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Studies on preparation and preservation of lemongrass (*Cymbopogon flexuosus* (Steud) Wats) powder for tea

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Abstract

The leaves of six varieties of lemongrass at full maturity stage (whole and cut into 5 cm pieces) were blanched at 80°c for 1 min, dried, ground in to fine powder and analyzed for chemical constituents. The powder was stored in 200 guage plastic bags at ambient (31±4°C) condition for 6 months. The powder samples were drawn at 30 days interval and evaluated for chemical constituents and sensory quality. The lemongrass leaves of all varieties contained essential oil (1.20 to 4.40%), ascorbic acid (1.75 to 1.89 mg/100g) and total chlorophyll (7.49 to 10.76 mg/g) with reasonably good amount of ash (3.0 to 7.00%) on dry weight basis. The leaves and powder of *'Krishna'* variety contained maximum essential oil, ascorbic acid and total chlorophyll followed by *'Kaveri', 'Praman', 'Pragati' 'OD-19'* and *'CKP-25'* varieties. The overall acceptability score of tea extract with 1% powder of lemongrass was highest. During storage for 6 months, the essential oil ascorbic acid and total chlorophyll content were significantly decreased while ash content significantly increased. However, the interactions between treatments and storage period were nonsignificant. The sensory quality scores of powders of all the varieties were significantly decreased during storage. The powder of '*Krishna*' variety was rated first followed by '*CKP-25*', '*Kaveri*', '*OD – 19*', '*Pragati*' and '*Praman*'.

Key words: Lemongrass, Powder, Tea, Organoleptic taste, Chemical composition

Introduction

The lemongrass (*Cymbopogon flexuosus* (Steud) Wats) is a perennial grass belonging to family Graminaceae and grouped under genus *Cymbopogon*. It is of indigenous origin and is a medicinal and aromatic plant. It is locally known by different names such as 'Gawati Chah', 'Nibugrass', 'Puthiganda' etc. in different languages. The three species of lemongrass are found in India. *Cymbopogon flexuosus* is grown in East Indian States which is famous for its oil and has a good market. *Cymbopogon citrates* found in the West Indian States contain less citral. *Cymbopogon pendulus* in Jammu region contain higher high citral but its cultivation is limited.

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The lemongrass is grown in a wide range of soils and climatic conditions. It requires hot and humid climate with high rainfall and long sunlight and well-drained soil. It is originated in India and grown in states of Kerala, Karnataka, Tamil Nadu, Sikkim, Bengal, Madhya Pradesh, Arunachal Pradesh and Maharashtra. It is also grown in Brazil, Guatemala, Argentina, West Indies, Vietnam, Thailand, Shri Lanka and China. Wild species of lemon grass are found in tropical region of Asia, Africa and Latin America.

Lemongrass normally grows to a height of 1 to 1.5 m reaching 3 m at flowering. Leaves are linear, lanceolate, about 100-125 cm long and 1.0 to 1.5 cm broad. Inflorescence is a panicle, large, dropping lax, grayish to grayish green with purple tinge. It produces small blue flowers. Lemongrass is an open pollinated species and is adapted for cross pollination because of its protogynous nature (Mercy et al., 1979; Thomas, 1995).

India is traditionally the largest producer of lemongrass oil. However, the production has declined steadily over the years and export failed from 1800 tonnes in 1961-62 to 65 tonnes in 1994-

95 and today it is 400 tonnes (Dumbre and Bhoite, 1999). Latin America, China and Guatemala are the major producers of lemongrass essential oil in the world. The improved cultivars such as '*CKP-25*', '*Praman*', '*Pragati*', '*Kaveri*', '*Krishna*' and '*OD-19*' are grown in India (Pals et al., 1992; Kulkarni et al., 1999).

