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Development of Berry-Flavored Lemongrass Herbal Tea

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Abstract

Lemongrass abundantly grows in almost any area of Benguet with proper drainage and adequate sunlight. It is being used as an herbal tea but its pale- or light-yellow color may not be appealing, locally produced packaging is unavailable, and its commercialization in Benguet is limited. The study aimed to increase the market competitiveness of lemongrass herbal tea by adding berry flavors from locally available strawberries and mulberries and packaging them in tea bags. The study determined the most acceptable berry-flavored lemongrass herbal tea as regards: (1) sensory qualities; (2) formulation or percentage of freeze-dried strawberries and mulberries; (3) return on cash expense; and (4) nutrient content of the most acceptable formulation. Sensory evaluation involving 50 consumer-type panelists determined the sensory qualities and acceptability of the tea formulations. Modes and means were used to interpret the results of sensory evaluation. ANOVA with repeated measures determined if significant differences exist among samples. The most acceptable berry-flavored lemongrass herbal tea sample was subjected to the computation of return on cash expense and nutrient content analysis. Results revealed the potential marketability of the berry-flavored lemongrass herbal tea. Pilot commercialization of berry-flavored lemongrass herbal tea consisting of 50% dried lemongrass leaves, 25% freeze-dried strawberries, and 25% freeze-dried mulberries is recommended.

Introduction

Tea, the most popular beverage consumed by two-thirds of the world's population, is made from the processed leaf of *Camellia sinensis* (Valavanidis, 2019). Fundamentally, tea is an infusion of the leaves or other parts of the evergreen tea plant (*Camellia* sp.). Tea types, based on processing or harvested leaf development, are black, green, and oolong (Khizar et al., 2015). Aside from the most common types of tea, some teas are not pure varieties but have been enhanced through additives or special processing, which allow for the design of an almost endless range of scented and flavored variants. At present, herbal tea has gained increasing popularity among consumers (Poswal et al., 2019).

Herbal tea, tisane, or aromatized tea plants are popular due to their fragrance and being naturally caffeine-free, which could inhibit calcium absorption (Rabade et al., 2016). Herbal tea is

made from the infusion or decoction of herbs, spices, or any other plant material in hot water and is categorized by what part of the plant it comes from: leaf (mint, neem, cocoa,); flower (rose, chamomile, hibiscus, and lavender); bark (cinnamon, slippery elm, and black cherry bark); root (ginger, echinacea, and chicory); and fruit (citrus peel, raspberry, blueberry, peach) (Ndife et al., 2019). Regular intake of herbal tea is associated with an improved antioxidant status that may contribute to lowering the risk of coronary heart disease, atherosclerosis, reduced mutagenicity, and inflammation (Sentkowska & Pyrzynska, 2017).

In Benguet, indigenous plants are available, used, and innovated (Chua-Barcelo, 2014). Therefore, it is imperative to explore the potential of indigenous plants like lemongrass in the development or innovation of existing products.

Lemongrass (*Cymbopogan citratus*) is a native aromatic tall sedge of the family Poaceae with diverse medicinal uses for treating digestive tract spasms, high blood pressure, convulsions, vomiting, cough, fever, etc. (Srivastava et al., 2013). According to Olorunnisola et al. (2013), the lemongrass plant could grow up to 6 inches high, and its bulblike stems consist of terete and glabrous linearly venerated sheathed leaves with a narrow base and acute apex. The leaf height is about 100cm in length and 2cm in width. When squeezed, the leaves usually produce yellow or amber-colored, aromatic essential oil (Tajidin, 2012). Aside from its medicinal use, the aqueous extract of lemongrass is used as a natural flavoring for traditional foods (Attokaran, 2017) and as an aromatic drink (Wifek et al., 2016) or herbal tea.

