical scavenging

Sensory Characteristics of Functional Tea

The mean scores for sensory evaluation of the functional tea produced from lemon grass, turmeric and *moringa* are presented in Table 3. The sensory parameters were evaluated by 25 panelists. For appearance, significant difference ($p < 0.05$) existed in some of the samples while some had no significant difference ($p > 0.05$). The appearance result ranged from 7.00 to 8.60 with the control having the highest sensory appearance and sample LTM4 (60% lemongrass, 10% *moringa* and 30% turmeric) had the lowest. It was observed that as concentration of the lemongrass reduced, the acceptability of the appearance by the sensory panelists decreased. This could be because the colour of the turmeric became more dominant. Appearance is very much important in food production as it plays a major role in determining consumer acceptance of food products (Onweluzo & Nnamuchi, 2019).

Taste is also considered to be very important in sensory evaluation. Taste is the sensation of flavour perceived in the mouth and throat on contact with a substance and it is one of the most important attributes in a food product. For taste significant variations were observed. The control (100% lemongrass) recorded the highest taste rating (8.20) by panelists while sample LTM5 (70% lemon grass, 23% turmeric and 7% *moringa*) recorded the lowest score in taste (6.00). Significant difference ($p < 0.05$) existed in all the samples even though the tastes of the samples were all acceptable to the panelists.

Table 2: Sensory scores of functional teas

Sample	Appearance	Taste	Aroma	After taste	Overall Acceptability
LTM1	$8.25^{a} \pm 1.25$	$7.75^{ab} \pm 1.63$	$7.55^{ab} \pm 1.84$	$7.80^{a} \pm 1.32$	$8.00^{a} \pm 1.21$
LTM2	$7.20^{b} \pm 1.60$	$7.00^{cd} \pm 1.25$	$6.43^{bcd} \pm 2.10$	$7.10^{ab} \pm 2.10$	$7.25^{ab} \pm 1.01$
LTM3	$7.15^{b} \pm 1.81$	$6.30^{d} \pm 1.75$	$5.95^{cd} \pm 2.35$	$6.35^{b} \pm 2.05$	$6.65^{bc} \pm 1.53$
LTM4	$7.00^{b} \pm 1.88$	$6.45^{d} \pm 1.63$	$6.05^{abc} \pm 1.46$	$6.50^{b} \pm 1.76$	$6.55^{bc} \pm 1.19$
LTM5	$5.80^{c} \pm 1.88$	$6.00^{d} \pm 1.43$	$5.50^{d} \pm 1.98$	$6.00^{b} \pm 1.71$	$6.25^{c} \pm 1.71$
CTRL	$8.60^{a} \pm 0.59$	$8.20^{a} \pm 0.89$	$8.00^{a} \pm 1.16$	$7.70^{a} \pm 1.80$	$7.85^{a} \pm 1.78$

Values are mean ± standard deviation of 25 panelists. Any value in each column not followed by the same superscript show significant difference (p < 0.05). LTM1 = (Lemongrass 70%, Turmeric 20%, Moringa 10%), LTM2 = (Lemongrass 67%, Turmeric 28%, Moringa 5%), LTM3= (Lemongrass 63%, Turmeric 30%, Moringa 7%), LTM4= (Lemongrass 60%, Turmeric 30%, Moringa 10%), LTM5= (Lemongrass 70%, Turmeric 23%, Moringa 7%), CTRL (Lemongrass 100%).

There were also significant differences ($p < 0.05$) in the panelists' perception of the samples based on aroma. The mean score obtained for aroma ranged from 5.50 to 8.00. The result showed that the control sample (100% lemongrass) recorded the highest score for aroma while sample LTM5 (70% lemongrass, 23% turmeric bud and 7% *moringa*) recorded the lowest score for aroma. It was observed that the higher the lemongrass the better the aroma. The aroma of the control was accepted more than other samples by the panelists.

In terms of aftertaste, there was significant difference ($p < 0.05$) between the control and sample LTM5 (70% lemongrass, 23% turmeric and 7% *moringa*), LTM3 (63% lemongrass, 30% turmeric and 7% *moringa*) and sample LTM2 (67% lemongrass, 28% turmeric and 5% *moringa*). For the after taste, there was no significant difference ($p > 0.05$) except for the control and sample LTM1 (70% lemongrass, 20% turmeric and 10% *moringa*) which were similar to each other and significantly different ($p > 0.05$) from the rest of the samples. Sample LTM1 (70% lemongrass, 20% turmeric bud and 10% *moringa*) recorded the highest mean score for after taste while sample LTM5 (70% lemon grass, 23% turmeric bud and 7% *moringa*) recorded the lowest mean score for aftertaste. It was observed that the samples with the higher amount of *moringa* had more persistent aftertaste when compared with the samples with the lower amounts of *moringa*.

Overall acceptability is an important parameter in organoleptic estimation as it plays a crucial role in decision making and it influences the panelist's acceptance and choices of the different samples. The overall acceptability revealed that the sample LTM1 (70% lemongrass, 20% turmeric and 10% *moringa*) and the control sample (100% lemongrass) were the most preferred tea samples, as they both had the highest values for overall acceptability. The preference for these samples could be because they contained higher amounts of lemongrass, which most of the panelists considered acceptable. Furthermore, sample LTM5 (6.25) was the least preferred product in overall acceptability. It scored the lowest preference in appearance (5.80), taste (6.00) aroma (5.50) and aftertaste (6.00).

CONCLUSION AND RECOMMENDATION

This study used lemongrass, turmeric, and *moringa* in production of functional tea, and results has shown that this herbal tea contained phytochemical compounds like tannins, saponins, flavonoids, and phenols, which could help prevent the onset of diseases. The combination of the raw materials in the tea formulation was observed to play a positive role on the phytochemical contents, as it improved their amounts, when compared to the control sample. Results also obtained from the sensory score showed that the herbal tea was generally acceptable by the panelists, as all samples scored above 5.

It is recommended that continuous research be carried out to evaluate the efficacy and safety of these extracts, both in laboratory settings and in well-designed clinical trials. Such research is crucial for developing a firm scientific foundation, unlocking new possibilities, and ensuring that consumers may fully benefit from the potential health benefits that the functional tea from lemongrass, turmeric and *moringa* provides.

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Conflict of Interest

The authors have no conflict of interest to declare.

Authors' Contributions

Author UOE, HOA, JCM & RON managed data collection, interpretation of data, data analysis and writing of the manuscript, all authors managed the development of methodology and reviewed the manuscript.

Ethics Statement

Not applicable

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