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Exploring The Characteristics Of Multi Herbal Powder Incorporated Tea And Its Therapeutic Implications

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Abstract
The growing consumer interest in herbal teas can be attributed to their purported nutritional and health benefits. This study aimed to evaluate the composition of herbal tea powder and its physical, chemical, functional, and sensory properties by incorporating a blend of herbs, including mint leaves, guava leaves, bay leaves, cardamom, cinnamon sticks, cloves, and dried ginger. The prepared herbal tea powders were designated as MHT1, MHT2, MHT3, and MHT4, with variations in the ratios of herbs used. The physical, chemical, and functional characteristics of the MHT samples were assessed using standardized methods, while the sensory attributes were evaluated utilizing a 9-point hedonic scale. ANOVA was employed to analyze the data, with mean and standard deviation serving as the key outcomes. The physical analysis indicated that the bulk density ranged from 0.44 to 0.46 g/ml. Notably, MHT2 and MHT4 exhibited higher tapped densities, which suggested enhanced compressibility and reduced void space, potentially improving packaging and handling efficiency. The samples displayed minor variations in the Carr index, a metric that evaluates flowability and compressibility of powders. The highest Hausner ratio recorded was 1.26 ± 0.16 in MHT3. MHT4 demonstrated the highest moisture loss at 0.55 ± 0.01%, whereas MHT2 was noted for the highest angle of repose at 15.3 ± 0.41°. Chemical analysis revealed modest differences in the moisture levels across the herbal tea powder formulations. MHT2 contained the highest carbohydrate content, while it also showcased the greatest protein content at 16.03 ± 0.51%, indicating a superior protein profile compared to the other formulations. MHT1 and MHT2 presented slightly lower and comparable fat contents. The energy levels associated with each formulation were comparable, and all formulations exhibited a high dietary fiber content. The functional characteristics of the MHT samples indicated that the pH values for the four MHT samples ranged from 6.02 ± 0.03 to 6.14 ± 0.06. Notably, the Reconstitution Index demonstrated a progressive increase from MHT1 to MHT4. An enhanced Swelling Index indicated a greater volume expansion upon hydration, while the Water Solubility Index also experienced a slight increase. Sensory evaluation results indicated that MHT2 was the preferred formulation across all assessed sensory parameters.
Keywords: *Herbs, Tea, Powder, Physical, Chemical, and Sensory evaluation.*

INTRODUCTION

Tisane is another name for herbal tea. Because of its biological qualities, it has grown in popularity and may undoubtedly supplement contemporary medicine. Any botanical material derived from plant species other than the widely consumed tea species, such as dried leaves, seeds, grasses, flowers, nuts, or other plant materials [1]. In addition to the herbs steeped in hot water, a variety of plants are used to make herbal tea [2]. Traditional Chinese Medicine (TCM) and Ayurveda are two examples of ancient cultures that developed herbal medicines to treat a range of ailments [3]. The herbs were combined according to how similar their health benefits were for each species. Since polyherbs are thought to have greater pharmacological effects than a single herb, the majority of herbal-based products on the market now use them instead of just one herb [4].

Herbs have been shown in numerous studies to have the ability to prevent anemia. Since ancient times, medicinal plants have been utilized to cure and prevent a variety of infectious diseases. Between 60 and 90 percent of people on the planet take plant-based medications. Urinary tract infections may be prevented or treated with medicinal herbs as an infusion or tea [5]. After water, tea is the most popular beverage. Many people like it's refreshing, slightly bitter, and astringent flavor. One of the most widely consumed drinks, tea is served every day in all social, formal, and home gatherings. In addition to many other benefits, this preparation strengthens immunity, keeps one active, rejuvenates cells, and relieves stress, fatigue, anxiety, and exhaustion [6].

Herbs, fruits, seeds, and roots steeped in hot water are used to make herbal teas. After water, tea is the beverage that people drink the most on Earth. Due to its numerous health benefits, such as a reduction in cardiovascular diseases and other forms of cancer, tea consumption has long been promoted. Additionally, it exhibits neuroprotective and antifibrotic qualities and raises the mineral density of bones. Tea is excellent for dental health. It has antimicrobial properties, lowers blood pressure, and aids in weight control [7]. Herbal tea differs from conventional drinks, such as genuine tea and coffee. Herbal teas are used worldwide because of their therapeutic and restorative properties [8]. Among the more than 4,000 bioactive substances found in herbal tea, polyphenols make up about one-third, with tannins and flavonoids making up the remaining portion. Herbal teas are a good substitute for traditional medication because of their immune-stimulating and therapeutic properties [9]. Most people drink tea because of its appealing flavor and scent, as well as the special place it occupies in many cultures. Growing consumer knowledge of the health advantages of tea intake has led to a resurgence of interest in tea in recent years. Because they can aid in inducing calm, herbal teas are frequently drunk for their medicinal and revitalizing qualities. Herbal teas can help cleanse the body and boost the immune system in addition to helping with digestive or stomach issues [10].

Pharmaceutical companies rely heavily on herbal products as their primary source of raw materials to extract chemicals that have therapeutic value. Men overused the beneficial medicinal plants during this period due to the development of science and technology and the rising need of the pharmaceutical industry. Therefore, it is necessary to use cutting-edge biotechnology techniques to conserve and propagate precious, uncommon, and endangered medicinal plants. One of the most significant natural resources and a significant part of the healthcare system is herbs. Therefore, managing the wild population and natural habitats is the most effective way to conserve species [11].

