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RESEARCH ARTICLE

Physico-chemical characteristics of a local spice (*Zanthoxylum armatum* DC) of Arunachal Pradesh and its utilization for development of blended tea

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ABSTRACT

Zanthoxylum armatum DC has been used in traditional medicinal systems to cure various health-related problems. The essential oil extracted by the hydrodistillation method was further analyzed for parameters such as iodine value, peroxide value, and the GC-MS volatile compound profile. Eight blended tea formulations based on yarma spice powder (SBT) and another eight blended tea formulations using essential oil (EBT) were developed and analyzed for sensory acceptability. The formula with the highest sensory score formula among the formulae was selected and termed optimized blended tea based on yarma spice powder (SBTo) and optimized blended tea based on yarma essential oil (EBTo). The SBTo product was analyzed for color, bulk and tapped density, moisture, protein, ash content, minerals, total polyphenolic content, and vitamin C, and compared with existing market tea (EMT). The physico-chemical properties of yarma fruits were as follows: length - 5.665 mm, width - 4.393 mm, thickness - 4.525 mm, fruit surface area - 48.57 mm2, fruit volume - 52.327 mm3, bulk density - 0.922 g/ml, true density - 2.305 g/ml, moisture - 10.26 ± 0.64%, ash - 4.33 ± 0.28%, carbohydrate content - 15.72 ± 0.87 g, protein - 10.06 ± 0.6 g, fat - 0.8 ± 0.4 g. The yield of essential oil was 6.73 ± 0.0057% v/w, and it contained 16 different major volatile compounds revealed by GC-MS analysis. The acceptability of SBTo was comparable to EMT, and it contained carbohydrates (21.66 ± 0.28 g), protein (4.71 ± 0.14 g), total phenolic content (92.40 GAE mg/g), and reducing power assay (37.8 mg/100 g). The yarma spice powder-based blended tea was rich in essential oil, volatile compounds, and antioxidant activity.

Keywords: Yarma, *Zanthoxylum armatum*, essential oil, GC-MS, blended tea.

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INTRODUCTION

Zanthoxylum is a genus of about 250 species of deciduous and evergreen trees and shrubs in the citrus or rue family. *Zanthoxylum armatum* DC is an evergreen, thorny shrub, and its height can reach up to 6 m. It can be found from China, Korea, and Japan eastward to India and Pakistan (Singh and Singh, 2011). In Nepal, it is referred to as Timur, which means “Nepal pepper” or “prickly ash” in English. Indian Prickly Ash, Tejowati (Sanskrit), and Mukthrubi (Manipuri) are important medicinal plants used in the treatment of various diseases such as headaches, fever, inflammation, and abdominal pain (Nooreen et al., 2019 and Mushtaq et al., 2019). Various parts of Z. armatum, including leaves, stems, fruits, and bark, have been used in traditional medicinal systems to cure problems such as poor appetite, fever, gas trouble, toothache, inflammation, and stomach pain (Phuyal et al., 2019).

Zanthoxylum armatum DC is locally known as Yarma by the Bokar, Pailibo, and Ramo community of the Shi Yomi district and *Shyein* by the Shertukpen community of the West Kameng district of Arunachal Pradesh. Northeastern India features a vast diversity of topography, climate, and altitudinal changes, which have led to a wide range of natural ecosystems. The region is rich in medicinal plants, and its biodiversity has earned it the label of a biodiversity “hotspot.” A large number of ethnic tribes also inhabit this part of India. Additionally, the tribal community possesses extensive traditional knowledge of efficient herbal medicines, which has been gained through experience and is typically passed down orally as a family secret (Chakrabortya et al., 2012). The isolated alkaloids from Z. armatum are well-known for their pharmacological and biological properties, such as antinociceptive, larvicidal, antioxidant, hepatoprotective, antibiotic, antiplasmodial, cytotoxic, antifungal, antiproliferative, anthelminthic, and antiviral effects (Negi et al., 2011). Various parts of Z. armatum, including leaves, stems, fruits, and bark, have been used in traditional medicinal systems to cure problems such as hypertension and stress.

The present investigation was carried out to investigate the proximate composition, characterization of the essential oil extracted, and product development from an indigenous spice locally known as “Yarma” (*Zanthoxylum armatum* DC).

Figure 1

Figure 2

MATERIALS AND METHODS

Sample

Seeds of *Zanthoxylum armatum* DC were obtained from Mukhuthing village, West Kameng District, Arunachal Pradesh. The seeds were graded and sorted manually.

Physico-chemical characterization of fruits of *Zanthoxylum armatum* DC

Physical Properties

A total of one hundred (100) spice seed pods (handful) were collected in a container from random locations for analysis. For each sample of 100 seed pods, a vernier caliper (Model: PR26, accuracy: 0.001 mm, Aerospace) was used. The physical properties of the seed pods, such as length, width, thickness, fruit surface area, fruit volume, sphericity, 1000 fruit weight, bulk density, and true density, were carried out according to the procedure of Bepary et al. (2018).

Proximate analysis

The moisture, ash, total carbohydrates, crude fat, and crude protein were analyzed using standard methods (AOAC, 2000).

