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RESEARCH ARTICLE

DEVELOPMENT OF HERBAL TEA USING MORINGA OLIFERA, ELSHOLTZIA COMMUNIS AND ALPINIA GALANGA: A SENSORY ACCEPTANCE STUDY

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Abstract

The present study aims to develop an herbal tea formulation from leaves of *Moringa oleifera* incorporating with rhizomes of *Alpinia galanga* and the inflorescence of *Elsholtzia communis* with an insight to improve its sensory attributes and also enhancing the nutritional value. The ingredients were processed and three herbal teas HT₁, HT₂, HT₃ were formulated by mixing them at different levels of incorporation. Acceptability trials for color, aroma, taste and overall acceptability revealed that HT₂ was the most liked infusion with highest scores for color (7.8), taste (8.04) and overall acceptability (7.96). The total antioxidant capacity of HT₂ was determined by the DPPH scavenging activity test by the method of Blois. The methanolic extracts of the herbal tea sample showed 76.12% radical scavenging activity whereas the sample extracted with DMSO showed a lower antioxidants capacity of 62.45%. The shelf life of the herbal tea was studied by storing in different packaging materials. HDPE Zip loc bags, tea bags (packed in paper cartons) and HDPE containers stored the product without spoilage over a period of six months. The developed herbal tea has a good market potential with significant health benefits.

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Introduction:-

Tea is the most consumed beverage in the world after water and is considered as an important world food product (Schmidt et al., 2005). The consumption of various types of tea as beverage had been documented from ancient times. A category of tea called herbal tea, is gaining consumer's interest from the past few years. Herbal tea is a mixture of spices, herbs or other plant materials in boiling water, known to have immense health benefits (Thomson et al., 2018). The use of *Moringa oleifera* leaves as a potent ingredient in formulation of herbal tea has been emerging in recent years. *Moringa oleifera* is the sole genus in the family Moringaceae and a widely cultivated species in India (Padayachee and Baijnath, 2012). It is one of the 'most nutrient-rich plant' ever discovered (Mahmood et al., 2010). The leaves of the plant are rich in vitamins, minerals, flavonoids, polyphenols, alkaloids, glucosinolates, isothiocyanates and has high anti-diabetic, antioxidant and immune boosting properties (Leone et al., 2015, Gopalakrishnan et al., 2016). Studies revealed that herbal tea developed only from moringa leaves had poor sensory characteristics hence limiting its scope for product development (Elkhalifa et al., 2007). The market value of such product with poor sensory appeal remains always low irrespective of their health benefiting properties (Geel et al., 2005). Hence, combination of moringa with other indigenous herbs and plants provides a good way to improve its sensory as well as nutritive properties.

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Generally indigenous herbs of North-east India are heavily under-exploited inspite of their huge health benefits (Oduro et al., 2013). *Elsholtzia communis*, a rare species of the genus *Elsholtzia* of the family Lamiaceae commonly known as Napa, is widely used by the tribes of Nagaland as a condiment (Guo et al., 2012). It has a strong fresh and sweet smell of lemon (Harley et al., 2004). *Elsholtzia communis* contain significant amount of vitamins, minerals, polyphenols, terpenoids, quinine, tannins, alkaloids and flavonoids which fight against microbial infections (Ding et al., 2004, Cowmann, 1999). *Alpinia galanga* Willd. also known as galangal is another widely used culinary herb of Nagaland with a hot-spicy taste and an aroma like ginger (Chudiwal, et al., 2010). It is traditionally used as diuretic, to improve appetite, to cure sore throat and its isolates possess significant antioxidant activity (Chudiwal, et al., 2010, Kumari et al., 2015). In today's world people are very cautious of their health and demand for food which are health benefitting and natural. Tea seems to be a good medium due to its high consumption rate and has a good potential to grow quickly in the health beverage market (Byun and Han, 2004). Therefore the present study was carried out to formulate an herbal tea from leaves of *Moringa oleifera*, rhizomes of *Alpinia galanga* and inflorescence of *Elsholtzia communis* with better sensory properties, acceptable at consumer level.