Lemongrass is well known for its essential oil which contains citral as the major constituent. The citral content varied from 44.3 – 91.4% to 79 – 91.5% (Kuriakose, 1995; Kulkarni and Ramesh, 1987). It is used as a starting material for synthesis of Vitamin A, in aromatherapy and in perfumery and flavourful grass, has therapeutic properties and is used internally as a medicinal tea. Oil is extensively used for scenting, waxes, polishes, deodorants. The leaves are used in teas in different countries as well as in culinary and cough treatment (Husain, 1994). The stalks are too tough to eat but, they can be chopped and powdered and add to flavour to fish or poultry sauces, grass leaves are used in curries and soup in Vietnam, Thailand and China. Lemongrass has medicinal use such as stomach smoother, also helps in reduction of cholesterol level. To make a tea from lemongrass leaves or powder and drink 1-4 cups per day to relieve congestion, coughing, bladder disorders, headaches, fever, stomach aches, digestive problems, diarrhea, gas, bowel sparms, vomiting, flu symptoms and to promote perspiration and as a possible cholesterol lowering agent. The leaves can also be dried and made into a powder for use in capsules. Powdered lemongrass is found in markets under the name "Sereh powder". The recipes such as lemongrass rice, sweet lemongrass blend, and lemongrass beef can be prepared from lemongrass.

The lemongrass has a very wide demand in nutritional, medicinal and flavouring industry. But it is not stored as fresh for long time at ambient condition because it rotten after long periods. Hence, lemongrass powder is preferred and it has huge demand in the world market. The price of the lemongrass powder is Rs. 80 to 100/kg and its oil is Rs. 300 to 500/kg. Traditionally, lemongrass powder is prepared by grinding the dried leaves. Lemongrass gives approximately 22.2 calories along with 4.59 g protein, 0.96 g sugar and 1.80 mg ascorbic acid per 100 g of powder. Also, lemongrass oil contains methyl eugenol, 15-20% (Sabti and Rao, 1987), geranyl acetate, 45-50% (Sabti and Rao, 1987 and Mathew et al., 1996), geraniol 49-80% (Kulkarni et al.,1992, 1996), bisabolo 37-38% (Thappa and Agrawal, 1989), Citronellol acetate and gerauyl acetate, 11.2 – 25.9% (Kulkarni et al., 1997), β-ocimene 17-20 % and V-terpineane, 8-10 per cent (Kulkarni et al., 1992) and elemiciu 53% (Sharma et al., 1999).

Owing to its medicinal value, excellent colour and flavour, it has a great potential in processing industry. It is, therefore, proposed to standardize the powder making technology from lemongrass and to study the organoleptic and chemical properties of lemongrass powder and the flavour stability during storage.

Materials and Methods

The lemongrass leaves of varieties such as *'CKP-25', 'Praman', 'Pragati', 'Kaveri', 'Krishna'* and *'OD-19'* at full maturity stage were obtained from the Medicinal and Aromatic Plants Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, India. The fully matured, healthy and uniform sized sound leaves were carefully harvested and brought to the laboratory for further experimental study. Most of the chemicals used in the present investigation were of analytical grade. Cross flow cabinet drier was used for drying of lemongrass leaves by keeping various treated samples in separate trays. Whelly Plant Grinding Mill from the Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri was used to grind the dried lemongrass leaves samples. The leaves were cut into approximately 5 cm pieces according to the treatment details.

Fresh leaves (500 g) with various treatments given and oven dried at 50-60°C. After cooling, the samples were weighed again until constant weight was obtained. The weights were recorded as dry matter. The dried treated lemongrass leaves samples were ground into fine powder using Whelly Plant Grinding Mill for further chemical analysis and preparation of lemongrass tea for organoleptic evaluation.

The nitrogen, crude fiber, lipids, ash, total chlorophyll and essential oils content from various lemongrass leaves powder samples were estimated by AOAC (1990) methods. The total sugars content in was extracted in 80% ethanol solution (Nelson 1944). The vitamin C content was estimated by 2, 6, dichlorophenol-Indophenol dye visual titration method as described by Ranganna (1986). Total phenolics were determined by the method of Swain and Hills (1959).

