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Physico-Chemical Composition of Tender and Mature Tamarind Leaves

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A B S T R A C T

The present investigation was carried out to study the physical characters such as length, width, volume, bulk density, colour, pH, titrable acidity and chemical composition such as moisture, protein, fat, crude fibre, ash, total carbohydrates, dietary fibre, mineral calcium and vitamin C of tender and mature tamarind leaves. The physical properties *viz*., color (L*, a*, b*), length, 1000 leaves weight, volume, and bulk density were significantly higher in mature tamarind leaves than tender tamarind leaves and the values ranged from 47.41 to 61.56, -8.22 to-3.24, 6.57 to 24.98, 9.03 to 12.21mm, 7.82 to 14.15g, 10.00 to 14.66ml, and 0.78 to 0.96g/ml respectively. The chemical composition of tender and mature tamarind leaves *viz*., protein (4.77 to 10.29%), fat (2.63to 6.915), ash (3.62 to 9029%), moisture (62.28 to 78.25%), energy (85 to 148 Kcal), vitamin C (15.21 to 19.28mg/100g), and calcium (98.60 to 160.43mg/100g). Mature tamarind leaves had showed significant higher values of physico-chemical composition compared to tender tamarind leaves.

Introduction

Tamarind (*Tamarindus indica* L.) is a dicotyledonous tree belongs to Caesalpiniaceae family. It is the third largest family of flowering plants with a total of 727 genera and 19,327 species. Tamarind is an economically important and most useful tree which grows wild in central and southern parts of India (Lewis *et al.*, 2005). The leaves are consumed as green leafy vegetable. It contains high level of protein with many essential amino acids which help to build strong and efficient muscles. It is also high in carbohydrate, which provides energy, rich in the minerals, potassium, phosphorus, calcium, and magnesium. Tamarind leaves also provide smaller amounts of iron and vitamin A. It is an important leafy vegetable and food resource for the Thai population, the flower and leaf are eaten as vegetables (Prakash and Misra, 1988). In India, the leaves are made into a dish which is known as "Chindar". Tamarind tender leaves are also used as seasoning vegetable in some Thai food recipes because of their specific aroma and sourness (Coronel, 1991). Tamarind leaves are used to make

curries, soups, salads, and stews in many countries, especially in times of scarcity (El-Siddig *et al.*, 2006). The tender leaves of tamarind are also used in the preparation of various vegetarian and nonvegetarian (meat) foods. Leaves ground into a paste with lime juice and heartwood of Acacia tundra wild are used in the treatment of boils to prevent suppuration and inflammatory swellings. The leaves are also used in the treatment of ulcers and the juice of the leaves is applied externally to treat rheumatism and external swelling in the Philippines and West Africa (Jayaweera, 1981; Rama Rao, 1975). It has been reported by Pino *et al.*, (2002) that the tender tamarind leaves are also used to produce an essential oil, which is primarily limonene and benzyl benzoate. The fruits of this plant showed anti-inflammatory, anti-bacterial and anti-diabetogenic effects (Maiti *et al.*, 2004). Tamarind leaves have several health benefits like antioxidant and anti-bacterial which will be helpful in curing liver diseases (Escalona-Arranz *et al.*, 2010). The tamarind leaves and barks are used for the treatment of wounds, especially in central West Africa. While the bark is used in the treatment of diarrhoea in West Africa, the leaves are also used for the same purpose in East Africa (Reinout *et al.*, 2010). Hence the present study was planned with the objective to analyze the physico-chemical composition of tender and mature tamarind leaves.

Materials and Methods

The experiment was conducted during the year 2020-2021 at the Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad. Mature tamarind leaves and tender tamarind leaves were collected from a fully grown tree in Hi-tech Horticulture division, University of Agricultural Sciences, Dharwad. The samples were collected, cleaned, dried, and stored in an airtight container for further analysis.

Physical characteristics of tamarind leaves such as volume (ml/1000 leaves), bulk density (Kaur *et al.*, 2007), colour of leaves was assessed in spectrophotometer model Konica Minolta, CM-2600/2500d and was measured in chromatic components of 'L' (black - 0 to white - 100), 'a' represents redness (+a values) to greenness (-a values) and 'b' represents yellowness (+b values) to blueness (-b values), length and width was recorded using digital vernier caliper having the least count 0.01 mm, pH was measured using pH meter calibrated with standard buffers, pH 7 and 4 (Kha *et al.*, 2010) and the titratable acidity of tamarind leaves was determined as per the procedure of Rangana (1986).