Herbs are regarded as one of the most popular alternative treatments for weight loss globally. Most of these herbs are used as simple plants, and they have been utilized to cure obesity all around the world in recent years [12]. The effectiveness and safety of using medicinal plants to treat diabetes mellitus, dyslipidemia, and obesity have been the subject of numerous studies [13]. Some herbal remedies for weight loss are safe and effective in Chinese trials [14]. Numerous plants, such as nigella sativa, green tea, and black Chinese tea, have been demonstrated to have anti-obesity properties [15]. The safety of traditional herbal medications has led to a rise in their use among hypertension patients, according to a study done on the South African population [16]. Therefore, the goal of this study was to formulate herbal tea powder and assess its physicochemical, functional, and sensory properties of herbal tea.

MATERIALS AND METHODS

Raw materials

The raw materials needed for this herbal tea powder making was procured from the local market in Kilakarai, Ramanathapuram District. Mint leaves (M*entha spicata*), also known as "Pudina" in India, are a popular culinary and medicinal herb. Mint leaves are also a good source of vitamins, minerals, and antioxidants. The guava leaves (*Psidium guajava* L.), belonging to the *Myrtaceae* family, are a very unique and traditional plant that is grown due to its diverse medicinal and nutritive properties. Bay leaf (*Laurus nobilis*) is a perennial shrub that belongs to the family laurel (*Lauraceae).* It has been used for thousands of years for food flavoring, essential oil applications, and in traditional medicine. *Elettaria cardamomum*, commonly known as cardamom, is a pungent, aromatic, herbaceous, evergreen perennial of the ginger family. Cinnamon (C*innamomum verum*), also called Ceylon cinnamon, is a bushy evergreen tree of the laurel family (*Lauraceae*) and the spice derived from its bark. Cloves are the aromatic flower buds of a tree in the family *Myrtaceae*, *Syzygium aromaticum*. They are commonly used as a spice, flavoring, or fragrance in consumer products. Ginger is a flowering plant whose *rhizome*, ginger root or ginger, is widely used as a spice and a folk medicine (figure 1).

Figure 1

The selected ingredients for making tea powder, such as mint leaves, guava leaves, bay leaves, cardamom, cinnamon sticks, clove, and dried ginger, have been carefully chosen for their complementary health-promoting properties. Together, they form a synergistic blend that supports blood sugar regulation, digestive health, and overall metabolic balance. Rich in antioxidants, dietary fiber, essential vitamins, and bioactive compounds, this formulation not only targets the prevention and management of diabetes mellitus but also contributes to immunity, detoxification, and digestive wellness. Incorporating such a tea powder into daily routines may offer a natural, holistic approach to managing lifestyle-related health concerns, especially in populations seeking plant-based and functional dietary solutions. The selected ingredients were dried and milled to get fine powder and then stored in a air tight container for further process.

Preparation of multi–herbal powder incorporated tea (MHT)

After collecting the dried powders, the formulation of MHT in different ratios in combination was carried out. Totally five variations (1 control and 4 variations) of multi herbal tea were prepared by mixing different ratios of multi herbal powder such as 10g, 15g, 20g and 25g and was shown in Table 1.

Table 1: Formulations of multi–herbal Powder incorporated tea (MHT)

Ingredients	Control	MHT1	MHT2	MHT3	MHT4
Commercial tea powder (g)	15	-	-	-	-
Multi herbal powder (g)	-	10	15	20	25
Water (ml)	250	250	250	250	250
Skimmed milk (optional) (ml)	50	50	50	50	50
Sugar (g)	2	2	2	2	2

MHT – Multi Herbal Tea

MHT preparation

In a pot or kettle, bring one cup (250 ml) of water to a boil. Add the herbs powder to the hot water after it has boiled and turn off the heat. Depending on the desired strength, soak the pan for 5 to 10 minutes with a lid and if needed add skim milk for taste. After steeping, use a fine mesh strainer to pour the tea into a cup.

Figure 2

Physicochemical analysis of multi herbal powder incorporated tea

Physical analysis of MHT

Bulk density and tapped density:

The volume occupied by the solid plus the volume of voids, divided by the mass of the powder, is known as the bulk density. In contrast, tap density is a different sort of bulk density achieved by tapping or vibrating the container in a certain manner to promote greater particle packing; hence, it is often higher than bulk density.

Bulk density = Weight of the powder/ Volume of the packing

Tapped bulk density = Weight of the powder/Volume of the tapped packing

Carr index and Hausner ratio:

They characterize the flow characteristics of powders. The ratio of the tapped density to the difference between the tapped and bulk densities is the Carr's index. Carr (1965), who created the flowability index, states that great flowability is found in the 5–15% Carr index range, whereas poor flowability is generally indicated by an index exceeding 25%.

Carr's index = (Tapped density-bulk density/ bulk density) × 100

Hausner's ratio = Tapped density/Bulk density

Angle of repose:

The funnel method was used to determine it. The precisely weighed powder was placed in a funnel. The height of the funnel was set up so that the tip of the funnel just touches the "head of blend" or "apex of the heap." "The drug excipient blend" was permitted to freely flow onto the surface through the funnel. The correlation between powder flow and angle of repose is calculated [17].

Height of pile (cm) = Average radius of circle in cm Angle of repose (ɵ) = tan−1 (h/r)

Loss on drying:

Take a clean, dry petri dish and weigh it. Weigh 2 g of sample powder and transfer to the petri dish and weigh. Place the Petri dish in a tray dryer and weigh it every 5 minutes. Allow it to dry until it is a constant weight, then down the constant dry weight. Calculate the percentage loss on drying and moisture content for the sample.

L.O.D = (Weight of sample before drying - Weight of sample after drying) × 100

Dust leak test:

Take a 2 g sachet of herbal tea and record its initial weight. Put it in the friability tester for 4 min at 25 rpm. After 4 minutes, record its final weight. The loss of powder should not be more the 1%. Repeat this experiment with 2 more sachets and take the average.

(Initial wt. − Final wt. / Initial wt.) × 100

Chemical analysis of multi herbal powder incorporated tea

Different chemical analyses of samples were performed for moisture content, ash, fat, protein, and total carbohydrate. All the determinations were done in triplicate, and the results were expressed as the average value.