Material and methods:-

Collection and processing of raw materials

Fresh moringa leaves were harvested from a local farm in Dimapur, Nagaland. All visibly diseased and wilted leaves were discarded. Fresh rhizomes of *Alpinia galanga* and dried inflorescence of *Elsholtzia communis* were both procured from local market in Dimapur, Nagaland. The leaves of *Moringa oleifera* were washed properly and dried in hot air oven at 40°C for 6hrs and crushed. The rhizomes of galangal were cleaned, washed, grated and dried in hot air oven at 40°C for 9hrs. The dried inflorescence of *Elsholtzia communis* was grinded in a mixer grinder (Bajaj GX 1 mixer grinder) and sieved with mesh size 200 μ to remove the pollen grains.

Formulation of herbal tea

The herbal tea was formulated by mixing the processed ingredients at different levels of incorporation. Three formulations were developed by keeping commercially available moringa tea as control (**Table 1**).

Table 1:- Formulations of herbal tea.

Ingrdients	Level of incorporation			
	HT ₁	HT ₂	HT ₃	Control
<i>Moringa oleifera</i>	80g	75g	70g	100g
<i>Elsholtzia communis</i>	10g	15g	20g	0g
<i>Alpinia galanga</i>	5g	5g	5g	0g
Cardamom	5g	5g	5g	0g

Sensory evaluation of the developed product

Formulation of score card

Sensory evaluation is defined as “a scientific discipline used to invoke, measure, analyze, and interpret reactions to characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing” (Sidel and Stone, 1993). It is done with the help of score cards.

Developing a score card is challenging, because a score card with too much details may discourage a person for careful judgement and in too brief may fail to obtain some important information (Lawless and Heymann, 2010).

A hedonic rating scale ranging from unacceptable to very acceptable is relatively considered as easy to construct. The degree to which a product was liked or disliked was expressed on a scale of 9 to 1.

(Wichchukit and Mahonyc, 2014). In the present study Sensory evaluation of the samples was carried out using the 9 point hedonic scale (**Fig.1**).

Sensory Evaluation Sheet

Name: _____ Date: _____

Product: _____ Time: _____

You are provided with sample samples. Please evaluate the sample for acceptability and allot a score from the Hedonic scale as below:

Liked Extremely: 9
 Liked Very much: 8
 Liked Moderately: 7
 Liked Slightly: 6
 Neither Liked nor Disliked: 5
 Disliked Slightly: 4
 Disliked Moderately: 3
 Disliked Very much: 2
 Disliked Extremely: 1

Product	Color	Taste	Aroma	Overall acceptability
HT ₁				
HT ₂				
HT ₃				
Control				

Remarks: _____

Signature: _____

Place: _____

Fig. 1:- Score card for sensory evaluation of developed herbal tea.

Selection of sensory panel

Acceptability trials were carried out in the Nutrition Laboratory of Department of Food, Nutrition and Dietetics, Assam down town University, Guwahati, Assam, India to evaluate the attributes of the developed product in terms of their color, aroma, taste and overall acceptability. A group of fifty members were recruited from the Department to carry out the trials. Participants were chosen on the basis of their willingness to take part in the sensory evaluation using the nine point hedonic scale.

Conduction of acceptability trials

Sample infusions were prepared by dipping 50 gm of each formulation in 1 liter hot water for 10 minutes and strained. The samples were coded as HT₁, HT₂, HT₃ and control. About 20-30 ml of each infusion was served in a 50 ml paper cup at one time. Participants were not given prior information about the constituent ingredients from which the infusions were prepared. They were asked to rinse their mouth after each tasting in order to appreciate the full sensory character of each individual sample. They were instructed to score their acceptance for the four attributes of the samples infusions in the scale of 9 to 1. The sample with the highest acceptance score was evaluated for its antioxidant capacity.