Tamarind leaves were dried and powdered and analysed for chemical composition. Chemical composition such as moisture, protein, fat, crude fibre, ash content by (Anon., 2019) and dietary fibre by enzymatic-gravimetric method (Asp *et al.*, 1983) and mineral content such as calcium by (AOAC, 1965) and vitamin C by (Anon., 2019).

Paired t-test was employed to test the significance of obtained results.

Results and Discussion

Table 1 indicated physical properties of tamarind leaves. The highest and the lowest lightness (L*) values was observed in tender tamarind leaves (61.56) and mature tamarind leaves (47.41). The greenness i.e., a* value ranged between -8.22 to -3.24. The highest a* values were observed in mature tamarind leaves and lowest in tender tamarind leaves. The yellowness i.e., b* value ranged 6.57 to 24.98. The highest b* values were observed in tender tamarind leaves and lowest in mature tamarind leaves. The leaf length ranged from 9.03 to 12.21 mm. The highest values were recorded by mature tamarind leaves and lowest by tender tamarind leaves. The leaf width ranged from 0.19 to 0.42 mm, however, there was no significant difference between tender and mature tamarind leaves. The 1000 leaves weight ranged from 7.82 to 14.15 g. The highest values were recorded by mature tamarind leaves and lowest by tender tamarind leaves. The 1000 leaves volume ranged

from 10.00 to 14.66 ml; bulk density ranged from 0.78 to 0.96 g per ml, which differed significantly (P ≤ 0.05) between tender and mature tamarind leaves. The highest values were recorded by mature tamarind leaves and lowest by tender tamarind leaves.

pH and acidity of the tamarind leaves are presented in table 2. pH and acidity of the tender tamarind leaves was 3.62 and 8.28 per cent respectively while that of mature tamarind leaves was 3.99 and 7.25 per cent, respectively. The highest pH values were observed in mature tamarind leaves while the highest percentage of acidity was observed in tender tamarind leaves. There was significant variation (P≤0.05) in pH and titrable acidity between tender and mature tamarind leaves.

In physical parameters colour is an important quality attribute of food, which influences consumers choice and preferences (Pathare *et al.,* 2013). Colour measurement of food has been used as an indirect measure of other quality attributes, such as flavour and contents of pigments because it is simpler, faster and correlates well with other physicochemical properties, such as appearance (Pathare *et al.*, 2013). Changes in colour were observed in tamarind leaves upon maturity (Table 1). Tender tamarind leaves were found to be lighter, with their L* value- 61.56, a* value -8.22 indicating increasing yellowness due to less of pigments such as chlorophyll and carotenoids from the leaves (Kidmose *et al.,* 2002). Whereas mature tamarind leaves are dark green in colour because of retention of chlorophyll pigment, with a* value of -3.24 and L* value of 47.41.

Length and width of the leaves indicates maturity stage of harvesting the leaves. Length and width were higher in mature tamarind leaves (i.e., 12.21 and 0.42 mm). Volume and bulk density indicate quality and thickness of leaves. Volume and bulk density were higher in mature tamarind leaves (i.e., 14.66 ml and 0.96 g/ml), whereas bulk density of rapeseed was observed to be 0.585 to 0.612 g per ml at three different moisture contents. Titrable acidity measures the amount of acid present in a solution. Both tender and mature tamarind leaves were acidic with pH ranging from 3.62 to 2.99 (Table 2). Tartaric acid is the main acid present in tamarind leaves. Aberound (2010) reported that the reduction of pH leads to inhibition of food spoilage microorganisms' growth.

Nutrient composition of tamarind leaves is presented in table 3. There was significant variation in moisture, protein, ash, energy, vitamin C and calcium content between tender and mature tamarind leaves (P≤0.05). Tender tamarind leaves contained highest moisture content (78.25%) and mature tamarind leaves contained lowest moisture content (62.28%). Protein content ranged from 4.77 to 10.29 per cent. The protein content was higher in mature tamarind leaves than tender tamarind leaves.

Ash content ranged from 3.62 to 9.29 per cent. The ash content was higher in mature tamarind leaves than tender tamarind leaves. Energy was higher in mature tamarind leaves (148.28Kcal/100g) than tender tamarind leaves (85.64Kcal/100g). But there was no significant difference in fat, crude fibre, total carbohydrates, and available carbohydrates between tender and mature tamarind leaves (P≤0.05). There was significant variation (P≤0.05) in vitamin C and calcium content between tender and mature tamarind leaves. Mature tamarind leaves contained highest vitamin C (19.28mg/100g) and calcium (160.43mg/100g), whereas tender tamarind leaves contained lowest vitamin C (15.21mg/100g) and calcium (98.60mg/100g).