Extraction of essential (volatile) oil from seed pods

Seeds of the plant Z. armatum were subjected to hydrodistillation for 8 hours using the modified Clevenger's Method. It is universally accepted as the official method, according to which volatile oil insoluble in water is obtained through steam distillation.

Analysis of extracted essential oil

Iodine value of essential oil

The determination of the iodine value of essential oil extracted from Z. armatum was carried out using the Hanus iodine method (Gurkin, 1972). A sample of 0.5g was taken for the test. The sample was dissolved in 10 ml of chloroform. 30 ml of the Hanus iodide solution was then added to the flask. The flask was allowed to stand in the dark for 30 minutes with occasional shaking. Meanwhile, a 50 ml burette was filled with 0.N sodium thiosulfate solution. Next, 10 ml of 15% potassium iodide solution was added to the contents of the flask and diluted to 100ml with water and quickly titrated the liberated iodine against the standard sodium thiosulfate solution until a pale yellow colored solution was obtained. 2.0 ml of starch solution was added and the titration continued until the blue color disappeared. A duplicate and a blank were carried out simultaneously.

The iodine number can be calculated using the following formula: Iodine number = {(B – S) × N × 12.69} / Weight of the sample

Where:

B = ml of 0.1 N sodium thiosulfate required by the blank,

S = ml of 0.1 N sodium thiosulfate required by the sample, and

N = Normality of the sodium thiosulfate solution.

Peroxide value of essential oil

AOCS Official procedures 2009 were used to measure the peroxide levels of all samples. A sample for analysis (3g) was dissolved in 30 ml of glacial acetic acid and 20 ml of chloroform. Next, a 1 mL saturated KI solution was added. The mixture was then stored in a dark place for 15 minutes. Afterward, 50 ml of distilled water was added and the mixture was titrated against sodium thiosulfate (0.02 N) using starch as an indicator. Concurrently, a blank titration was carried out. Triplicate values were recorded for all tests.

Gas Chromatography-Mass Spectrometry (GC-MS)

Gas Chromatography-Mass Spectrometry (GC-MS) was used to obtain the volatile flavor compounds. The basic principle of GC-MS is that the direct combination of a fast scanning mass spectrometer with the gas chromatograph provides a technique of enormous analytical power. In this manner, the identification and isolation of the various compounds in the chromatograph can be obtained.

For the sample, the front inlet was maintained at 220°C and the Oven temp ranged from 50 to 250 °C at a rate of 10°C. The carrier gas used was helium at a flow rate of 1 ml/min. The sample volume taken was 1 µl. The scan range was 50 to 620 amu, and the GC interface temperature was noted as 250°C. The ion chamber temperature was 250°C with an energy of 70 ev. A photomultiplier tube detector was used.

Formulation of blended tea based on yarma spice powder (SBT)

The whole fruit of yarma and cardamom was dried separately at a temperature of 55°C, and then each was milled separately with a grinder until a smooth powder was obtained. After being sieved individually, the powders were then kept in the laboratory at room temperature (32 ± 2°C) in zip-lock bags until they were used. The yarma spice blended tea (SBT) was prepared as shown in Fig. 1. For the preparation of SBT, 5g of maltodextrin was dispersed in warm water (40°C), after which the yarma spice powder, cardamom (5g), and tea were mixed with the maltodextrin dispersion solution uniformly according to the proportions specified in Table 1. After that, the yarma spiced blended tea (SBT) was dried, packed in polyethylene bags, and stored at ambient temperature (Fig. 1). There were eight types of SBT, namely S1, S2, S3, S4, S5, S6, S7, and S8, that were prepared, and the product with the highest sensory score was referred to as the optimized blended tea based on yarma spice powder, SBTo.