Moisture content

Moisture content was determined by adopting method [18] as follows:

$$\text{Moisture content} = \frac{\text{Loss in weight \%}}{\text{Weight of sample}} \times 100$$

Total carbohydrate

Total carbohydrate content of the samples was determined as total carbohydrate by difference, that is, by subtracting the measured protein, fat, ash, and moisture from 100% phenol sulphuric acid [18].

Protein

Protein content was determined using the AOAC (2005) [18] method. Percentage of nitrogen and protein calculated by the following equation:

$$\text{\% Nitrogen} = \frac{\text{TS - TB} \times \text{Normality of acid} \times 0.014}{\text{Weight of sample}} \times 100$$

Where, TS = Titre volume of the sample (ml), TB = Titre volume of Blank (ml), 0.014= M eq. wt. of N2.

% Protein = Nitrogen × 6.25.

Fat

The AOAC (2005) [18] method using the Soxhlet apparatus was used to determine the crude fat content of the sample. The percent of crude fat was expressed as follows:

Weight of dried ether-soluble material

% Crude Fat = ———————————— × 100
Weight of sample

Dietary fibre

The crude fiber was determined utilizing sequential hot digestion of the defatted measurements with acidic and alkaline buffers, the crude fat through continuous extraction in a Soxhlet apparatus using hexane as the solution of choice for 18 hours, the ash through burning at 550°C, and the total carbohydrate through distinction [18]. The quantities of soluble (SDF) and insoluble (IDF) dietary fiber were assessed using the recognized enzymatic-gravimetric method [18].

Functional properties of multi herbal powder incorporated tea

pH Measurement

The method of Mathew *et al.* (2015) [19] was used to determine the pH of the samples. The pH was measured by making a 10% (w/v) powdered suspension of each sample in distilled water. Each sample was mixed thoroughly in a beaker, and the pH was recorded with an electronic pH meter (Model PHN-850, Villeur-Banne, France).

Reconstitution Index (RI)

From the ground sample, five grams were dissolved in 50 cm3 of boiling water. The mixture was agitated for 90 seconds and was transferred into a 50cm3 graduated cylinder, and the volume of the sediment was recorded after settling for 30 minutes [20].

Volume of sediment
RI = ...
Weight of sample

Water Absorption Capacity (WAC)

The method of Onwuka (2005) [20] was used to determine the water absorption capacity. Clean centrifuge tubes were weighed, and 2g of dried ground sample was dispersed into the centrifuge with 20 mL of distilled water and stirred with a glass rod for 1 minute. The tubes were centrifuged at 5000 rpm for 30 minutes. The volume of the supernatant was decanted, and the tubes with their content were reweighed as water absorbed per gram of sample. The weight change gives the water absorption capacity.

Swelling Index (SI)

The swelling index (SI) was determined according to Ukpabi and Ndimele, (1990) [21]. For each sample, 4g was poured into 50 mL measuring cylinders and leveled gently. Distilled water (40mls) was added to each sample and swirled. After allowing the solutions to stand for 1 hour, the volume was measured. The SI was calculated using:

Change in volume of the sample
SI= ....
Original weight of the sample

Water Solubility Index (WSI)

WSI was measured according to the method of Anderson *et al.* (1996) [22]. 2.5g of supplemented tea sample was dispersed in 25 ml of distilled water, taking care to break up any lumps using a glass rod. After 30 min of stirring, the dispersion was rinsed into tarred centrifuge tubes made up to 32.5 mL and then centrifuged at 3000 rpm for 10 min. The supernatant was decanted, and the weight of its solid content was determined after it had been evaporated to a constant weight. The WSI was calculated as:

Weight of the solid
WSI = ...
Weight of dry powder sample

Sensory evaluation of herbal tea powder

Sensory characteristics of MHT were evaluated for different sensory attributes by a group of thirty panelists. Sensory attributes like appearance, colour, aroma, taste, flavour, texture, and overall acceptability for all samples were assessed using a nine-point hedonic scale. The hedonic scale was in the following sequence: like extremely - 9, like very much - 8, like moderately- 7, like slightly - 6, neither like nor dislike - 5, dislike slightly 4, dislike moderately - 3, dislike very much - 2, dislike extremely – 1.

Statistical analysis

Mean and standard deviations for the various parameters were computed. Analysis of Variance (ANOVA) was employed using the IBM SPSS, version 25. Least Significant Difference (LSD) at 5% was calculated for the comparison among the parameters.

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RESULTS AND DISCUSSION

Physical properties of multi herbal powder incorporated tea

Table 2

Physical properties of multi herbal powder incorporated tea

Physical properties	Control	MHT1	MHT2	MHT3	MHT4
Bulk density (g/mL)	0.54±0.04^{b}	0.44±0.02^{a}	0.45±0.01^{ab}	0.44±0.01^{b}	0.46±0.01^{ac}
Tapped density (g/mL)	0.57±0.01^{a}	0.45±0.02^{b}	0.52±0.01^{a}	0.5±0.02^{c}	0.51±0.01^{ab}
Carr index (%)	0.96±0.1^{c}	0.89±0.2^{a}	0.94±0.12^{ab}	0.93±0.31^{b}	0.95±0.20^{c}
Hausner ratio	1.29±0.42^{b}	1.21±0.41^{a}	1.24±0.26^{ab}	1.26±0.16^{c}	1.24±0.24^{ac}
Angle of repose (°)	15.9±0.50^{c}	14.9±0.40^{c}	15.3±0.41^{ac}	15.2±0.39^{a}	15.2±0.37^{b}
Loss on drying (% w/w)	0.69±0.05^{a}	0.49±0.02^{b}	0.51±0.02^{ac}	0.53±0.02^{c}	0.55±0.01^{ab}

MHT -Multi herbal Tea;

Note: All values represent the means ± standard deviations from three separate experiments. Different superscripts (a to c) within the different columns denote significant differences ($p < .05$).