Lemongrass herbal tea is usually prepared by boiling lemongrass and is naturally drunk without any additional flavoring (Nambiar & Matela, 2012). Lemongrass tea infusion is light colored with a characteristic mild lemongrass aroma. In the study, the researcher considered improving the color of the lemongrass tea infusion by adding natural sources of more pronounced and appealing color. Thus, mulberries were identified. Mulberries are the latest in a fairly long line of fruit berries to be given "superfood" status because the level of antioxidants present in the fruits are 70% higher than blueberries and 24% higher than cranberries, thus promoting medicinal, nutritional, and commercial values (Asha Krishna et al., 2015). In addition, mulberries are appetizing, low in calories (Wang et al., 2016), and possess a more concentrated flavor for fruit production and fresh consumption (Zhang et al., 2018). Mulberry trees thrive in Benguet and are planted along roadsides, sheds, and backyards of most homes and institutions, which are usually ignored due to their limited known benefits and uses (Flora, 2018). On the other hand, to add excitement to the "berry" aroma of the lemongrass tea infusion, the researcher added strawberries. Strawberries are a rich source of health-promoting phytonutrients, minerals, and vitamins (Cosalan, 2014). Strawberries possess high amounts of phenolic flavonoid phytochemicals called anthocyanins and ellagic acid. Anthocyanins produce soluble glycoside pigments that generate blue-to-red coloring in flowers and plants that promotes additional palatability (Soares, 2014). In addition, strawberries possess a distinct, powerful flavor when used as a flavoring in all types of food and beverages, especially when treated with modern technologies (Schwieterman et al., 2014). Strawberries are locally available in Benguet, particularly in the municipalities of La Trinidad, Mankayan, Tublay, and Kibungan (Alimondo, 2018). The berry-flavored lemongrass tea combines the delicate aroma of the lemongrass, the berry flavor of strawberries, and the appealing color of the mulberries packed in tea bags for convenience.

In line with the preservation of the flavor of strawberries and the color of mulberries, Skrovankova et al. (2015) suggested freeze-drying as a postharvest preservation technique for these berries to maintain the biological substances in the fruits. Freeze drying is a dehydration method that involves sublimation. The vacuum allows ice to turn directly into vapor without first passing through the water stage (Bhambere et al., 2015). Freeze drying produces food items that maintain their natural flavor and color (Mat et al., 2018), lengthen shelf life, lessen contamination, achieve and maintain the sterility of the product (Valentina et al., 2016), and retain almost all the nutrients that a fruit possesses (Timilehin & Yoon, 2020). Thus, freeze-drying technology was considered for the dehydration of mulberries and strawberries to be used in tea formulations.

In the study, lemongrass leaves, strawberry, and mulberry fruits went through different

processes of dehydration to prevent undesirable changes in their sensorial and nutritional qualities. Dried lemongrass leaves, freeze-dried strawberries, and freeze-dried mulberries were mixed to form a herbal tea, which is conveniently packed and ready to be sold.

Materials and Methods

Materials

The lemongrass, *Cymbopogan citratus* (Figure 1), was used in the study. The lemongrass species grows abundantly in Benguet (Dagupen et al., 2009) and is readily available in the public markets of Baguio City and La Trinidad.

The strawberries used in the study were the marble Sweet Charlie variety (Figure 2). Marble strawberries are usually sold cheaper and intended for processing. Fully ripe marble strawberries were procured from the local farmers of La Trinidad, Benguet. The ripe mulberries (Figure 3) were bought from the locals of Tuba, Tublay, and La Trinidad. The tea formulations were packed in commercial tea bags.

Methods

Preparation of Lemongrass Samples

The steps in the preparation of the lemongrass leaves are presented in Figure 4. The leaves were washed in clear, running water to remove dust and other dirt particles. Washed shoots were cut 4 to 6 inches away from the roots and equally weighed and divided. The washed lemongrass leaves were blanched for 1 minute for enzyme inactivation and retention of the initial quality of the fresh lemongrass (Saetan et al., 2016), immersed in cold water to prevent the heat-liable antioxidant from degradation caused by prolonged heat, and then spread out in the feed of the cabinet dryer. The lemongrass leaves were dehydrated at 70°C. After dehydrating for approximately 2 hours, the lemongrass leaves were allowed to cool in the cooling system of the cabinet dryer. Finally, the leaves were ground, sifted, and stored in a clear plastic container.