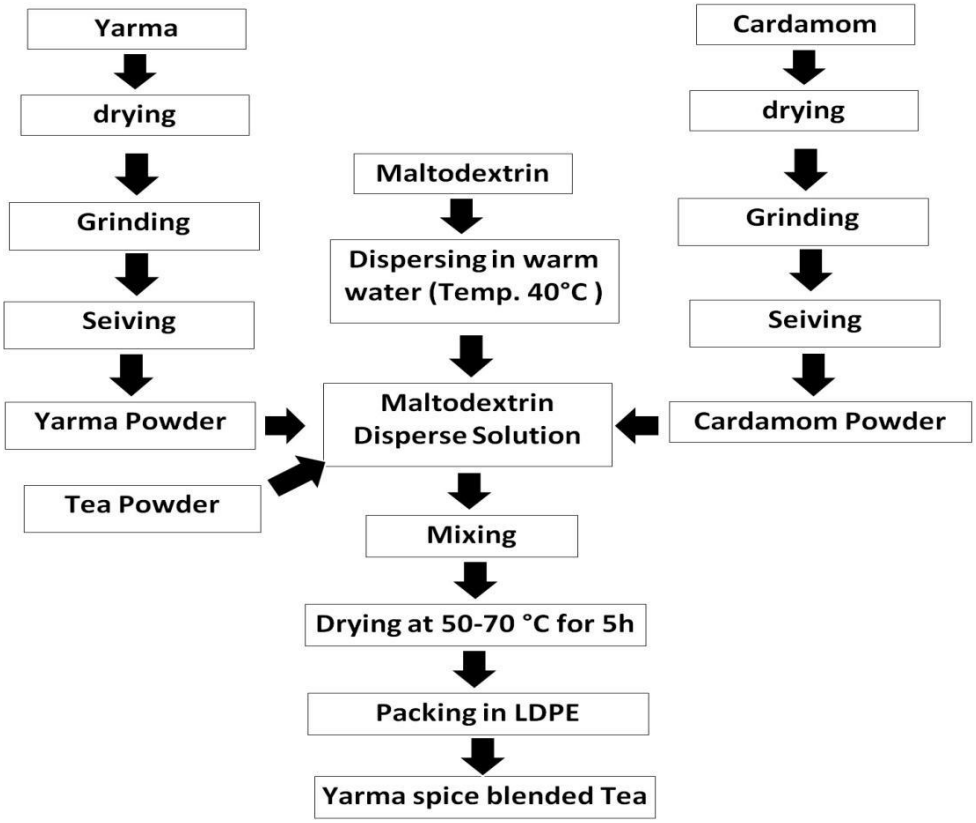


Fig. 3: Process flowchart for yarma spice blended tea (SBT)

Formulation of blended tea based on yarma essential oil (EBT)

The essential oil from yarma fruits was extracted using the modified Clevenger's Method through hydro distillation apparatus for 8 hours. The yarma essential oil blended tea (EBT) was then prepared according to Fig. 4. To prepare the EBT, 5g of maltodextrin was dispersed in warm water (40°C). After that, the yarma spice powder, cardamom (5g), and tea were mixed with the maltodextrin dispersal solution uniformly, as per the proportions mentioned in Table 2. Next, the yarma essential oil blended tea (EBT) was dried, packed in polyethylene bags, and stored at ambient temperature (Fig. 4). Eight types of SBT, namely E1, E2, E3, E4, E5, E6, E7, and E8, were prepared, and the product with the highest sensory score was termed as optimized blended tea based on yarma essential oil (EBTo).

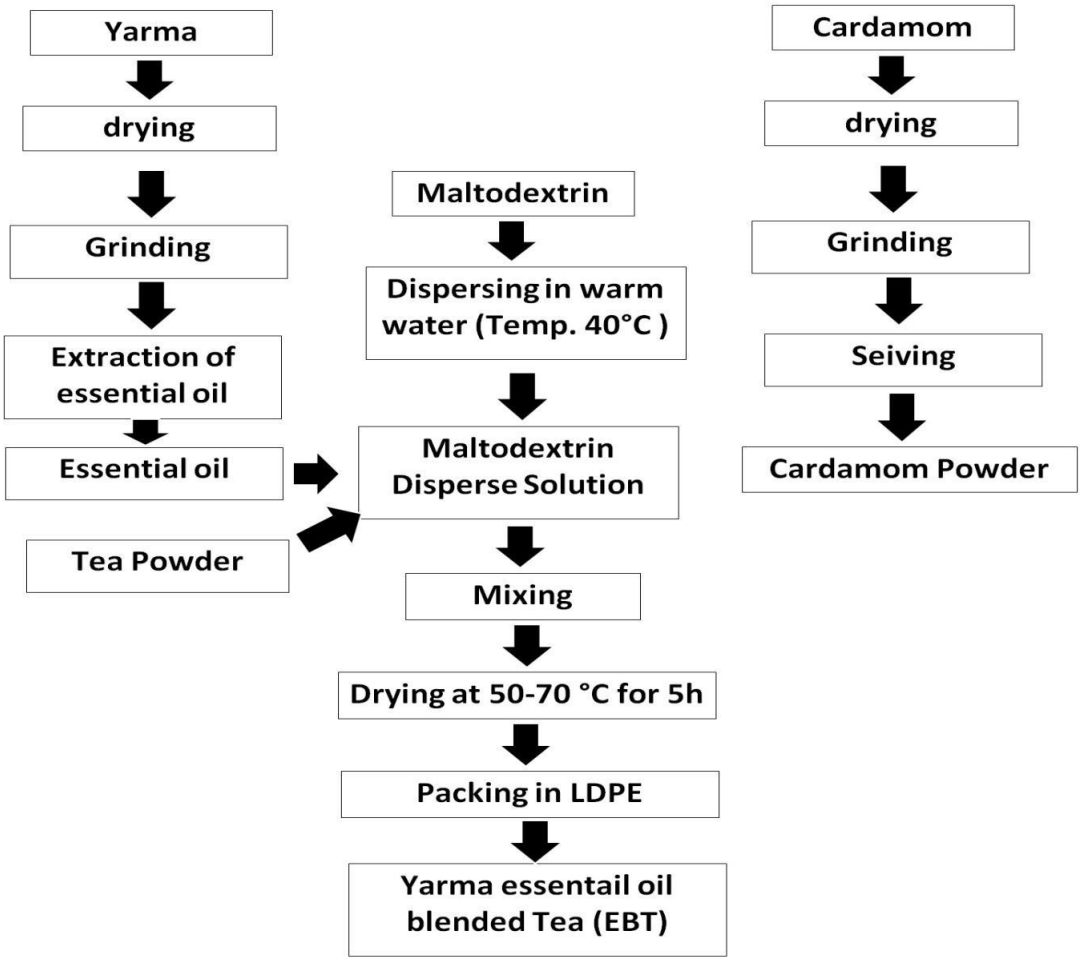


Fig. 4: Process flowchart for yarma essential oil blended tea (EBT)