Treatment details

The leaves at full maturity stage were harvested and then treated as follows for the preparation of powder.

a. Cutting treatments
    1. Whole leaves
    2. Cut into 5 cm pieces
b. Blanching treatments

1. Control
2. Blanching in 80°C hot water for 1 min
3. Blanching in 1% Na_2CO_3 at 80°C for 1 min

c. Drying treatment
1. Sun drying
2. Cabinet tray drying at 40°C

Preparation and packaging of powder

Evenly maturity, disease free and sound leaves of '*Krishna*', '*CKP-25'*, '*OD-19*', '*Praman*', '*Pragati*' and '*Kaveri*' lemongrass cultivar were selected. The leaves were washed with clean water and subjected to the above treatments like cutting, blanching and drying (Figure 1).

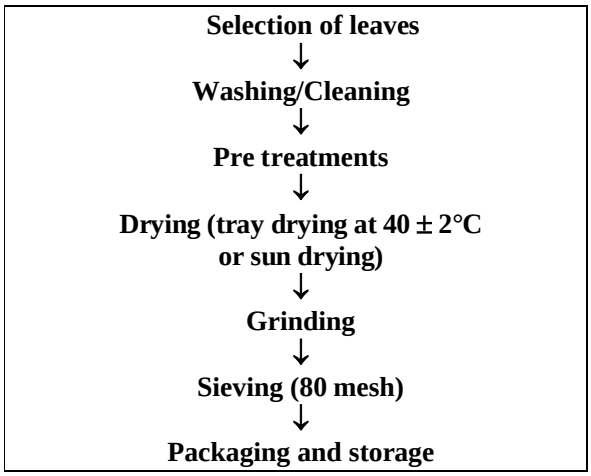

Figure 1. Flow chart for preparation of lemongrass powder.

The dried samples were ground into a fine powder and were sealed in 200 gauge LDPE bags and stored at ambient temperature. The chemical composition and organoleptic properties of lemongrass powder were tested by using different levels in the hot water or tea. The storage study was conducted up to 6 months.

Chemical analysis of powder

The powdered samples were chemically analyzed for essential oil, ascorbic acid, total chlorophyll and ash by the same procedure as described earlier for analysis of fresh leaves. The lemongrass powders were analyzed for chemical composition 60,120 and 180 days and for sensory qualities were assessed after 6 months of storage.

Sensory evaluation of powder

On the basis of highest amount of essential oil content '*Krishna'* variety was chosen for standardization of optimization of powder level for tea. Preliminary trials for standardization of level of lemongrass powder for preparation of tea were carried out using different levels viz. 0.5, 1.0, 1.5, 2.0 and 2.5 g/100 ml and heated upto boiling by adding 15% sugar. From these levels 1.0 g/100 ml lemongrass powder and 15% sugar level were standardized and used for further experimental study.

The sensory evaluation of powder stored at ambient condition was done at 180 days of storage by a panel of semi-trained judges as reported by Amerine et al. (1965) on 9 point Hedonic scale. At a time, six samples of powder were kept for evaluation and the average score of minimum five judges for each of colour of powder, colour of extract, aroma of extract, taste and overall acceptability was recorded. The experiment was planned by using Factorial Completely Randomized Design (FCRD) with 3 replications and the results were collected for chemical composition and sensory parameters. The results obtained were analyzed for the statistical significance according to the procedure as reported by Panse and Sukhatme (1967).