Figure 1

Lemongrass (Cymbopogan citratus)

Figure 2

Fresh Strawberries

Figure 3

Fresh Mulberries

Figure 4

Preparation of Lemongrass Leaves

Preparation of Strawberries and Mulberries

The freeze-drying of strawberries and mulberries was adopted from the study of Somyden et al. (2019). The strawberries and mulberries were prepared separately. The calyxes of the strawberries were removed, then the strawberries were washed thoroughly and drained. After draining, these were soaked in a solution with 4% citric acid for two minutes. After soaking, the strawberries were drained, arranged in a tray lined with wax paper, covered with cling wrap, and frozen for 24 hours. The mulberries were washed in running water, drained, soaked in a 4% citric acid solution for two minutes, then drained again. Afterward, the mulberries were blended with 10% maltodextrin as a binder and thickener to hold the shape and avoid surface collapse. After blending, the mulberries were scooped in freezer-safe molders, covered with cling wrap, and frozen for 24 hours. The fruits were freeze-dried separately following the same procedures. Before freeze-drying, the cling wraps of the frozen fruits were removed, and the frozen fruits were freeze-dried using the fabricated freeze dryer of DOST housed at BSU-ATBI/IC. In freeze-drying, the condenser temperature was set at -25°C and the heater temperature at 15°C. Freeze-drying is completed when the pressure indicates 9.9x10 (99) pascals. After freeze-drying, the freeze-dried fruits (Figures 5 and 6) were packed in aluminum foil pouches, sealed using the multi-function band sealer, and set aside until needed.

Figure 5

Freeze-Dried Strawberries

Figure 6

Freeze-Dried Molded Mulberries

Preparation of Tea Formulations

In the formulation of herbal tea, trial and error were used. After several attempts, the varied formulations of the lemongrass herbal tea were established (Table 1).

The tea formulations were packed in tea bags of 3 grams in net weight. Each tea bag consists of an equal percentage of dried lemongrass leaves (1.5 grams) and varying amounts of freeze-dried strawberries and mulberries.

Sensory Evaluation of the Berry-Flavored Lemongrass Herbal Tea

A sensory evaluation of tea samples was conducted to establish preference ratings of the berry-flavored lemongrass herbal tea formulations for color, the strength of the lemongrass, strawberry, and mulberry flavors, aftertaste, and acceptability. Tea samples (3g) were steeped in 150 ml of freshly boiled water for one minute, and then the infusion was poured into paper cups for quality assessment. Random sampling was employed in choosing the sensory evaluators composed of 50 consumer-type panelists.

Statistical Analysis

The results of the sensory evaluation were tabulated. The mode was used to determine the color; strength of lemongrass, strawberry, and mulberry flavors; and aftertaste of berry-flavored lemongrass herbal tea, considering varied descriptors. The mean was used in determining the level of acceptability of the qualities and overall acceptability of the berry-flavored lemongrass herbal tea. Analysis of variance (ANOVA) with repeated measures using Statistical Program for the Social Sciences (SPSS) was used to determine if significant differences in the level of acceptability of the identified attributes exist among the samples.

Return of Cash Expense and Nutrient Analysis

The following formula was used in computing the return on cash expense (ROCE):

$$\text{ROCE} = \frac{\text{Profit}}{\text{(Total cash expense per unit)}} \times 100$$

Finally, the most acceptable tea formulation was subjected to nutrient analysis at the Department of Science and Technology (DOST) in Region 1 to determine the nutrient content in terms of ash content, crude protein, crude fat, moisture content, and total carbohydrates.

Results and Discussion

Characteristics of Berry-Flavored Lemongrass Herbal Tea Formulation

Color

Table 2 shows the sensory evaluation results on color characteristics and degree of liking of berry-flavored lemongrass herbal tea. The red