Sensory analysis of blended tea and exiting market tea

The sample tea samples were taken for sensory evaluation using a 9-point hedonic scale. The total panel members were 15, which included young adults aged 20-27 years and older adults aged 40-68 years. The samples of SBT, EBT, SBTo, EBTo, and the existing market tea (EMT) were extracted in 100 mL of hot boiling (100°C) water for 3 minutes. Then, an additional 5 g of sugar was added to taste, and the samples were coded. Each sample of herbal tea was provided randomly in an amount of about 40 mL. The sensory attributes were fermented, bitterness, grassiness, and sourness (Goula et al., 2011).

Quality Characteristics of SBTo

Determination of bulk density, tapped density and colour

For the final product, a bulk density test was carried out. The sample weighed 5g. It was determined using the modified Goula et al. (2004) method. 5g of the sample was put into a 10mL graduated cylinder.

The bulk density (g/ml) is calculated as follows: Weight of sample (g) divided by Volume occupied by the sample (ml).

For the final spice blended tea (5g) was taken to conduct bulk density analysis was conducted. Tapped density was determined using the modified Goula et al. (2004) method. 5g of powder was transferred to a 10mL graduated cylinder. Tapped density was calculated using the following formula after tapping the cylinder by hand on a bench 100 times from a height of 10 cm.

Tapped density (g/ml) = 9 g

Volume occupied by the sample: (ml)

Determination of Colour

Colour measurement of the final tea product is done by instrumental surface color (CIE L*a*b*). The determination of sample colour is evaluated using a Hunter Lab MiniScan XE Plus Color Meter (Illuminant D65, 10° standard observer, 2.5 cm diameter aperture; Hunter Associates Laboratory, Inc., Reston, VA). Before color measurement, calibration is done by using standard black and white tiles prior to the color measurement. During the evaluation, CIE L*a*b* values are used to obtain the saturation index/chroma [(a^2+b^2)^1/2] and hue angle [tan-1(b*/a*)].

Determination of total phenolics content of spice blended tea

Total phenolics content of spice-blended tea was determined using Folin-Ciocalteu's reagent (Velioglu et al., 1998). Initially, 100 µl of extract was added with 0.75 mL of Folin-Ciocalteu's reagent (previously diluted 10-fold with distilled water) and kept undisturbed at 22°C for 5 min. Later, 0.75 mL of sodium bicarbonate (60 g/L) solution was added to the mixture. The absorbance at 725 nm was measured after 90 min at 22°C. Lastly, the obtained result was expressed as gallic acid equivalent (mg GAE/g).

Determination of antioxidant content by reducing power assay

The antioxidant content of the samples was determined using the reducing power assay. In this assay, the extracts (100 µl) of the sample were added to phosphate buffer (2.5 ml, 0.2 M, pH 6.6) and 1% potassium ferricyanide (2.5 ml). The mixture was then incubated at 50°C for 20 minutes. After that, aliquots of 10% trichloroacetic acid (2.5 ml) were added to the mixture. The mixture was centrifuged at 3000 rpm for 10 minutes. A freshly made ferric chloride solution (0.5 ml, 0.1%) was measured at 700 nm absorbance after combining the upper layer of the 2.5 ml solution with 2.5 ml of pure water. Reducing power is given as ascorbic acid equivalent (AAE) in milligrams per gram (mg/g) of dry material (Oyaizu, 1986).

Determination of Ascorbic Acid

5g of the sample was weighed and soaked in 4% oxalic acid for 10 mins. Ground sample solution was centrifuged and the supernatant was collected in a 50ml SMF. This process was repeated 3-4 times. The collected supernatant in the SMF was

made using 4% oxalic acid. 5ml of the prepared sample was taken in a conical flask and titrated against 2,6 dichlorophenol-indophenol dye. The end point, a pale pink color, persisted for 30 seconds. Concordant values were obtained, followed by standard preparation. Ascorbic acid was used as the standard (AOAC, 2000).

Statistical analysis

All experiments were carried out in triplicate. Data is expressed as mean ± standard deviation of the mean (SD) using SPSS.

RESULTS AND DISCUSSION

Physical properties of yarma seeds

The physical properties of yarma fruit (Fig. 2) are as follows: length (5.665 mm), width (4.393 mm), thickness (4.525 mm), fruit surface area (48.57 mm2), fruit volume (52.327 mm3), sphericity (0.85, 1000), fruit weight (119.74 g), bulk density (0.922 g/ml), and true density (2.305 g/ml).