Results and Discussion

Physico-chemical characteristics of leaves

The leaves are dark green colored with an average weight of 3.5 to 4.5 g/100g leaves. Lemongrass leaves are linear, lanceolate, about 100-125 cm long and 1.0 to 1.5 cm broad. The fresh leaves contained average dry matter 43.59%, *'Pragati'* variety of lemongrass contained high dry matter 49.33% and low dry matter content was in *'OD-19'* variety of lemongrass as 39.93%. The nitrogen content in '*CKP-25*' variety of lemongrass was 0.98% and in *'Pragati'* was 0.49%. The crude fiber content of '*CKP-25*' variety was 85.5% and *'Praman'* was 77%. Average crude fiber content was 81.66%. The total sugars content in '*OD-19'* was 0.99% and *'Pragati'* 0.93%, average total sugars content was 0.96%. The ash content in *'Praman'* leaves was 6.33% and *'CKP-25'* is 3.00 average ash content was 5.33%. The ascorbic acid content in *'Krishna'* leaves was 1.89 mg/100 g and *'Kaveri'* and *'Pragati'* leaves content 1.75 mg/100 g, average vitamin C is 1.80 mg/100 g. The total chlorophyll content in '*OD-19*' leaves was 10.76 mg/g and *'Krishna'* leaves was 7.49 mg/g, average total chlorophyll is 8.93 mg/g. The total fat content in '*Krishna'* leaves is 4.80% and 'CKP-25' leaves was 1.40%, average total fat is 2.86%. The total phenolics content in '*Krishna'* leaves are 0.99% and 'CKP-25' leaves are 0.88%, average total phenolics are 0.941%. The essential oil content in '*Krishna'* leaves was 4.4% and '*CKP-25*' was 1.2%, average essential oil was 2.466% (Table 1). There for '*Krishna'* variety was used for preparation of lemongrass powder tea.

Best level of powder for preparation of lemongrass tea

Appropriate level of lemongrass powder for the preparation of extract/tea was determined using various concentrations such as control (green leaves 2.0%), 0.5, 1.0, 1.5, 2.0 and 2.5% in hot water containing 15% sugar. From this, best one was selected for further experiments on lemongrass tea preparation (Table 2). Considering the higher scores for colour, aroma of extract, taste and their overall acceptability score, 1.0% lemongrass powder level was found best for the preparation of lemongrass tea. Therefore, for further study 1.0% level of lemongrass powder was fixed.

Best treatment for preparation of lemongrass powders

From the six genotypes of lemongrass and drying treatments only one best treatment was selected for further storage study. For *'Krishna'* treatment Tray-whole-blanching in hot water, for '*CKP-25*' treatment Sun-whole-blanching in hot water for '*Kaveri'* treatment Tray-whole-blanching in hot water, for '*OD-19*' treatment sun-whole-blanching in hot water for *'Pragati'* treatment sun-whole-blanching in hot water and for *'Praman'* treatment sun-whole-blanching in hot water were found best. These treatments samples were further utilized for the storage study.

Sensory evaluation of fresh and stored lemongrass powder

The results indicated that the mean score for colour of powder was 7.84, colour of extract was 7.85, aroma of extract 7.69, taste of extract 7.94 and overall acceptability was 7.83. The colour of powder, colour of extract, aroma of extract, taste of extract and overall acceptability is better in '*Krishna'* variety powder which was 8.22 followed by *CKP-25* powder and '*Kaveri'* powder (Table 4). These results indicated that the varietal variation occur in the powder. This variation mainly contributes for the organoleptic properties of the lemongrass powder when used for the preparation of tea at specific concentration and conditions.

The results of sensory evaluation are reported in guava powder (Khurdiya and Roy, 1974; Ahire, 1989), mango powder (Dabhade and Khedkar, 1980), banana powder (Lal et al., 1989) and in sapota powder (Raut, 1999) are similar to these results.

Table 1. Chemical composition of six genotypes of lemongrass leaves (on dry weight basis).

Genotype	Dry matter (%)	Nitrogen (%)	Crude fibre (%)	Total fat (%)	Total sugars (%)	Ash (%)	Total chlorophyll (mg/g)	Ascorbic acid (mg/100 g)	Total phenolics (%)	Essential oil (%)
Krishna	40.00	0.84	82.50	4.80	0.98	4.66	7.49	1.89	0.99	4.4
CKP-25	41.66	0.98	85.50	1.40	0.95	3.00	7.71	1.82	0.88	1.2
Kaveri	45.00	0.77	78.00	3.60	0.97	7.00	10.12	1.75	0.90	3.1
OD-19	39.93	0.63	84.00	1.70	0.99	5.33	10.76	1.82	0.93	1.3
Pragati	49.33	0.49	83.00	2.60	0.93	5.66	9.32	1.75	0.98	2.2
Praman	45.66	0.70	77.00	3.10	0.94	6.33	8.20	1.82	0.97	2.6
Mean	43.59± 1.5	0.735± 0.0	81.66±0.3	2.86± 0.5	0.96±0.0	5.33 ±0.5	8.93±0.5	1.80±0.0	0.94±0.0	2.47±0.0
CD at 5 % (n=3)	4.282	0.223	1.071	1.446	0.0270	1.606	1.544	0.0606	0.0408	0.0521

Each value is the mean of three determinations.