Antioxidant activity of the herbal tea

The antioxidant analysis of the samples was carried out in National Institute of Pharmaceutical Education and Research (NIPER), Guwahati, Assam, India. The antioxidant capacity of the herbal tea was determined with the DPPH scavenging activity test by the method given by Blois (Blois,1958). 100mg of sample was weighed and 1ml of each DMSO (Dimethyl sulfoxide) and methanol was added and vortexed for 5 hours continuously. The samples were centrifuged at 10000 rpm for 5 minutes and supernatant was collected and further analyzed for antioxidant assay. 20 µl of the extract was added to 200 µl of 0.2mM DPPH in methanol and incubated for 20 minutes in the dark at room temperature. Absorbance at 517 nm was read using a spectra max reader. Ascorbic acid was employed as the reference. DPPH scavenging capacity is calculated using the following formula:

$$\text{DPPH scavenge (\%)} = \frac{(A_{con} - A_{test})}{A_{con}}$$

Where,

A_{con} – Absorbance of the control

A_{test} – Absorbance in the presence of sample

Storage study of the developed product

The shelf life of the herbal tea sample with highest acceptance was studied by storing in different packaging materials at room temperature for a period of six months. Each packaging was done maintaining proper hygiene and sanitation to prevent contamination during packaging and was properly sealed at the same temperature and humidity to prevent loss of flavor, leakage and moisture absorption. The different packaging materials for shelf life study are low density polyethylene (HDPE) zip loc bags, low density polyethylene (LDPE) packets, tea bags (packed in paper cartons) and high density polyethylene (HDPE) containers.

Statistical analysis

All the data were statistically analyzed and results obtained were tabulated. Excel (2007) was used to calculate the mean, standard deviation and to carry out Analysis of Variance (ANOVA) on the data where the level of significance between various parameters was measured at 5% level of significance ($P < 0.05$).

Results:-

Sensory acceptance test of the developed products

Sensory evaluation studies are essential in order to monitor the quality of newly developed food products and to make sure that they are acceptable at customer level (Singham *et al.*, 2015). The developed herbal tea formulations were evaluated on the basis of four parameters viz., color, aroma, taste and overall acceptability (**Table 2**).

Table 2:- Mean sensory score of the developed formulations.

Formulations	Quality attributes			
	Color	Aroma	Taste	Overall acceptability
HT ₁	7.48±0.50 ^b	6.90±0.58 ^b	7.30±0.58 ^b	7.30±0.50 ^c
HT ₂	7.80±0.63 ^a	7.48±0.67 ^a	8.04±0.69 ^a	7.96±0.60 ^a
HT ₃	7.52±0.64 ^b	7.56±0.88 ^a	7.52±0.50 ^b	7.56±0.61 ^b
Control	6.56±0.50 ^c	6.36±0.66 ^c	6.20±0.83 ^c	6.88±0.52 ^d

*Mean values within the same column with same superscript do not differ significantly ($p < 0.05$)

Color as a sensory characteristic plays a major role in the food industries. Studies revealed that color not only influences the consumers selection of a product but stimulate the appetite, determination of consumption, satiation, and ingestion (Nayane *et al.*, 2012). Among the developed products, HT₂ brewed infusions had the most preferred color with highest scores (7.80±0.63) which is significantly different at $p < 0.05$ from the others, followed by HT₃ (7.52±0.64), HT₁ (7.48±0.50) and then the least preferred i.e. control (6.56±0.50). Aroma is perceived by the olfactory tissue (odor receptor sites) of the nasal cavity (Belitz *et al.*, 2008). Aroma of a food is the fundamental parameter to determine food quality which influences consumers buying decisions (Zawirska-Wojtasiak, 2005). Out of the three formulations panelist showed highest preference for the aroma of HT₃ (7.56±0.88) followed by HT₂ (7.48±0.67). Though HT₃ scored highest for its aroma but there is no significant difference ($p < 0.05$) to the scores of HT₂. The least scores were obtained by control (6.36±0.66). Taste, on the perception of gustatory input, is the most influential factor in a person's selection of a particular food (Dalton, 2000). The taste preference scores of product code HT₂ were highest (8.04±0.69), followed by HT₃ (7.52±0.50) and HT₁ (7.30±0.58). The difference between the scores was significant at $p < 0.05$. The product kept as control scored lowest (6.20±0.83). The scores for overall acceptability showed that Product code HT₂ had the highest acceptance (7.96±0.60), significantly different at $p < 0.05$ from the scores of HT₁, HT₃ and control. This was expected as it scored highest for most of the sensory attributes except for aroma where HT₃ had the highest score (7.56±0.88). The formulation HT₃ (7.56±0.61) was most preferred after HT₂ (7.96±0.60) followed by HT₁ (7.30±0.50) and then control (6.88±0.52). Conversely the herbal tea made solely from moringa leaves, kept as control (6.88±0.52) was the least preferred product in overall acceptability. It scored the lowest for color (6.56±0.50), aroma (6.36±0.66) and taste (6.20±0.83).