Proximate Composition of fruits

In (Table 1), the values of moisture and ash content of the local spice were 10.26 ± 0.64% and 4.33 ± 0.28% respectively. The carbohydrate content of the spice was 15.72 ± 0.87 g, the protein was 10.06 ± 0.6 g, and the fat was 0.8 ± 0.4 g.

Table 1: Nutritional composition of raw spice (yarma) seed

Plant species	Moisture content %	Ash content %	Carbohydrate (g)	Protein (g)	Fat (g)	Free fatty acid(g)
Yarma	10.26±0.64	4.33±0.28	15.72±8.796	10.06±0.6	0.8±0.4	0.40±.02

Yield and chemical characteristics of yarma essential oil

The yield of essential oil extracted from *Zanthoxylum armatum* DC by hydrodistillation was 6.73 ± 0.0057% w/v in 8 hours. The volatile constituents have a much lower boiling point than that of water, and hence they become volatilized and distilled along with water vapors.

Iodine value and Peroxide value

The iodine value of the sample oil was found to be 81.53. The higher the iodine values, the higher the degree of unsaturation is also reported to be. The iodine value/content is a reliable indicator of lipid oxidation (Naz, 2004). Hydroperoxides, which are quantified by the peroxide value, are mostly produced by primary oxidation reactions in oil. The oil's time quality is generally improved by a decreased peroxide value (PV). The IV ("iodine adsorption value" or "iodine number" or "iodine index") determines the number of reactive double bonds present in the oil. More double bonds in the sample are indicated by a higher IV number. As a consequence, care should be taken to slow down oxidation (Meftahizade et al., 2010). The peroxide value of the sample was found to be 0.37± 0.03. One of the most popular tests for oxidative rancidity in oils and fats is the peroxide value. This analysis is a good indicator of lipid oxidation (v et al., 2007).

Table 2 Compounds identified by GC-MS

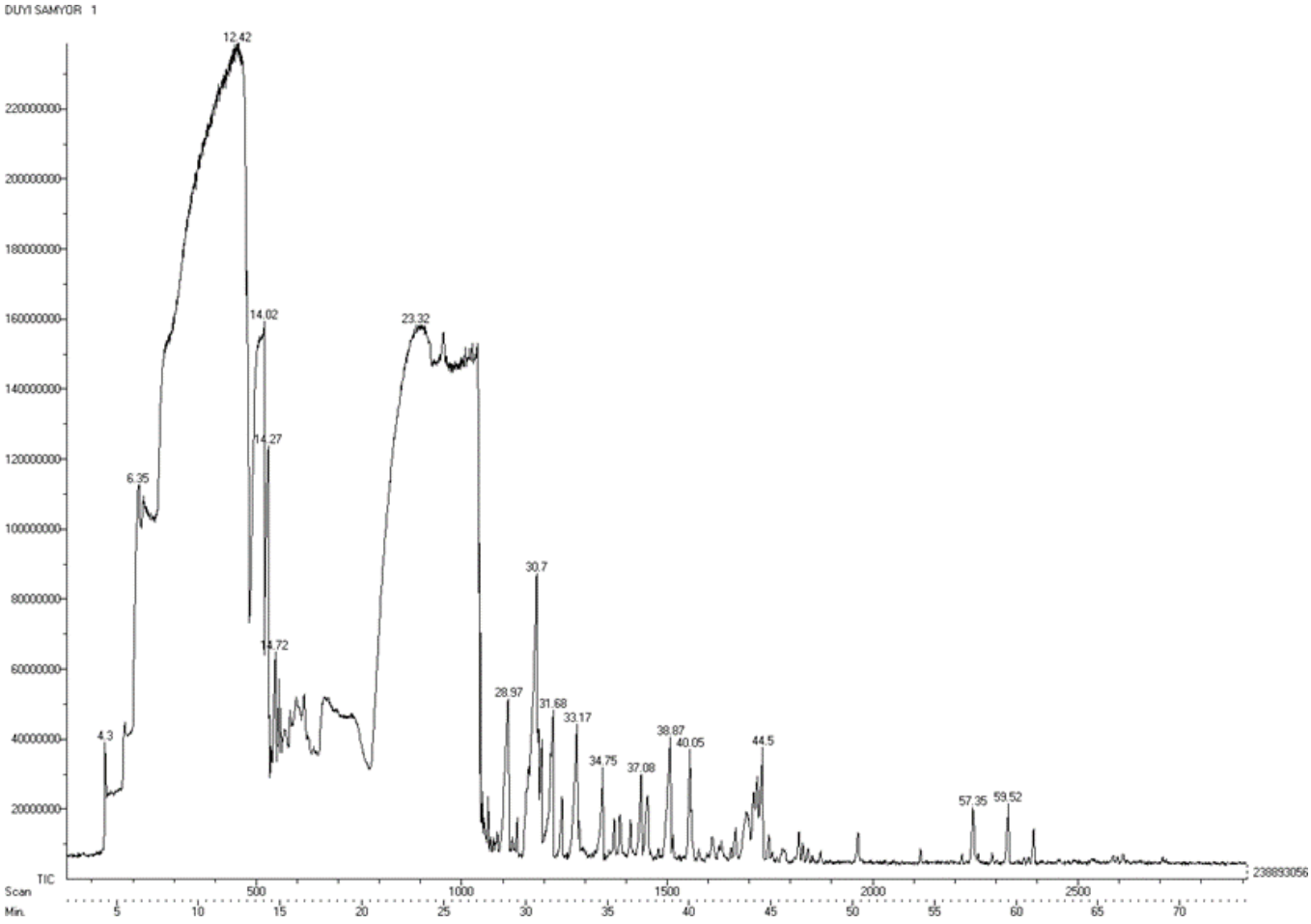
Volatile compound name	TIC	Base % FS	#Ions	RT
Hydrocarbon				
1.Isocaryophillene	48255232	18.4	387	31.68
2. 1, 6- cyclooctadiene, 1-methyl-5-methylene-8-(1-methylethyl)-,[s-[E,E]]-	31862016	30.6	383	34.75
3.2-cyclohexen-1-one, 3-methyl-6-(1-methylethyl)-	158242816	72.8	401	23.32
4. Cyclohexene, 1-methyl-4-(1-methylethenyl) - or (limonene)	235906816	74.2	91	12.48
5. Naphthalene, 1, 2, 3, 5, 6, 8a-hexahydro-4, 7-dimethyl-1-(1-methylethyl)-, (1S-cis)-	29924608	23.2	317	37.08
6.2,6,11,15-tetramethyl-hexadeca-2,6,8,10,14-pentaene	19566080	13.8	301	59.55
Alcohols				
1.longipinocarveol,trans	37150464	12	334	40.05
2.Cadinol	37581056	18.9	310	44.50
3.a-Cubenol	40348928	16.5	356	59.72
4.Terpineol,CIS-a-	80478464	43.2	390	14.05
5.1-Heptatriacotanol	14407680	8.7	307	61.08
Esters				
1.Benzeneacetic acid,2-phenylethyl ester	20485632	27	312	57.35
2.1,6-ocadiene-3-ol,3,7-dimethyl-,acetate	121099776	64.3	469	14.30
3. 4-flourobenzoic acid,2-phenyethyl ester	51254016	65.7	380	28.97
4. 2- propionic acid,3-phenyl,methyl ester	79886336	68.8	384	131.03
5.5-chloropentanoic acid,2-phenylethyl ester	44290816	69.8	324	104.02