Table 2. Organoleptic evaluation for optimization of lemongrass powder level for tea/extract.

Treatment	Colour of extract	Aroma of extract	Taste	Overall acceptability	Ranks
Control (Green leaves 2.0 %)	6.90	6.80	6.60	6.76	4th
(Dry powder) 0.5 %	7.00	6.60	7.20	6.93	2nd
1 %	8.10	8.40	8.20	8.23	1st
1.5 %	7.20	7.00	6.40	6.86	3rd
2.0 %	6.50	6.00	6.00	6.16	5th
2.5 %	5.60	5.40	5.60	5.53	6th

Each value is the average of ten trails.

Table 3. Effect of storage on chemical composition of lemongrass leaves powder (6 months storage).

Genotype	Essential oil (%)				Vitamin C (mg/100g)				Total Chlorophyll (mg/g)				Ash (%)			
	0	60	120	180	0	60	120	180	0	60	120	180	0	60	120	180
Krishna	3.00	2.70	0.27	0.20	1.48	1.33	1.21	1.08	3.09	2.93	2.85	2.73	7.00	7.60	8.00	8.70
CKP-25	0.90	0.70	0.50	0.50	1.55	1.41	1.28	1.15	3.38	3.25	3.12	3.03	10.00	11.35	11.5	11.9
Kaveri	2.30	1.57	1.47	1.40	1.62	1.48	1.35	1.21	5.82	5.75	5.67	5.60	7.20	7.78	8.49	9.00
OD-19	1.00	0.80	0.60	0.49	1.41	1.28	1.15	1.01	6.05	5.90	5.80	5.68	7.75	8.00	8.60	9.20
Pragati	1.90	1.60	1.20	1.00	1.48	1.35	1.21	1.08	4.93	4.80	4.68	4.59	8.00	9.00	9.50	10.28
Praman	2.20	1.80	1.60	1.48	1.68	1.55	1.41	1.21	4.28	4.15	4.06	3.97	5.93	7.00	7.50	8.00
Mean	1.88	1.53	1.27	1.18	1.54	1.40	1.34	1.12	4.59	4.46	4.36	4.27	7.65	8.45	8.93	9.51
Treatment/ Storage (n=3)	S. E. ±		C. D. at 5%		S. E. ±		C. D. at 5%		S. E. ±		C. D. at 5%		S. E. ±		C. D. at 5%	
T	0.034		0.095		0.023		0.065		0.024		0.068		0.048		0.135	
S	0.036		0.102		0.025		0.070		0.026		0.073		0.052		0.146	
T x S	0.089		N. S.		0.061		N. S.		0.064		N. S.		0.013		N. S.	

Changes in chemical composition of lemongrass powder during storage

The results indicated that there was a slight decrease in the essential oil content of the lemongrass powder with advancement of storage period. In general, essential oil content decreased from 1.88 to 1.18% (Table 3). The statistical analysis showed that there is a significant difference in the reduction of essential oil content with individual genotypes but the interaction effect genotypes vis. storage period showed non-significant effect. This indicates that lemongrass powder can be stored upto 6 months with good acceptability for the tea preparation at ambient condition. It is reported that, essential oil content decreased during storage in dried lemongrass leaves (Kulkarni, 1992).