Table 1

Formulations of Berry-Flavored Lemongrass Herbal Teas

Treatments	Dried Lemongrass leaves	Freeze-Dried strawberries	Freeze-dried mulberries	Total
1 (50:25:25)	50 % (1.5 g) dried lemongrass leaves	25 % (0.75 g) freeze-dried strawberries (powdered)	25 % (0.75 g) freeze-dried mulberries (powdered)	100 % (3 grams)
2 (50:32:18)	50 % (1.5 g) dried lemongrass leaves	32 % (0.48 g) freeze-dried strawberries (powdered)	18 % (0.27 g) freeze-dried mulberries (powdered)	100 % (3 grams)
3 (50:18:32)	50 % (1.5 g) dried lemongrass leaves	18 % (0.27 g) freeze-dried strawberries (powdered)	32 % (0.48 g) freeze-dried mulberries (powdered)	100 % (3 grams)

tones of colors observed were from the extracted pigments of anthocyanins from strawberries and mulberries. Anthocyanins are the major polyphenolic compounds in strawberries and mulberries, which are expected to be more in ripe fruits than unripe fruits (Orid, 2017). According to Skrovankova et al. (2015), the anthocyanin content of strawberries is much lower than the anthocyanin present in mulberry (Larasati & Issutarti, 2017), which gave the result that when combined, even if proportions varied, they would produce red-tone colors. Therefore, it is likely that the anthocyanins in strawberries and mulberries in the tea samples may have dissolved more readily in the infusion, thereby overshadowing yellow pigments (flavonoids) contained in lemongrass (Anesi De-Heer, 2011).

The berry-flavored lemongrass herbal tea formulation 50:25:25 was described as red-violet and obtained the highest mean, indicating that it was the most liked in terms of color. This result implies that the panel members are attracted to red-violet color for their herbal tea preference, making 50:25:25 the most acceptable in terms of color. The other herbal tea samples were described as light red and were described as liked moderately and liked slightly. These samples have lighter color of the infusion due to the unequal distribution of ingredients (Downham & Collins, 2000).

Strength of Lemongrass Flavor

The panelists perceived that the three samples of berry-flavored lemongrass herbal tea possess moderate lemongrass flavor (Table 3) due to the presence of aromatic oil such as citral aroma as the principal constituent (Dzah, 2015). The citral component is composed of geranial and neral. Geranial has a strong lemon odor while the neral has a weaker but sweeter odor than the geranial; both are insoluble in water (Tajidin, 2012).

Overall, the three tea samples are evaluated as possessing a moderate lemongrass flavor due to

Table 2

Results of Sensory Evaluation on the Color and the Level of Acceptability of Color of the Berry-Flavored Lemongrass Herbal Tea Samples

	Description			Degree of Liking		
Treatments	Mode	Descriptive Value	Mean	Descriptive Value	F-value	P-value
T1: 50:25:25	27	Red violet	7.54[a]	Liked very much	10.930**	0.000
T2: 50:32:18	20	Light red	6.44[b]	Liked moderately		
T3: 50:18:32	25	Light red	5.94[c]	Liked slightly		

Legend: Means of different letters are significant at 1% level using Bonferroni of ANOVA Repeated Measures

Table 3

Results of Sensory Evaluation on the Strength of Lemongrass Flavor and the Level of Acceptability of Strength of Lemongrass Flavor of the Berry-Flavored Lemongrass Herbal Tea Samples

	Description			Degree of Liking		
Treatments	Mode	Descriptive Value	Mean	Descriptive Value	F-value	P-value
T1: 50:25:25	25	Moderate Lemongrass Flavor	7.02[a]	Liked very much	9.141**	0.000
T2: 50:32:18	28	Moderate Lemongrass Flavor	6.10[b]	Liked slightly		
T3: 50:18:32	22	Moderate Lemongrass Flavor	5·92[b]	Liked slightly		

Legend: Means of different letters are significant at 1% level using Bonferroni of ANOVA Repeated Measures

the equal distribution of weight, which is 50% (1.5 grams per tea bag) of dried lemongrass leaves in the three tea samples. This implies that 1.5 grams of dried lemongrass leaves possess moderate lemongrass flavor, although a varied consumer panel acceptability was observed. This result may be due to the obscured effect of the color of the sample, as it was established that a darker color is associated with a stronger lemongrass flavor in tea infusions (Spence et al., 2015; Hutchings, 2003). Thus, the formulation 50:25:25 was liked very much in terms of the strength of lemongrass flavor which is perceived as having a darker color and a moderately strong lemongrass flavor. Meanwhile, other herbal tea samples were liked slightly.