The bulk density of the multi herbal powder incorporated tea formulations exhibited minimal variation among the samples. Compared with control, MHT4 recorded the highest bulk density at 0.46 ± 0.01 g/mL, indicating a more compact arrangement of particles. MHT2 closely followed with a density of 0.45 ± 0.01 g/mL, while both MHT1 and MHT3 displayed identical densities of 0.44 ± 0.02 g/mL and 0.44 ± 0.01 g/mL, respectively. These findings suggest that all samples demonstrated favorable packing characteristics, with MHT4 being marginally denser in its natural (uncompacted) state. The bulk behavior of herbal powders is influenced by various physical properties, including particle size and shape distribution, weight, chemical composition, and moisture content [23].
Tapped density values among the formulations ranged from 0.45 ± 0.02 g/mL to 0.52 ± 0.01 g/mL. While compared with control, MHT2 exhibited the highest tapped density at 0.52 ± 0.01 g/mL, followed closely by MHT4 at 0.51 ± 0.01 g/mL and MHT3 at 0.50 ± 0.02 g/mL. In contrast, MHT1 recorded the lowest tapped density value of 0.45 ± 0.02 g/mL. The increased tapped densities observed in MHT2 and MHT4 suggest improved compressibility and a reduction in void space, which may enhance both packaging and handling efficiency. Shanmugam (2015) [24] indicated in his study that herbal powders with extremely fine particle sizes may encounter processing challenges in industrial applications, a finding that aligns with the results of the current study.
The Carr index, which serves as an indicator of the flowability and compressibility of powders, demonstrated slight variations among the tested samples. The formulation identified as MHT4 exhibited the highest Carr index value of 0.95 ± 0.20%, closely followed by MHT2 at 0.94 ± 0.12% and MHT3 at 0.93 ± 0.31%. Conversely, MHT1 recorded the lowest Carr index value of 0.89 ± 0.20%, indicating marginally superior flow properties. All observed values fell within an acceptable range, suggesting that the powders generally possess good flowability. Additionally, the Hausner ratio, another critical measure of powder flowability, ranged from 1.21 to 1.26. Specifically, MHT1 demonstrated the lowest Hausner ratio of 1.21 ± 0.41, while both MHT2 and MHT4 presented identical values of 1.24 ± 0.26 and 1.24 ± 0.24, respectively. MHT3 recorded the highest Hausner ratio of 1.26 ± 0.16, indicating slightly diminished flow characteristics. The analysis of the MHT formulations, as presented in the accompanying table, indicated that all samples were classified as "free flowing." The free-flowing nature of the formulated beverage is likely to mitigate challenges associated with caking in industrial applications. Nevertheless, all formulations-maintained compliance within acceptable limits for powder flow behavior. Furthermore, the enhancement of particle size has been shown to improve flowability, as smaller particle sizes typically hinder flow [25]. This observation aligns with the findings that MHT samples exhibited favorable flow characteristics.
The angle of repose, which serves as an indicator of the internal friction and flow potential of powders, exhibited minimal variation across the formulations. MHT2 recorded the highest angle at 15.3 ± 0.41°, followed closely by MHT3 and MHT4, both of which demonstrated equivalent values of 15.2 ± 0.39° and 15.2 ± 0.37°, respectively. MHT1 presented the lowest angle at 14.9 ± 0.40°. These findings indicate that all formulations possess excellent flow properties, as angles below 30° are generally associated with favorable flowability. Moreover, the loss on drying, a measurement of residual moisture in the samples, showed a slight increase across the formulations. MHT1 exhibited the lowest moisture content at

0.49 ± 0.02%, followed by MHT2 at 0.51 ± 0.02% and MHT3 at 0.53 ± 0.02%. MHT4 displayed the highest moisture loss at 0.55 ± 0.01%. These results suggest that all samples maintained low moisture levels, thereby supporting stability and extending shelf life. Herbal supplements are some of the alternative solutions to weight loss or weight maintenance, having the advantages of being efficient, safe, and less expensive than pharmacological drugs [26].

Chemical Properties of multi herbal powder incorporated tea

Table 3 Chemical Properties of multi herbal powder incorporated tea

Chemical Properties	Control	MHT1	MHT2	MHT3	MHT4
Moisture (%)	6.87±0.69^{a}	6.51±0.32^{b}	6.41±0.42^{ab}	6.59±0.33^{a}	6.59±0.36^{c}
Carbohydrate (%)	68.89±0.90^{ac}	60.87±0.85^{ac}	61.9±0.82^{b}	60.25±0.81^{a}	60.87±0.83^{c}
Protein (%)	17.99±0.53^{ab}	15.84±0.52^{ab}	16.03±0.51^{b}	15.64±0.56^{a}	15.82±0.52^{c}
Fat (%)	3.58±0.78^{c}	3.07±0.55^{c}	3.07±0.52^{b}	3.12±0.53^{ac}	3.19±0.56^{b}
Energy (kcal/100g)	347.8±1.59^{b}	339.2±1.52^{b}	340±2.56^{a}	341.2±1.89^{ac}	342.6±2.64^{c}
Dietary fibre (%)	6.36±1.22^{b}	8.10±1.20^{b}	8.15±1.68^{c}	8.17±1.60^{ac}	8.19±1.46^{c}

MHT -Multi herbal tea;
Note: All values represent the means ± standard deviations from three separate experiments. Different superscripts (a to c) within the different columns denote significant differences ($p < .05$).