Fig 2:- HT₂ Formulation and brewed infusion

Antioxidant activity analysis

The antioxidant capacity was determined with the DPPH scavenging activity test by the method of Blois, 1958. DPPH is a stable free radical that is deep purple in color. This assay measures the ability of biological samples to reduce 2, 2-diphenyl-2-picryl hydrazyl radical to 1, 1-diphenyl-2-picryl hydrazine, therefore a reduction in purple color indicates a reduction in free radicals.

Antioxidant capacity of inflorescence of *Elsholtzia communis*

The radical scavenging activity of inflorescence of *Elsholtzia communis* was determined with the DPPH scavenging activity test. The sample was extracted with methanol and DMSO and tested for its antioxidant capacity, the extract of *Elsholtzia communis* showed 82.79% and 74.62% radical scavenging activity when extracted with methanol and DMSO respectively. This result shows that the inflorescence of *Elsholtzia communis* has very high antioxidant capacity and thus maybe useful in protection and prevention of many diseases and oxidative stress. A study conducted by Barua et al., (2015), also reported that there is high antioxidant capacity in *Elsholtzia communis* when conducted a test by DPPH (2, 2-diphenyl-1-picrylhydrazyl assay), FRAP (ferric reducing antioxidant power) and SOSA (Superoxide scavenging assay).

Antioxidant capacity of *Moringa oleifera* leaves

Many studies have been done on the radical scavenging activity of moringa leaves using different test methods like DPPH, FRAP, ORAC and TEAC etc. In this study the dried leaves of *Moringa oleifera* were tested for its antioxidant capacity with the DPPH radical scavenging assay. The methanolic extracts of dried moringa leaves when tested for its radical scavenging activity showed a high antioxidant capacity of 75.56% in methanolic extract and 59.09% in DMSO extract. A study conducted by Falowo et al., (2017), also suggested that the percentage inhibition of DPPH radicals for *M. oleifera* leaf extracts was 75.9%. These results are also similar to the study conducted by Sultana et al., (2009) where the DPPH radical scavenging activity of moringa leaves were found to be 80.6%.

Antioxidant capacity of *Alpinia galanga*

The dried rhizomes of galangal extracts were taken for determination of its antioxidant capacity by DPPH antioxidant capacity test method. The result from the DPPH test showed that the extract of galangal rhizomes obtained by 100% Methanol had high antioxidant activity at 46.08% inhibition and with DMSO had 23.14% antioxidant activity. The result is similar to the study conducted by Mahae and Chaiseri (2009) where the galangal rhizomes were extracted with 50% and 75% ethanol at 30°C and 50°C and exhibited similarly high inhibition activities at 33.58-36.63% inhibition. The difference in the values of scavenging activity when extracted with Methanol and Dimethyl sulfoxide is because methanol enhances the activity of the antioxidant enzymes.

Antioxidant capacity of the herbal tea (HT₂)

The Methanolic extracts of the HT₂ sample showed 76.12% radical scavenging activity and the sample extracted with DMSO showed an antioxidant capacity of 62.45% which is more than the antioxidant activity of *Moringa oleifera* and *Alpinia galanga* alone but less than inflorescence of *Elsholtzia communis* (Table 3). The moringa leaves when combined with the herbs not only enhanced the taste and flavor but also enhanced the antioxidant activity thus there is a huge potential of developing herbal moringa tea combined with indigenous herbs which may have immense health benefits.