Strength of Strawberry Flavor

Based on the results of the three herbal tea samples, the panel members observed that the strength of strawberry flavor of Treatment 50:25:25 has moderate strawberry flavor and was liked moderately, while Treatments 50:32:18 and 50:18:32 have weak strawberry flavor and were liked slightly (Table 4). Accordingly, the strength of the strawberry flavor in the three herbal tea samples varies from one another because each sample constitutes a varied allocation of freeze-dried strawberries.

Each combination of the three tea samples has a slightly different volatile profile, as it was observed that the more volatile ones are present in higher concentrations and vice versa (Forney et al., 2000). Dzah (2015) emphasized that mixtures having a higher percentage of materials had higher scores for their strength of (strawberry) flavor and vice versa. Furthermore, Schwieterman et al. (2014) emphasized that the strength of the strawberry flavor relied on approaches in which the presence of volatiles is at least initially based on abundance and vice versa. This was evident in treatment 50:25:25, wherein a high proportion of freeze-dried strawberries in the herbal tea produces a strong strawberry flavor. Moreover, treatment 50:32:18 contains a much higher proportion of freeze-dried strawberries in the mixture, but it was not described as having a stronger strawberry flavor. It may be due to the psychological impact of the color of the tea, that a light-colored tea sample is perceived to have a weaker flavor and vice versa (Spence, 2015). This was confirmed in the perceptual preferences of the panel members in evaluating the berry-flavored lemongrass herbal tea. For treatment 50:18:32, it possesses a low proportion of freeze-dried strawberries, thus possessing a weaker strength of strawberry flavor as associated with the response of the panel members.

Strength of Mulberry Flavor

The respondents rated the strength of the mulberry flavor as moderately strong (Table 5). According to Wani et al. (2017), the strength of the mulberry flavor is a key quality that determines the potential for consumption and further processing.

The results showed that the varied percentage of mulberry added to the tea samples did not affect the panelists' observed level of the strength of the mulberry flavor. This result may be because

Table 4

Results of Sensory Evaluation on the Strength of Strawberry Flavor and the Level of Acceptability of Strength of Strawberry Flavor of the Berry-Flavored Lemongrass Herbal Tea Samples

Treatments	Description		Degree of Liking			
	Mode	Descriptive Value	Mean	Descriptive Value	F-value	P-value
T1: 50:25:25	24	Moderate Strawberry Flavor	6.70[a]	Liked moderately	6.392**	0.003
T2: 50:32:18	19	Weak Strawberry Flavor	6.02[b]	Liked slightly		
T3: 50:18:32	15	Weak Strawberry Flavor	5.80[b]	Liked slightly		

Legend: Means of different letters are significant at 1% level using Bonferroni of ANOVA Repeated Measures

the same steeping time of 1 minute was done on the three samples. Brewing can make the aroma compounds evaporate regardless of consistency. Thus, the strength of the mulberry flavor in the three tea formulations was the same due to equal steeping time (Taufik et al., 2016). This result implies that the period of brewing or steeping the herbal tea also affects the strength of the mulberry flavor in the infusion. Furthermore, regardless of the proportion of freeze-dried mulberries in the tea bag, the same strength of mulberry flavor will be observed as long as the same steeping time is maintained. As to the degree of liking, the formulation 50:25:25 had the highest mean rating described as moderately acceptable indicating that the panel members prefer 25% freeze-dried mulberries on their herbal tea infusion. Meanwhile, a slight acceptance was observed in the formulations with 32% and 18% freeze-dried mulberries, respectively.

After Taste

The result of the sensory evaluation for the aftertaste of the berry-flavored lemongrass herbal tea for the three samples exceeds no astringent aftertaste (Table 6). The results confirm the studies of Ashok and Upadhyaya (2012) and Rabade et al. (2016) that herbal teas are free from caffeine and tannins, which usually cause astringency. No astringent aftertaste was observed compared to the usual tea from the plant *Camelia sinensis*, which has polyphenols, caffeine, and some amino acids that cause bitterness (Scharbert & Hofmann, 2005; Tfouni et al., 2018). Furthermore, the no astringent aftertaste in the samples may be attributed to the addition of berry flavors involved in hiding its aftertaste (Contreras-Lopez et al., 2021).