According to Pandey *et al.* (2006) [27], proximate or chemical analysis is crucial for determining the nutritional value of food. The necessity and significance of establishing the proximate analysis of herbal formulations for standardization reasons had been underlined by the World Health Organization (WHO) [28]. Tea's moisture content is a crucial quality indicator [29]. There was a minor variation in the multi herbal powder incorporated tea formulations' moisture content between the samples. MHT2 had the highest moisture level (6.41±0.42%), while MHT1 had the lowest (6.51±0.26%). Comparable moisture values of 6.59±0.41% and 6.59±0.43% were found in MHT3 and MHT4, respectively. According to these findings, all four formulations kept their moisture content comparatively low, which is advantageous for extending shelf life and reducing microbial development. Because high moisture contents improve the cohesive strength of powders, Perez and Flores (1997) found that the low moisture content of the powder samples was the reason of their free-flowing character (Table). According to Jayawardhane *et al.* (2016) [30], moisture content should be kept between 2.5 and 6.5% to prevent a breakdown reaction. This allows samples to be stored safely for an extended amount of time and improves stability, both of which were achieved in this MHT formulation. To lower the samples' moisture content, Müller & Heindl (2006) [31] recommended either extending the drying period or employing a different technique, like using dryers set to a certain temperature.

The MHT samples' carbohydrate content varied only slightly. At 61.90 ± 0.82%, MHT2 had the greatest level of carbohydrates. MHT1 and MHT4 had the same values, 60.87 ± 0.85% and 60.87 ± 0.83%, respectively. At 60.25 ± 0.81%, MHT3 had the lowest carbohydrate content. These figures indicated that all formulations contributed the same quantity of calories, with MHT2 perhaps providing a little more energy from carbs. MHT2 had the highest protein content (16.03 ± 0.51%), suggesting a better protein profile than the other formulations. With corresponding scores of 15.84 ± 0.52% and 15.82 ± 0.52%, MHT1 and MHT4 came in close second and third. At 15.64 ± 0.56%, MHT3 had the lowest protein level. All formulations had a significant protein content, indicating their possible nutritional advantages despite these minor variations.

There was little difference in the fat content amongst the MHT samples. At 3.19 ± 0.56%, MHT4 had the greatest fat level, followed by MHT3 at 3.12 ± 0.53%. The fat contents of MHT1 and MHT2 were 3.07 ± 0.55% and 3.07 ± 0.52%, respectively, which were slightly lower and identical. These findings showed that fat had a very uniform distribution and had a moderate contribution to the formulation's overall nutritional value. Minor changes in the macronutrient composition of the herbal tea powders were mirrored in their energy content. At 342.6 ± 2.64 kcal/100 g, MHT4 had the highest caloric value. MHT3 (341.2 ± 1.89 kcal/100 g), MHT2 (340.0 ± 2.56 kcal/100 g), and MHT1

(339.2 ± 1.52 kcal/100 g) were next in line. According to these results, all formulations provided comparable energy levels, with MHT4 providing slightly more energy per 100 g.
All of the formulas had a comparatively constant amount of dietary fiber. At 8.19 ± 1.46%, MHT4 had the highest fiber content, followed by MHT3 (8.17 ± 1.60%) and MHT2 (8.15 ± 1.68%). At 8.10 ± 1.20%, MHT1 got the lowest value. All formulations might be regarded as good sources of dietary fiber, improving digestive health, according to the tight range of values. The crude fiber value was between 8.10 and 8.19g, which is less than the 16.05% crude fiber found by Pradhan and Dubey (2020). Tea made from young leaves has very little fiber, whereas tea that was mechanically picked had a lot of fiber because of the stem [32]. Crude fiber aids in promoting intestinal motility and avoiding constipation [33].

Functional properties of multi herbal powder incorporated tea

Table 4 Functional properties of multi herbal powder incorporated tea

Functional properties	Control	MHT1	MHT2	MHT3	MHT4
pH	6.42±0.12	6.02±0.03	6.11±0.02	6.12±0.05	6.14±0.06
Reconstitution Index (RI) (g/mL)	6.80±0.42	6.61±0.23	6.82±0.21	6.94±0.31	7.10±0.25
Water Absorption Capacity (WAC) (ml/g)	85.23±1.34	83.55±1.20	83.62±1.52	8.60±1.30	8.63±1.25
Swelling Index (SI) (ml/g)	3.41±0.40	2.80±0.32	2.90±0.26	3.20±0.41	3.50±0.64
Water Solubility Index (WSI) (sec)	75.21±1.84	72.0±1.60	72.35±1.62	73.15±1.35	75.65±1.52

MHT -Multi herbal tea;