The ascorbic acid of lemongrass powder decreased significantly in all varieties (Table 3). Mean decrease in vitamin C was from 1.53 to 1.12 mg/100 g. Ascorbic acid (Vitamin C) is one of the important vitamins needed in the human diet. It also play important role as an antioxidant. It increases nutritional value of the lemongrass powder. So it must retain in the lemongrass powder at higher level. Therefore, while giving various treatments to lemongrass leaves, care was taken for preservation of vitamin C in the lemongrass powder. But during storage there might be some oxidation due to presence of oxygen in the surrounding area of the lemongrass powder. The interaction between genotypes and storage period of lemongrass powder was non-significant. These results indicated that lemongrass powder can be stored upto 6 months in good condition. Ascorbic acid (vitamin C) might have been lost due to enzymatic oxidation in storage (Das and Dash, 1967).

The decrease in total chlorophyll content in all lemongrass powder during storage was observed. Mean of six genotypes and their storage period showed that the decrease in total chlorophyll was from 4.59 to 4.26 mg/g. The chlorophyll of lemongrass powder gives dark colour to the tea. Higher level of chlorophyll gives green colour to tea which is undesirable because it also affect the taste of tea. Therefore, optimum level or lower level of chlorophyll content in lemongrass powder is needed. While storage there might be oxidation of chlorophyll in natural environmental condition. This can cause reduction in the chlorophyll content of lemongrass powder. In the present study the chlorophyll content in lemongrass powder was at optimum level. There was neither very dark nor very faint colour to the tea prepared from them. Therefore, there was no significant difference in the colour parameters of tea prepared from six different genotypes. The statistical analysis of various genotypes and their storage period interaction showed non-significant effect. A decrease in total chlorophyll is reported in green teas during storage (Frederink, 1959).

The ash content of lemongrass powder increased significantly in all varieties as the storage period progressed. The average increase in ash content of lemongrass powder was from 7.64 to 9.51% (Table 3). Ash content of lemongrass powder non-significantly increased while stored upto 6 months at ambient condition. Ash contents all types of minerals and these minerals are not loosed during storage. There is no effect of environmental condition on the lemongrass ash content. The increase in the ash content in the lemongrass powder during storage might be due to reduction in the moisture content during storage as well as oxidation and reduction of other parameters

from powder. The increase in ash content is reported in chicory powder during storage (Ramalakshmi, 1994), dried spinach (Howard et al., 1962) and turmeric powder (Viasan et al., 1989).

Changes in sensory parameters of lemongrass powder during storage

The mean scores of sensory quality parameters of six varieties of lemongrass powders before storage were 8.10 for colour of powder, 8.16 for colour of extracts, 7.82 for aroma, 8.63 for taste and 8.10 for overall acceptability. On storage of powders for 6 months at ambient condition, the score for the colour of powder decreased. It decreased continuously from 8.10 to 7.40 as the storage period progressed (Table 4). The results indicated that the score for the colour of extract decreased during storage in all genotypes. It decreased continuously from 8.16 to 7.40 as the storage period progressed. The powder extract colour during storage period was decreased due to the oxidation or other biochemical reactions that occur during storage. Due to this reason while preparation of tea or extracting colour in hot water it was decreased. The decreasing rate of colour intensity was different for each genotype and might be due to their genotypic characteristics. The statistical analysis showed that the interaction between storage period and treatments were non-significant. The colour of extract slightly affected in green and black teas (Friderink, 1959) during storage at room temperature.

The results indicated that aroma of lemongrass powder extract score decreased from 7.82 to 7.50 throughout storage period. The variety '*Krishna*' powder showed score from 8.16 to 7.40 throughout the storage period. Aroma producing compounds are generally volatiles or they get combined with other biomolecules when samples are grinding or crushing for preparation of extract or powder. Mostly aromatic, flavors, flavonoids and essential oil gives aroma/smell to the lemongrass extract. Due to various treatments of cutting and powder making these aroma/smell forming compounds will be exposed to the natural environment. During storage period these compounds might get reacted with oxygen or other environmental condition and get reduced or defused. These are some of possibilities to reduce score of aroma of lemongrass powder's extract judged by semi-trained judges. The statistical results showed that there is non-significant difference in the reduction of aroma from all genotypes during 180 days storage period. The results revealed that the score for taste of extract decreased significantly from 8.63 to 7.43 during storage. The powder of '*Krishna*' variety gave better taste followed by '*Kaveri*' powder and '*Pragati*' powder. The taste organoleptic parameter mostly depend upon the compounds those are present in the extract/solution. In case of lemongrass powder's extract, there might be soluble sugars, free amino acids, chlorophyll, soluble proteins and other soluble metabolites. These all components may affect the taste of extract. During storage there might be oxidation, reduction and other reactions occur within these components as well as may be some complex formation. These all parameters may be responsible for the change in the taste of lemongrass powder's extract. The statistical analysis of the results showed that individual genotype or storage period reduced the taste score but their interaction was non-significant.