For the degree of liking, the results showed that Treatment 1 is moderately accepted, indicating the highest mean of acceptability, and Treatments

Table 5

Results of Sensory Evaluation on the Strength of Mulberry Flavor and the Level of Acceptability of Strength of Mulberry Flavor of the Berry-Flavored Lemongrass Herbal Tea Samples

	Description			Degree of Liking		
Treatments	Mode	Descriptive Value	Mean	Descriptive Value	F-value	P-value
T1: 50:25:25	26	Moderate Mulberry Flavor	6.78[a]	Liked moderately	7.333**	0.002
T2: 50:32:18	27	Moderate Mulberry Flavor	6.02[b]	Liked slightly		
T3: 50:18:32	17	Weak or Moderate Mulberry Flavor	5.54[b]	Liked slightly		

Legend: Means of different letters are significant at 1% level using Bonferroni of ANOVA Repeated Measures

Table 6

Results of Sensory Evaluation on the Aftertaste and the Level of Acceptability of Aftertaste of the Berry-Flavored Lemongrass Herbal Tea Samples

	Description			Degree of Liking		
Treatments	Mode	Descriptive Value	Mean	Descriptive Value	F-value	P-value
T1: 50:25:25	32	No Astringency	6.62[a]	Liked moderately	5.697**	0.006
T2: 50:32:18	30	No Astringency	6.12[b]	Liked slightly		
T3: 50:18:32	31	No Astringency	5.94[b]	Liked slightly		

Legend: Means of different letters are significant at 1% level using Bonferroni of ANOVA Repeated Measures

2 and 3 were slightly accepted. Analysis showed varied acceptability among the sample in their aftertaste, though it was determined that the three tea samples has no astringent aftertaste. This may be due to individual differences in aftertaste preference or variance in the perceptual qualities of the panel members leading to different hedonic evaluations.

Overall Acceptability of Berry-Flavored Lemongrass Herbal Tea

The results of the sensory evaluation on the overall acceptability of the berry-flavored lemongrass herbal tea reveal a highly significant difference between Treatment 1 when compared to Treatments 2 and 3 (Table 7). Formulation 50:25:25 obtained the highest mean for overall acceptability with a descriptive equivalence of liked very much. The other two samples were rated as liked moderately. Based on the results, it can be deduced that consumers liked the most the formulation with 50% dried lemongrass leaves and 25% each of the freeze-dried strawberries and mulberries. It may be recalled that this treatment 50:25:25 also received the highest acceptability rating in terms of color, strength of lemongrass flavor, strength of strawberry flavor, and mulberry flavor.

Return on Cash Expense of the Most Acceptable Berry-Flavored Lemongrass Herbal Tea Samples

The ROCE and selling price were computed for the most acceptable berry-flavored lemongrass herbal tea formulations based on sensory evaluation (Table 8).

Results of computation show that the most acceptable berry-flavored lemongrass herbal tea costs Php379.73 with a 13.04% return on cash expense assuming a yield of 500 tea bags. When the cost is compared with the existing commercial herbal teas as presented in Table 9, the newly developed product is expensive though with a high return of cash expense (WallstreetMojo, 2019; Esajian, 2019). This may be primarily due to the amount spent on renting the fabricated freeze-dryer (Duan et al., 2015). However, the selling price may be lowered and comparable to commercialized herbal teas when efficient production equipment like a commercialized freeze–dryer is used, negotiation of prices with suppliers for the raw materials is established, and production of larger yields of the herbal tea to maximize operational cost is performed.