The pH values of the four MHT samples ranged from 6.02 ± 0.03 to 6.14 ± 0.06, showing a slight but consistent increase from MHT1 to MHT4. This trend suggested that thermal processing had a mild alkalinizing effect on the samples. The gradual rise in pH might have been attributed to the degradation of acidic compounds or the formation of mildly basic constituents during processing. All samples-maintained a near-neutral pH, which was favorable for both product stability and consumer acceptability.
The Reconstitution Index increased progressively from 6.61 ± 0.23 g/mL in MHT1 to 7.10 ± 0.25 g/mL in MHT4. This increase indicated an improvement in the rehydration capacity of the powders with each processing stage. A higher RI reflected better reconstitution properties, likely resulting from improved dispersion or breakdown of the matrix due to high-temperature treatment. This enhancement was considered beneficial in terms of product functionality and ease of use.
The Water Absorption Capacity for MHT1 and MHT2 was 83.55 ± 1.20 mL/g and 83.62 ± 1.52 mL/g, respectively, while MHT3 and MHT4 showed significantly lower values of 8.60 ± 1.30 mL/g and 8.63 ± 1.25 mL/g. This sharp decline may have indicated either a substantial change in processing or a potential typographical error in data entry. If accurate, the results implied a dramatic reduction in the powder's capacity to absorb water, possibly due to structural breakdown or reduced hydrophilic components in the matrix. This variation warranted further investigation. Lower WAC may be due to less availability of polar amino acids in flours. The increase in WAC of blends may be due to an increase in the amylose leaching and solubility, and loss of starch crystalline structure [34].
The Swelling Index increased from 2.80 ± 0.32 mL/g in MHT1 to 3.50 ± 0.64 mL/g in MHT4, indicating that the processed powders exhibited greater volume expansion upon hydration. This trend suggested that thermal treatment enhanced the ability of the matrix to retain water and swell, possibly due to changes in cellular structure or polymer relaxation. The increased SI values were considered favorable for improving the texture and mouthfeel of the final product. The Swelling Index of tea powder measures how much the tea expands when it's added to hot water. It's a quantitative way to describe the volume change of the tea powder upon hydration, which can indicate its particle size, processing methods, and infusion properties.
The Water Solubility Index increased slightly from 72.00 ± 1.60 seconds in MHT1 to 75.65 ± 1.52 seconds in MHT4. The gradual increase in time indicated a marginal decrease in the solubility rate. This could have been due to molecular changes such as protein denaturation or partial starch retrogradation during processing. However, all samples maintained acceptable solubility characteristics, suggesting that the powders remained functionally suitable for reconstitution. Medoua et al. (2005) [35] also reported that the decrease in WSI could be due to the mobilization of soluble substances.

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Sensory evaluation of multi herbal powder incorporated tea

Table 5 Sensory evaluation of multi herbal powder incorporated tea

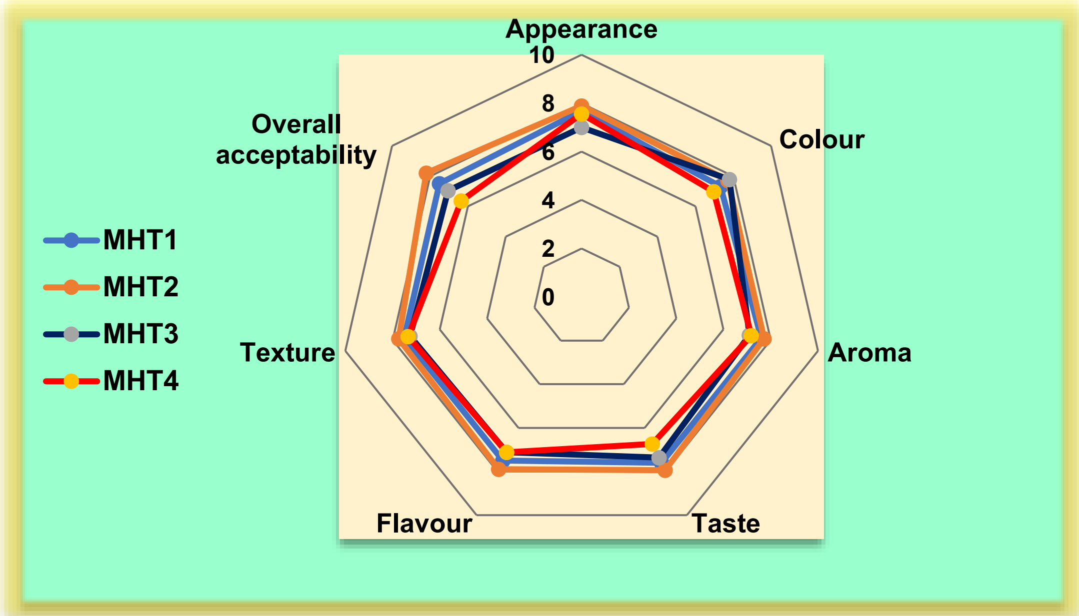
Sensory parameters	Control	MHT1	MHT2	MHT3	MHT4
Appearance	$7.60±1.09^{b}$	$7.89±1.09^{b}$	$7.68±1.09^{b}$	$7.00±0.93^{c}$	$7.56±0.79^{c}$
Colour	$7.25±0.95^{a}$	$7.72±0.85^{bc}$	$7.32±0.85^{a}$	$7.79±0.95^{e}$	$6.97±0.82^{d}$
Aroma	$7.40±0.98^{a}$	$7.72±0.92^{a}$	$7.60±0.98^{a}$	$7.10±0.82^{c}$	$7.18±0.95^{b}$
Taste	$7.50±0.88^{ab}$	$7.94±0.99^{b}$	$7.60±0.96^{ab}$	$7.36±0.85^{c}$	$6.73±0.67^{ab}$
Flavour	$7.40±0.87^{b}$	$7.90±0.88^{c}$	$7.50±0.81^{b}$	$7.12±0.80^{d}$	$7.12±1.26^{c}$
Texture	$7.45±0.64^{b}$	$7.74±1.15^{b}$	$7.50±0.54^{b}$	$7.26±0.81^{d}$	$7.34±0.94^{c}$
Overall acceptability	$7.10±0.78^{b}$	$8.20±0.90^{b}$	$7.50±0.88^{b}$	$7.04±0.93^{c}$	$6.36±0.75^{a}$

MHT -Multi herbal tea;

Note: All values represent the means ± standard deviations from three separate experiments. Different superscripts (a to c) within the different columns denote significant differences ($p < .05$).