Gas Chromatography-Mass Spectrometry (GC-MS)

Identification of volatile compounds by GC-MS revealed the presence of a total of 16 major volatile compounds (Table 2). Out of the 16 volatile compounds, 6 compounds were hydrocarbons, namely Isocaryophillene, 1,6-cyclooctadiene, 2-cyclohexen-1-one, 1-methyl-5-methylene-8-(1-methylethyl)-,[s-[E,E]]-, 3-methyl-6-(1-methylethyl)-, Cyclohexene, 1-methyl-4-(1-methylethenyl) - or (limonene), 2,6,11,15-tetramethyl-hexadeca-2,6,8,10,14-pentaene, and Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)- (Fig. 4). Five compounds were alcohols, namely longipinocarveol, trans, Cadinol, a-Cubenol, Terpineol, CIS-a-, 1-Heptatriacotanol, and five esters were Benzeneacetic acid, 2-phenylethyl ester, 1,6-ocadiene-3-ol, 3,7-dimethyl-, acetate, 4-flourobenzoic acid, 2-phenyethyl ester, 2-propionic acid, 3-phenyl, 5-chloropentanoic acid, 2-phenylethyl ester, and methyl ester.

Effect of yarma spice powder on sensory acceptability of SBT

The sensory scores for fermented smell, bitterness, astringency, grassiness, and overall acceptability among the different treatments were shown in Table 3. The S6 sample had the highest scores for fermented smell (6.93±1.16), bitterness (6.80±0.86), astringency (7.00±1.07), grassiness (6.67±1.23), and overall acceptability (7.07±1.16), in which 3% yarma spice powder was mixed with 87% tea powder. The OAA of S5, S4, S3, S2, and S1 was significantly ($p<0.05$) low, which was due to a higher level of astringency compounds released from ground spice. As the S6 sample had the highest OAA score, hence it is termed as SBTo. The SBTo product had tea powder and yarma spice powder as 87% and 3%, respectively (Fig. 6).



X –Axis m/z ratio (mass/charge), Y-Axis abundance, TIC: total ion chromatogram

Fig. 5: Graph of GC-MS

Table 3: Effect of yarma spice powder on sensory acceptability of yarma spice based blended tea.