Table 4. Sensory quality of the lemongrass powder extracts (after 6 months storage at ambient condition).

Genotype	Colour of powder	Colour of extracts	Aroma	Taste	Overall acceptability	Rank
Krishna	8.26	8.20	8.16	8.25	8.22	1
CKP-25	8.20	8.03	7.80	7.80	7.96	2
Kaveri	7.80	8.20	7.40	8.20	7.90	3
OD-19	7.80	7.60	7.50	7.91	7.70	5
Pragati	7.40	7.68	7.75	8.03	7.72	4
Praman	7.62	7.40	7.53	7.45	7.50	6
Mean	7.19±0.32	7.17±0.27	6.98±0.22	7.23±0.32	7.14±0.25	-
C.D. at 5% (n= 5)	0.98	0.84	0.68	0.99	0.76	-

Each value is the average of five trails.

Figure in parenthesis are the mean score values of fresh lemongrass powder extracts.

There was a significant decrease in overall acceptability of lemongrass powder. The score decreased from 8.10 to 7.50 during the storage period. The overall acceptability of the extract is based on the organoleptic properties such as colour of powder, colour of extract, aroma of extract and taste of the extract. These parameters showed decreasing trend during storage period. Therefore, the overall acceptability also showed decreasing trend in all lemongrass genotypes. There was a variation in the rate of decrease in overall acceptability which is based on each genotype characteristic. The statistical analysis showed there is non-significant effect of storage period on the overall acceptability of lemongrass powder's extract when stored up to 180 days.

The cost of lemongrass powder did not include rent and transport charges, sales commission, local taxes etc. The results indicated that the cost of production of lemongrass powder at prevailing rate was in the range of Rs. 56.25 to 66.25/Kg.

Conclusion

The 1% powder level was better in quality for preparation of tea/extract as determined by the basis of 9 point Hedonic score method. Powder prepared from '*Krishna*' variety was found superior over other varieties of lemongrass in respect of essential oil, colour of powder, colour of extract, aroma of extract, taste and overall acceptability. All powder samples remained in good condition even after 6 months of storage in 200 guage polythene bags at ambient condition. Further studies on preparation of lemongrass powder on pilot scale and their mass consumer acceptability studies are needed for better utilization of lemongrass.

References

Ahire, A. A. 1989. Studies on the development of preserved products from guava (*Psidium gujava* L.) M.Sc. (Agri.) Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.).

Amerine, M. A., Pangborn, R. M., Roessier, E. B. 1965. Laboratory studies: Quantity and quality evaluation. Principals of Sensory Evaluation of Foods. Academic Press New York, p. 349-397.

AOAC. 1990. Official Methods of Analysis 15th ed. Association of Official Analytical Chemists, Washington DC.

Dabhade, R. S. and D. M. Khedkar. 1980. Studies on drying and dehydration of raw mangoes for preparation of mango powder (amchur). Indian Food Packer 34(3):39-42.

Das, R. C. and J. Dash. 1967. The effect of wax emulsion on storage behaviour of mousambi fruits Processing Interval Symposium held at New Delhi, pp.104-107.

Dumbre, A. D. and K. Bhoite. 1999. Cultivation of medicinal and aromatic plants. University Press MPKV, Rahuri (M.S.) pp. 76-78.

Frederink, T. W. 1959. The chlorophyll content of tea. Bulletin of the Torrey Botanical Club. 86(3):184-189.