The sensory evaluation (Table 5; Figure 2) of the multi herbal powder incorporated tea (MHT) formulations revealed notable differences across various attributes. In terms of appearance, MHT2 received the highest mean score (7.89 ± 1.09), indicating superior visual appeal, followed by MHT1 (7.68 ± 1.09) and MHT4 (7.56 ± 0.79), whereas MHT3 scored the lowest (7.00 ± 0.93), suggesting a comparatively less favorable appearance. For colour, MHT3 was rated the highest (7.79 ± 0.95), denoting a preferred hue among the panelists, while MHT2 and MHT1 received moderately high scores (7.72 ± 0.85 and 7.32 ± 0.85, respectively). MHT4 exhibited the lowest colour score (6.97 ± 0.82), reflecting a reduced visual appeal in this category. Muhimbula *et al.* (2011) [36] posit that sensory evaluation is easy in principle, but its implementation in the field could be challenging, particularly because of the literacy level of the panellist. It is pertinent to note that some processing techniques can improve some of the sensorial attributes.

The aroma attribute showed minimal variation, with MHT2 (7.72 ± 0.92) and MHT1 (7.60 ± 0.98) being rated similarly and more favorably than MHT4 (7.18 ± 0.95) and MHT3 (7.10 ± 0.82). Regarding taste, a key determinant of consumer preference, MHT2 achieved the highest score (7.94 ± 0.99), followed by MHT1 (7.60 ± 0.96) and MHT3 (7.36 ± 0.85), while MHT4 scored significantly lower (6.73 ± 0.67), indicating limited palatability. Aroma is an integral part of the taste and general acceptance of the food before it is put in the mouth. It is therefore an important parameter when testing the acceptability of food samples [36] . Similar trends were observed for flavour, where MHT2 again ranked highest (7.90 ± 0.88), surpassing MHT1 (7.50 ± 0.81), whereas both MHT3 and MHT4 recorded equal but lower scores (7.12 ± 0.80 and 7.12 ± 1.26, respectively), suggesting a weaker or less balanced flavour profile. Ethno-botanically herbs and spices have been significantly utilised traditionally due to their flavour enhancement properties and their medicinal values [37, 38]. In terms of texture, MHT2 (7.74 ± 1.15) received the most favorable evaluation, closely followed by MHT1 (7.50 ± 0.54) and MHT4 (7.34 ± 0.94), while MHT3 had the lowest score (7.26 ± 0.81). Finally, the assessment of overall acceptability demonstrated a clear preference for MHT2, which received the highest score (8.20 ± 0.90), highlighting its superior sensory quality. MHT1 followed with a score of 7.50 ± 0.88, while MHT3 and MHT4 scored 7.04 ± 0.93 and 6.36 ± 0.75, respectively, indicating comparatively lower acceptability. These findings collectively suggest that MHT2 was the most preferred formulation across all sensory parameters.



Sensory evaluation of multi herbal powder incorporated tea
Figure 2

CONCLUSION

It is necessary to encourage the use of tea as a beverage, health drink, or medicated tea to conduct a study and publish the findings. After a thorough review of the literature, it was discovered that tea could be an intriguing research topic. Here, four distinct formulations of a novel herbal tea have been developed and evaluated utilizing mint leaves, guava leaves, bay leaves, cardamom, cinnamon sticks, cloves, and dried ginger. In summary, the development and assessment of MHT1 (10%) offer a viable path forward for investigation in the realm of pharmaceutical studies. Additionally, the sensory evaluation shows that the MHT1 provides a tasty and pleasurable sensory experience, which increases its consumer appeal. Therefore, it was determined that the MHT1 formulation was more palatable and had a higher nutritional value than the other formulations. All things considered, this study adds to the expanding corpus of information about herbal therapy and highlights the promise of natural treatments for a range of illnesses. Herbal products are widely used around the world and are said to be both economical and effective. Utilizing environmentally and biologically friendly plant-based products to treat various human ailments has received a lot of attention lately.

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REFERENCES

1. Lasekan O, Lasekan A. Flavour chemistry of mate and some common herbal teas. Trends in Food Science & Technology. 2012;27(1):37–46.
2. Zhao J, Deng J W, Chen Y W, Li S P. Advanced phytochemical analysis of herbal tea in China. Journal of Chromatography A. 2013;1313: 2–23.
3. Kong D X, Li X J, Zhang H Y. Where is the hope for drug discovery? Let history tell the future. Drug Discovery Today. 2009;14(3/4):115–119.
4. Guimaraes R, Barros L, Duenas M, Calhelha R C, Carvalho A M, Santos-Buelga C, Queiroz M J R P, Ferreira I C F R. Infusion and decoction of wild German chamomile: Bioactivity and characterization of organic acids and phenolic compounds. Food Chemistry. 2013;136 (2): 947–954.
5. Alshami I, Alharbi A E. Antimicrobial activity of Hibiscus sabdariffa extract against uropathogenic strains isolated from recurrent urinary tract infections. Asian Pacific Journal of Tropical Disease. 2014;4(4):317-322.
6. Nikam P H. Future Trends in Standardization of Herbal Drugs. Journal of Applied Pharmaceutical Sciences. 2012; 02(06): 38-44.
7. Alakali J S, Ismaila A R, Alaka I C, Faasema J, Yaji T A. Quality evaluation of herbal tea blends from ginger and Pavetta crassipes. Eur. J. Med. Plants. 2016; 12:1– 8.