Recipe Code	TP (g)	YSP (g)	CP (g)	MD (g)	Fermented Smell	Bitterness	Astrigency	Grassiness	OAA
S1	70	20	5	5	6.5±1.10^{a}	6.15±1.42^{a}	5.6±1.71^{a}	6.15±1.32^{a}	6.00±1.15^{a}
S2	75	15	5	5	6.5±1.12^{a}	6.18±1.40^{a}	5.7±1.71^{a}	6.15±1.30^{a}	6.00±1.11^{a}
S3	80	10	5	5	6.60±1.13^{a}	6.2±1.42^{a}	5.8±1.70^{a}	6.20±1.31^{a}	6.20±1.15
S4	85	5	5	5	6.60±1.12^{a}	6.20±1.42^{a}	6.07±1.71^{b}	6.27±1.34^{a}	6.40±1.35^{b}
S5	86	4	5	5	6.67±1.23	6.40±1.50^{b}	6.27±1.39	6.27±1.10^{a}	6.40±0.83^{b}
S6	87	3	5	5	6.93±1.16	6.80±0.86	7.00±1.07	6.67±1.23^{b}	**7.07±1.16**
S7	88	2	5	5	6.40±1.24^{a}	6.33±1.63^{b}	6.07±1.10^{b}	6.53±1.13^{b}	6.67±1.05^{c}
S8	89	1	5	5	6.50±1.15^{a}	6.43±1.63^{b}	6.03±1.23^{b}	6.40±1.11	6.66±1.05^{c}

TP: Tea powder, YSP: Yarma spice powder, CP: Cardamom powder, MD: Maltodextrin, OAA: Overall Acceptability. Value= Mean ± SD, Note: Means with different letters in the same row indicate that there is a significant difference between samples (P ≤ 0.05) from Duncan's multiple range test.

Effect of yarma essential oil on the sensory acceptability of EBT

The data presented in Table 4 indicate differences in scores for fermented smell, bitterness, astringency, grassiness, and overall acceptability among the different treatments. The E6 sample had the highest scores for fermented smell (7.27±0.88), bitterness (7.20±0.68), astringency (7.33±1.07), grassiness (7.07±0.96), and overall acceptability (7.73±0.46) in which 3% yarma essential oil was mixed with 87% tea powder. The OAA of E5, E4, E3, E2, and E1 was significantly ($p<0.05$) low, which was due to a higher level of astringency compounds released from ground spice. As the E6 sample had the highest OAA score, hence it is termed as EBTo. The EBTo product had tea powder and yarma essential oil as 87% and 3%, respectively.

Table 4: Effect of yarma essential oil on sensory acceptability of yarma essential oil based blended tea (EBT)

Recipe Code	TP (g)	YE (g)	CP (g)	MD (g)	Fermented Smell	Bitterness	Astrigency	Grassiness	OAA
E1	70	8	5	5	6.32±0.94^{bcd}	6.28±0.86^{a}	6.16±1.22	5.90±1.42^{a}	6.47±0.74^{ab}
E2	75	7	5	5	6.54±0.84^{b}	6.38±0.76^{ab}	6.33±1.13	5.93±1.42^{a}	6.55±0.94^{ab}
E3	80	6	5	5	6.90±0.64^{ab}	6.42±0.56^{b}	6.42±1.42	6.06±1.42^{a}	6.76±0.64^{a}
E4	85	5	5	5	7.13±0.74^{a}	6.53±0.83^{b}	6.53±1.06	6.13±0.92 ^{ab}	6.87±0.74^{ac}
E5	86	4	5	5	6.53±1.25^{b}	6.27±0.70^{a}	6.60±1.40	6.73±0.96	6.87±0.74^{ac}
E6	87	3	5	5	7.27±0.88^{a}	7.20±0.68	7.33±1.07	7.07±0.96	7.73±0.46
E7	88	2	5	5	6.27±1.34^{d}	6.27±0.96^{a}	6.47±1.51^{b}	6.07±1.28^{a}	6.60±1.21^{c}
E8	89	1	5	5	6.06±1.14^{c}	6.07±0.78^{a}	6.34±0.68^{a}	5.98±1.42^{a}	6.50±0.84^{ab}

Comparsion of sensory quality of SBTo and EBTo with existing market tea

The comparison of the sensory quality of SBTo and EBTo with existing market tea is shown in Fig. 5. The OAA of EBTo was higher than SBTo, but not significant at $p<0.05$. Hence, the sensory score of SBTo or EBTo is comparable with existing market tea in terms of overall acceptability (Fig. 5). Though the OAA score for EBTo is higher, SBTo was considered the optimized formula because several other bioactive compounds may come into the tea from yarma ground powder. This SBTo is further characterized for physicochemical quality.

Quality Characteristics of SBTo

Colour, Bulk Density and Tapped Density

The colour value L*,a*,b*, which indicates lightness, redness, and yellowness, is shown in Table 1. The ‘L’ and ‘a’ values for EMT were higher than SBTo, which shows that the product has less lightness and less redness. This means that thearubigin, which is responsible for reddish brown color, is less in the final product.

On the other hand, the ‘b’ value of SBT (3% YGP) was higher than that of EMT, which indicates that the yarma-based blended tea has more yellowness than tea. This suggests that SBTo may contain more carotene content in the product.

The bulk and tapped density of the product were reported as 0.26 ± 0.18 and 0.27 ± 0.01 (g/l), respectively. Gurkin et al. (1972) also reported a lower value of bulk density in the spray-dried instant tea, 0.045-0.10 g/ml.