Nutrient Content of the Most Acceptable Berry-Flavored Lemongrass Herbal Tea Sample

The nutrient content of the most acceptable berry-flavored lemongrass herbal tea consisting of 50% dried lemongrass leaves, 25% freeze-dried strawberries, and 25% freeze-dried mulberries (Treatment 1) at 3 grams per serving, based on its proximate analysis has 10 kcal, 0g total fat, 0g carbohydrates, 0mg sodium, 2g total carbohydrates, 0g sugar, and 0g protein (Table 10). Based on the results, the most acceptable berry-flavored lemongrass herbal tea has a nutritional composition comparable to the commercial herbal tea brands on the market. Moreover, it has a higher amount of calories and carbohydrates as compared to the flavored herbal tea samples A and B, which has no calories and carbohydrates. Meanwhile, a lesser amount of calories and carbohydrates were analyzed in flavored herbal tea sample C. The higher amount of calories and carbohydrates analyzed in the most acceptable berry-flavored lemongrass herbal tea may be due to the availability of retained natural sweeteners in strawberries and mulberries after

Table 7

Results on the Overall Liking of the Berry-Flavored Lemongrass Herbal Tea Samples

Treatments	Mean	Descriptive Value	F-value	P-value
T1: 50:25:25	7.40[a]	Liked very much	7.843**	0.001
T2: 50:32:18	6.64[b]	Liked moderately		
T3: 50:18:32	6.42[b]	Liked moderately		

Legend: Means of different letters are significant at 1% level using Bonferroni of ANOVA Repeated Measures

Table 8

Computation of ROCE and Selling Price of the Most Acceptable Berry-Flavored Lemongrass Herbal Tea

Item		Amount (Php)	Amount (Php/20pcs-pack)
Direct cost			
Material costs (Yield: 500 tea bags)	750 g Dried Lemongrass	144.98	
	375 g Freeze-dried Strawberry	2243.51	
	375 g Freeze-dried Mulberry	3157.28	
	Tea bag for packaging	1650.00	
Subtotal		7,505.77	
Labor cost		310.00	
Indirect cost (10%)		750.58	
Total Cash Expense		8,256.35	330.20
Mark-up Price: 15%			Php 49.53
Suggested Selling Price (20s)			Php 379.73
ROCE	Php 49.53/Php 379.73 x 100		13.04%

freeze-drying (Food and Drug Administration, 2018; Hursel et al., 2009). This result implies that the higher the sugar of the ingredients in herbal tea, the higher the calories and carbohydrates extracted. In addition, the total weight per serving of the most acceptable berry-flavored lemongrass herbal tea is higher by one gram compared to the other flavored herbal tea, resulting in a higher amount of analyzed calories and carbohydrates. Therefore, the results showed that the most acceptable berry-flavored lemongrass herbal tea presented a better nutritional profile for energy consumption (Sridnar & Charles, 2021).

Table 9

Price Range of Other Flavored Tea Brands

Tea Brands	Price per pack of 20s
A	Php 209.50
B	Php 251.00
C	Php 261.50
Berry-Flavored Lemongrass Herbal Tea	Php 379.73

Table 10

Nutrient Content of the Most Acceptable Berry-Flavored Lemongrass Herbal Tea as Compared to Other Flavored Herbal Tea

Test Parameter	Berry-flavored lemongrass herbal tea (3 grams)	Flavored herbal tea sample A (2 grams)	Flavored herbal tea sample B (2 grams)	Flavored herbal tea sample C (2 grams)
Calories	10	0	0	2
Total Fat	0 g	0 g	0 g	0 g
Cholesterol	0 g	0 mg	0 mg	0 g
Sodium	0 mg	0 mg	0 mg	< 0.01 mg
Total Carbohydrate	2 g	0 g	0 g	0.6 g
Sugar	0 g	0 g	0 g	0.2 g
Protein	0 g	0 g	0 g	0 g