Table 3:- Antioxidant activity of the herbal tea and its constituents.

Sample	Antioxidant activity (%)	
	Methanol extract	DMSO Extract
Herbal tea (HT ₂)	76.12%	62.45%
<i>Moringa oleifera</i>	75.56%	59.09%
<i>Alpinia galanga</i>	46.08%	23.14%
<i>Elsholtzia communis</i>	82.79%	74.62%

Shelf life study of the developed herbal tea

The shelf life of HT₂ formulation was studied by storing it in different packaging materials at room temperature for a period of six months to analyze which packaging materials prevented the spoilage of the product (Table 4). The herbal tea sample was observed at an interval of 15 days for three months and then after every one month for a period of six months. The different packaging materials for shelf life study are low density polyethylene (LDPE) packets, high density polyethylene (HDPE) zipper bags, tea bags and high density polyethylene (HDPE) containers.

The study revealed that HT₂ sample kept in transparent LDPE packets lost its original color, aroma and started mould formation by 60 days and thus by 90 days the sample got spoiled (**Table 4**). This is because LDPE is permeable to oxygen and is a poor odor barrier. Comparatively the other packaging materials like zipper bags (HDPE), tea bags and HDPE containers stored the product without spoilage, loss of color, aroma and taste over a period of six months.

Table 4:- Shelf life study of the developed product with different packaging materials.

No. of days	Packaging materials				
	LDPE bags	HDPE bags	Zipper	Tea bags (packed in paper cartons)	HDPE air tight containers
15	✓	✓		✓	✓
30	✓	✓		✓	✓
45	Loss of color, aroma	✓		✓	✓
60	Mould formation	✓		✓	✓
90	X	✓		✓	✓
120	X	✓		✓	✓
150	X	✓		✓	✓
180	X	✓		✓	✓

Discussion:-

The present study mainly aims at developing a herbal tea using *Moringa oleifera* keeping in mind its ennumerous health benefits. The brewed infusion with highest amount of *Elsholtzia communis* inflorescence was preferred most for its aroma because inflorescence of *Elsholtzia communis* has a strong lemon-like aroma which is very appealing (Guo et al., 2012). On the other hand moringa tea kept as control showed lowest acceptance for its poor herbal aroma (Elkhalifa et al., 2007). The overall acceptability was found highest for HT₂ and lowest for the control which contain 100 percent moringa. This is because moringa leaves have poor sensory appeal due to its absence of distinctive flavor properties and aroma (Out et al., 2013). The sensory acceptability of moringa leaves can be improved by incorporation with other herbs having significant taste and aroma. The antioxidant analysis of HT₂ reveals a high antioxidant capacity of 76.12% (Methanol extract) and 62.45% (DMSO Extract) which is mainly due to the presence of moringa leaves and *Elsholtzia communis* because it has been emphasized that *Elsholtzia communis* has the ability to counteract stress and has high antioxidant properties (Barua et al., 2016). The shelf life studies of the developed tea revealed that all the packaging materials except for LDPE can store the product in good condition for 6 months which is mainly due to low oxygen permeability of HDPE Zipper bags, Tea bags (packed in paper cartons) and HDPE air tight containers (Geel et al., 2005).

Conclusion:-

Moringa oleifera leaves have shown to be beneficial in several chronic conditions, including hypercholesterolemia, high blood pressure, diabetes, insulin resistance, non-alcoholic liver disease, cancer and overall inflammation (Vergara-Jimenez et al., 2017). It does not contain caffeine and its consumption in the form of herbal tea will provide immense health benefits (Aoshima et al., 2007). Sensory acceptance study of the formulated herbal tea revealed that the product is highly acceptable compared to herbal tea made of moringa leaves alone. The formulated tea had a high free radical scavenging activity of 76.12% (methanolic extract) and 62.45% (DMSO extract) and can be stored for more than six months in properly sealed packaging materials without spoilage. Hence the developed product has a good market potential and also provides business exposure to indigenous herbs of North-east India.

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