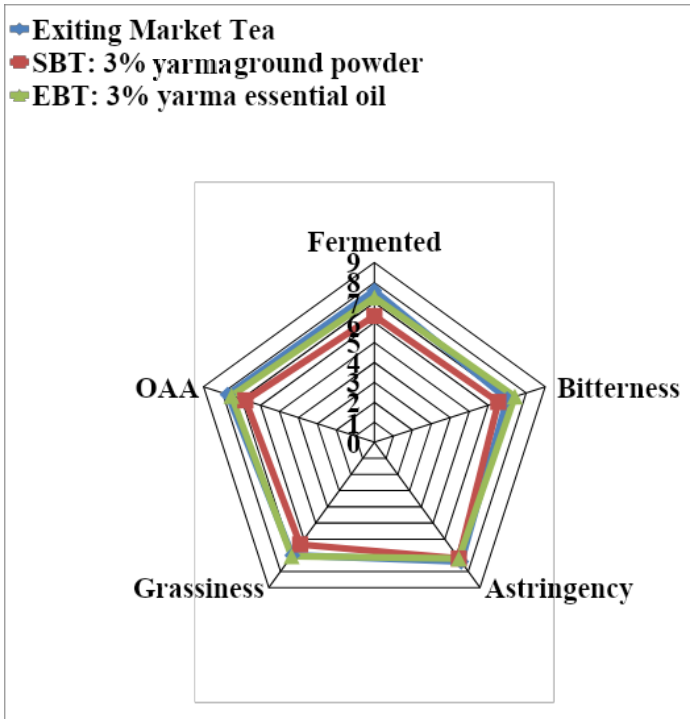


Fig. 6: Comparsion of sensory quality of SBTo and EBTo with exiting market tea

Nutritional Characteristics

Nutritional parameters such as moisture, carbohydrates, proteins, fats, ash, total polyphenolic content, antioxidant activity, and vitamin C of the optimized product and Existing Market Tea (EMT) are shown in Table 5. The moisture content, ash content, carbohydrates, proteins, and fats of the spice blended tea (SBT) were 9.1 ± 0.15%, 21.66 ± 0.28%, 4.71 ± 0.14%, 0.002 ± 0.001%, and 4.5 ± 0.2%, respectively, which were higher than EMT. The incorporation of spices in black tea may enhance the nutrient content. The addition of nutrients in black tea, such as 15.72% carbohydrates and 0.8% fat content, and maltodextrin used as a binder, which is carbohydrates in nature are generally simple sugars or starches may enhance the nutritional value of the final product. Malt oligosaccharides or maltodextrins represent a commonly available source of energy. Maltodextrins are a preferred substrate because they are highly abundant in amylases and readily incorporate glucose into the metabolic pathway (Quiocho et al., 1997).

Total phenolics content, antioxidant content, and vitamin C

The total polyphenolic content, antioxidant activity, and vitamin C of the optimized product and Existing Market Tea (EMT) are shown in Table 5. The total phenolic content of SBT with ethanol solvent is higher (92.40 GAE mg/g) than with chloroform solvent (91.33 GAE mg/g dry material). The affinity of a polar compound attracts polar compounds, and ethanol is a polar solvent, so it attracts the polar compound of phenols. The total phenolic content of commercial tea (LIPTON commercial brand) was higher, 98.05 mg/g, when extracted with distilled water (Abbasian et al., 2013). The antioxidant activity of SBT with ethanol solvent is lower (20.50±0.21(mg/100g)) than with chloroform solvent (30.49±0.41mg/100g dry material). The affinity of a polar compound attracts polar compounds, and ethanol is a polar solvent, so it attracts the polar compound of phenols. Phenolic compounds are a class of antioxidant agents that can absorb and neutralize free radicals (Seal et al., 2013). These findings showed that SBT's high total polyphenol content had strong antioxidant properties. When separating phenolic chemicals from various plant sources, aqueous methanol and aqueous ethanol extraction solvents worked better (Chatha et al., 2006, Anwar et al., 2007, Siddhuraju et al., 2003, and Shabbir et al., 2011). The vitamin C value of SBT was 37.8 mg/100g. Seal et al., (2013) reported

that the presence of antioxidants in the extracts reduced Fe/ferricyanide complex to the ferrous form. Because the extracts have the ability to break the chain of free radicals by donating hydrogen atoms, this reducing capacity may be used as an indicator of possible antioxidant activity.

Fig. 7: Optimized blended tea based on 3% yarma spice powder (SBTo)

CONCLUSION

Spice-blended black tea was prepared by using 3 ml of essential oil from a locally available spice called Yarma, mixed with 87 g of black tea, 3 ml of essential oil, 5 g of cardamom, and 5 g of maltodextrin. The hydrodistillation process yielded 6.73±0.0057% v/w of essential oil from the spice Zanthoxylum armatum DC. GC-MS revealed 16 major volatile compounds, such as limonene, cubenol, and linalyl acetate. The color of the tea was compared with an Existing Market Tea (EMT) color flex instrument. The phenolic content of the product was measured using different solvents, chloroform and ethanol, and the sample showed more total phenolic content in the ethanol solvent. Phenolic compounds, due to their redox characteristics, phenolic compounds have been shown to be the main plant chemicals with antioxidant action.

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