Howard, F. D., J. H. Macgillivery and M. Jamaguchi. 1962. Nutrient composition of fresh California grown vegetable. Calif. Univ. Agri. Expt. Sta. Bull.p. 788.

Husain, A. 1994. Essential oil plants and their cultivation CIMAP, Lucknow. J. Med. Arom. Plant Sci. 25:5-7.

Khurdiya, D. S. and S. K. Roy. 1974. Studied on guava powder by cabinet drying. Indian Food Packer 28:5-8.

Kulkarni, R. N. and S. Ramesh. 1987. Heritability estimates of citral content in East Indian lemongrass. Theor. Appl. Genet. 73:476-477.

Kulkarni, R. N., G. R. Mallavarapu and S. Ramesh. 1992. The oil content and composition of new variants of cymbopogan flexuous. J. Essent. Oil Res. 4:511-514.

Kulkarni, R. N., K. Baskaran and S. Ramesh. 1996. Comparative performance of geraniol rich variants of cymbopogon flexuous. J. Med. Arom. Plant Sci. 18:499-501.

Kulkarni, R. N., G. R. Mallavarapu, K. Baskaran, S. Ramesh and S. Sushilkumar. 1997. Essential oil composition of a citronella-like variant of lemongrass. J. Essential Oil Res. 9:393-395.

Kulkarni, R. N., K. Baskaran and S. Ramesh. 1999. Lemongrass cultivar "*Krishna*". J. Med. Arom. Plant Sci. 447-449.

Kuriakosem, K. P. 1995. Genetic variability in East Indian lemongrass. Indian Perfumer. 39:76-83.

Lal, B. B. A. M. Genzaler and M. A. Wesali. 1989. Some aspects in storage behaviour of freeze

dried banana powder. Indian Food Packer 43(2):38-41.

Mathew, S., G. J. Chittattu and J. Thomsan. 1996. OD-468 a lemongrass genotype rich in geranyl acetate. Indian Perfumer. 40:9-12.

Mercy, S. T., V. G. Nair and C. L. Babu. 1979. Anthesis in Indian lemongrass. Agric. Res. J. Kerala 17:200-203.

Nelson, N. 1944. A photometric adoption of the Somogyl method for determination of glucose. J. Biol. Chem. 15:375.

Pals, S., S. Chandra, S. S. Balyan, A. Singh and B. L. Rao. 1992. Developed new lemongrass strain CKP-25. Indian perfumer. 36:78-80.

Panse, V. S. and P. V. Sukhatme. 1967. Statistical Methods for Agril. Workers. ICAR, New Delhi, pp. 527-679.

Ramalakshmi, K. 1994. Ash content in chicory powder. Indian Coffee. 58(3):22-24.

Ranganna, S. 1986. Handbook of analysis and quality control of fruits and vegetable products 2nd Ed. Tata McGraw Hill Publication New Delhi.

Raut, S. A. 1999. Studies on the preparation of sapota powder M.Sc. (Agri.) Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.).

Sabti, S. N. and B. L. Rao. 1987. Breeding of a citral rich cymbopogan. Indian Perfumer 31:44-47.

Sharma, K. K., S. C. Nath, P. A. Leclerca. 1999. Essential oil composition of cymbopogon-flexusous. J. Essent. Oil Res. 11:381-385.

Swain, T. and W. E. Hills. 1959. Phenolic constituents of prunusdomestica. Quantitative analysis of phenolic constituents. J. Sci. Food Agric. 10:83-87.

Thappa, R. and S. G. Agrawal. 1989. Cymbopogon flexuous oil a rich source of bisabolol. J. Essent. Oil Res. 1:107-110.

Thomas, J. 1995. Lemongrass. In: K. L. Chandha, and Guptar (Eds.), pp.717-733. Advances in Horticulture Vol. II MAP Malhotra, New Delhi, India.

Viasan, A. C., A. J. Nirmala Menon, C. S. Narayanan and A. G. Mathew. 1989.Chemical analysis of some cultivars of *Curcuma longa* Linn. J. Food Sci. Tech. 26:293-295.