On the other hand, 0.01 mg of sodium and 0.20 grams of sugar were found in flavored herbal tea sample C, while sodium and sugar were not found in the most acceptable berry-flavored lemongrass herbal tea and flavored samples A and B. The absence of sodium may be due to the lack of sodium-causing ingredients in herbal tea (Rolls et al., 2002). The absence of sodium content in the most acceptable berry-flavored lemongrass herbal tea makes it suitable for the treatment of hypertension and renal diseases (Ndife et al., 2019). In addition, the unavailability of sugar was recorded. Naturally, lemongrass, strawberries, and mulberries contain sugars (Wray & Ranaswamy, 2015); however, the application of drying methods with varied temperatures in the drying process caused the loss of bioactive compounds like sugar (Kowalska et al., 2018). The absence of sugar indicates that the herbal tea could be consumed without risk of hypertension by diabetic and obese individuals (Ekissi et al., 2015). Meanwhile, the unavailability of other nutrients in terms of fat, cholesterol, and protein among the four samples of flavored herbal teas was recorded since berries and other ingredients are not good sources of the said nutrients (Bere, 2007). Therefore, results showed that the absence of fat and cholesterol in herbal teas supports heart health (Ravikumar, 2014) and induces weight loss (Hosen et al., 2014).

Finally, on a dry formulation basis, considering its macronutrients, a tea sample consisting of 50% dried lemongrass leaves, 25% freeze-dried strawberries, and 25% freeze-dried mulberries (Treatment 1) contains 0.144g of ash, which may indicate a reasonable amount of minerals (Parvathy et al., 2021); 0.78g moisture, which indicates juiciness of the ingredients that may help in body hydration and may help in identifying appropriate packaging material to be used (Fegus et al., 2015); 0.2445g of protein which may make physiological activities easier (Ezeabara & Mbah, 2016); 0.0642g of fat for energy storage (Pisoschi, 2015); and 2.47g of carbohydrates, which may help in improving the immune system and brain functioning (Neji & Agwupuye, 2019). Meanwhile, a tea sample consisting of 50% dried lemongrass leaves, 25% freeze-dried strawberries, and 25% freeze-dried mulberries (Treatment 1), when infused with 150ml of water, contains 0.0027g of ash, 2.76 g of moisture, 0g of protein, 0.0054g of fat, and 0.23g of carbohydrates (Table 11). Results show that much lesser nutrients are observed in the tea infusion compared to the dry formulation. This may be due to the amount of water that is used in the infusion (Gordon, 2020). It is most likely that the nutrients are soluble in water, therefore lessening their nutritional values (Pace et al., 2004).

Therefore, the amount of nutrients extracted in the most acceptable berry-flavored lemongrass herbal tea varies depending on the techniques in manufacturing and process involved before drinking the herbal tea. Some processes result in the unstable characteristics of the aforementioned nutrients (Devi, 2015). Thus, the most acceptable berry-flavored lemongrass herbal tea either in dry formulation or tea infusion possesses nutrients but in lesser quantities.

Table 11

Nutrient Content of the Most Acceptable Berry-Flavored Lemongrass Herbal Tea in Terms of Dry Formulation and Tea Infusion

Test parameter	Dry formulation (g/3 grams)	Tea infusion of 3 grams (with 150 ml water)
Ash Content	0.1440	0.0027 g
Crude Protein	0.2445	0.0000 g
Crude Fat	0.0642	0.0054 g
Moisture Content	0.7800	2.7600 g
Total Carbohydrates	2.4700	0.2300 g

Conclusions

Based on the findings, the following conclusions were drawn: 1) the proportion of freeze-dried flavors in the berry–flavored lemongrass herbal tea affects the qualities of the tea; 2) Berry-flavored lemongrass herbal tea can be potentially marketed because of its high level of acceptability; and 3) at 3g per serving, the most acceptable berry-flavored lemongrass herbal tea has higher total cash expense and selling price compared to the commercialized herbal teas; and 4) the most acceptable berry-flavored lemongrass herbal tea has comparable nutrients with the existing commercialized herbal tea.

Recommendations

Based on the conclusions, the following recommendations are offered: 1) the berry-flavored lemongrass herbal tea formulation comprised of 50% dried lemongrass leaves, 25% freeze-dried strawberries, and 25% freeze-dried mulberries; 2) pilot commercialization of berry-flavored lemongrass herbal tea to validate marketability; and 3) use of commercialized freeze-dryer to lessen production cost and selling price and make it comparable with commercial herbal teas. It is also recommended that further studies be done on the shelf-life stability and testing of phenolic and antioxidant compounds in berry-flavored lemongrass herbal tea.

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