8. Anand J, Upadhyaya B, Rawat P, Rai N. Biochemical characterization and pharmacognostic evaluation of purified catechins in green tea (*Camellia sinensis*) cultivars of India. Biotech. 2015; 5:285–294.
9. Astill C, Birch M R, Dacombe C, Humphrey P G, Martin P T. Factors affecting the caffeine and polyphenol contents of black and green tea infusions. J. Agric. Food Chem. 2001; 49:5340–5347.
10. Roheena Abdullah, Swaiba Zaheer, Afshan Kaleem, Mehwish Iqtedar, Mahwish Aftab, Faiza Saleem, Formulation of herbal tea using *Cymbopogon citratus*, *Foeniculum vulgare* and *Murraya koenigii* and its anti-obesity potential, Journal of King Saud University - Science, 2023; 35 (6): 102734.
11. Akshay K R, Sudharani N, Anjali K B, Deepak T M. Biodiversity and strategies for conservation of rare, endangered, and threatened medicinal plants research and Reviews. J pharmacogn phytochem. 2014; 2 (3): 12-20.
12. Barnes P M, Powell-Griner E, McFann K, Nahin R L. Complementary and alternative medicine use among adults: United States, 2002. Adv Data 2004; 27:1-19.
13. Han L, Kimura Y, Okuda H. Anti-obesity effects of natural products. Stud Nat Prod Chem. 2005; 30:79-110.
14. Hasani-Ranjbar S, Larijani B, Abdollahi M A. systematic review of the potential herbal sources of future drugs effective in oxidant-related diseases. Inflamm Allergy Drug Targets. 2009; 8:2-10. 7.
15. Hasani-Ranjbar S, Nayebi N, Moradi L, Mehri A, Larijani B, Abdollahi M. The efficacy and safety of herbal medicines used in the treatment of hyperlipidemia; a systematic review. Curr Pharm Des. 2010; 16:2935-47.
16. Hughes G D, Aboyade O M, Clark B L, Puoane T R. The prevalence of traditional herbal medicine use among hypertensives living in South African communities. BMC Complement Altern Med. 2013; 13:38.
17. Singh H, Arora S, Mani M, Mahaur KK, Chandra P. Development of multicomponent formulation of herbal drugs for evaluation of Antidiabetic activity. Pharm Lett. 2014; 6:219-23.
18. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists International. In: Horwitz, W. (Ed.), 18th Ed. AOAC Press, Arlington, VA, USA, 2005.
19. Mathew J T, Ndamitso M M, Shaba E Y, Muhammed S S, Salihu A B, Abu Y. The determination of nutritive and anti-nutritive value of pelophylax esculentus (Edible Frog). Advance Resources. 2015; 4(6): 412-420.
20. Onwuka G I. Food Analysis and Instrumentation. Theory and Practice. Naphtali Prints. Surulere Lagos Nigeria. 2005;133 - 137.
21. Ukpabi U J, Ndimele C. Evaluation of the Quality of Garri Produced in Imo State. Nigerian Food Journal. 1990; 8:105-110.
22. Anderson A A. Hypoglycemic and hypolipidemic effects of fresh leaf aqueous extract of *Cymbopogon citratus Stapf* in rats. Journal of Ethnopharmacology. 1996; 112: 440–444.
23. Fu X, Huck D, Makein L, Armstrong B, Willen U, Freeman T. Effect of particle shape and size on flow properties of lactose powders. Particuology. 2012;10(2):203-8.
24. Shanmugam S. Granulation techniques and technologies: recent progresses. Bioimpacts. 2015; 5(1): 55-63. PMID: 25901297.
25. Fitzpatrick J, Hodnett M, Twomey M, Cerqueira P S, O'flynn J. Glass transition and the flowability and caking of powders containing amorphous lactose. Powder Technology. 2007; 178: 119-128.
26. Curioni C C, Lourenco P M. Long-term weight loss after diet and exercise: A systematic review. Int. J. Obes. Vol. 2005; 29:1168 1174. doi: 10.1038/sj.ijo.0803015.
27. Pandey M, Abidi A B, Singh S, Singh R P. Nutritional evaluation of leafy vegetable paratha. Journal of Human Ecology. 2006; 19(2): 155-156.
28. Niranjan R M, Kanaki S. Phytochemical standardization of herbal drugs and poly herbal formulations. Bioactive Molecules and Medicinal Plants. 2008;349-369
29. Rehman S U, Almas K, Shahzadi N, Bhatti N, Saleem A. Effect of time and Temperature on infusion of tannins from commercial brands of tea. Int. J Agric Biol. 2002; 4 (2):285-7.
30. Jayawardhane S A D P S, Madushanka K, Mewan K, Jayasinghe S. Karunajeewa N, Edirisinghe E N U. Determination of quality characteristics in different green tea products available in Sri Lankan supermarkets. In 6th Symposium on Plantation Crop Research. 2016; 57-68.
31. Müller J, Heindl A. Chapter 17: Drying of medicinal plants. Medicinal and Aromatic Plant. 2006; 237–252.
32. Œmiechowska M, Dmowski P. Crude fibre as a parameter in the quality evaluation of tea. Food Chem. 2006; 94(3), 366-368.
33. Mohammed M I, Sulaiman M A. (2009) Proximate, caffeine and tannin analyses in some brands of tea consumed in Kano Metropolis. Nigeria Bayero J Pure Appl Sci. 2009; 2(2):19-21.
34. Kuntz I D. Hydration of macromolecules III. Hydration of polypeptides J Am Chem Socie. 1971; 93:514–515. doi: 10.1021/ja00731a036.
35. Medoua G N, Mbome I L, Agbor-Egbe T, Mbofung C M F. Physicochemical changes occurring during post-harvest hardening of trifoliate yam (Dioscorea dumetorum) tubers. Food Chem. 2005; 90:597–601. doi: 10.1016/j.foodchem.2004.04.018.
36. Muhimbula H S., Issa-Zacharia A, Kinabo J. Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania. African Journal of Food Science. 2011; 5:26-31.
37. Ayodele J A, Ayodeji A O, Oluwafemi T O, Sunday A O, Scholarstical A. Inhibitory effect of tannic acid and its derivative (gallic acid) against cisplatin–induced thiobarbituric acid reactive substances (TBARS) production in rat kidney–in vitro. International Journal of Advanced Research. 2015; 3(1), 116-126.
38. Alexandra N Welz, Agnes Emberger-Klein, Klaus Menrad. Why people use herbal medicine: insights from a focus-group study in Germany. BMC Complementary and Alternative Medicine. 2018; 92(18):2160-6. PMID: 29544493.