It is clearly indicated from the results that tender tamarind leaves have higher moisture content than mature tamarind leaves which could be attributed to the reason that as the plant matures the moisture content decreases due to accumulation of solid materials with the advancement of maturity (Khatun *et al.,* 2003).

Table.1 Physical properties of tamarind leaves

Parameters		Tender leaves	Mature leaves	t value
Colour	L*	61.56±0.72	47.41±1.89	**19.54***
	a*	-8.22±0.58	-3.24±0.20	**22.63***
	b*	24.98±0.88	6.57±0.26	**28.31***
Length (mm)		9.03±0.87	12.21±2.06	**4.57***
Width (mm)		0.19±0.02	0.42±0.11	**NS**
1000 leaves weight (g)		7.82±0.27	14.15±0.54	**14.52***
Volume (ml)		10.00±1.00	14.66±0.57	**5.29***
Bulk Density (g/ml)		0.78±0.05	0.96±0.002	**5.81***

All values are expressed as mean ± SD of 3 replications.
* - Significant at P ≤ 0.05, NS- not significant.

Table.2 pH and titrable acidity of tamarind leaves

Parameters	Tender leaves	Mature leaves	t value
pH	3.62±0.01	3.99±0.01	**112.00***
Titrable Acidity (%)	8.28±0.04	7.25±0.09	**13.72***

All values are expressed as mean ± SD of 3 replications.
* - Significant at P ≤ 0.05

Table.3 Nutrient composition of tamarind leaves

Parameters	Tender leaves	Mature leaves	t value
Moisture (%)	78.25±0.11	62.28±0.46	**58.22***
Protein (%)	4.77±0.61	10.29±0.87	**6.44***
Fat (%)	2.63±0.45	6.91±1.82	**NS**
Ash (%)	3.62±0.10	9.29±0.09	**170.12***
Crude fiber (%)	5.72±0.53	6.61±0.52	**NS**
Total CHO (%)	10.71±1.16	11.21±2.78	**NS**
Available CHO (%)	5.00±1.00	4.66±2.51	**NS**
Energy (Kcal)	85±1.93	148±7.34	**12.62***
Vitamin C (mg/100g)	15.21±0.09	19.28±0.14	**135.66***
Calcium (mg/100g)	98.60±0.34	160.43±0.22	**241.15***

Moisture and vitamin C is expressed on fresh weight basis and other all values are expressed on dry matter basis as mean ± SD of 3 replications.
* - Significant at P ≤ 0.05, NS- not significant

The Protein, ash and energy increased in mature tamarind leaves than tender tamarind leaves (4.77 to 10.29%, 3.62 to 9.29%, and 85 to 148Kcal) and these results were comparable to the study conducted by Verma *et al.,* (2012) and Deepak *et al.*, (2016). Oboh (2005) reported that high nitrogen levels in the soil, could result in plants with higher protein content. All the leafy vegetables were found to be poor sources of fat. The high ash content of mature tamarind leaves reflects the mineral contents preserved in the food material. The results therefore suggest a high deposit of mineral elements in the leaves. These variations in the chemical constituents may be due to different agro climatic conditions and

due to different age and stage of the plant. Mature tamarind leaves had higher amount of vitamin C (19.28mg/100g) compared to tender tamarind leaves (15.21mg/100g). Xiao *et al.*, (2012) found total ascorbic acid content of 62 microgreens ranged from 20.4 to 147.00 mg per 100 g fresh weight (FW). The vitamin C levels are influenced by weather (temperature, relative humidity, and solar radiation), crop management practices and post-harvest management as well as the variety (Koudela and Petrikova, 2008). In tender tamarind leaves, the calcium content was 98.60 mg per 100 g, whereas in mature tamarind leaves it was 160.43 mg per 100 g.

In plants, the role of calcium is to promote root formation and is also responsible for hardness of plant tissues, detoxifying agents for organic acids by way of formation of calcium oxalate and calcium carbonate and translocation of carbohydrates necessary for mitosis. At the level of microgreens, calcium will be utilized in mitosis, hence microgreens have lower calcium content than mature leaves (Kokate *et al.*, 2015)

The physical dimensions viz., colour (L *, a * and b *), length, 1000 leaves weight, volume, bulk density had significant variation (P 0.05) between tender and mature tamarind leaves and these parameters ranged from 47.56 to 61.56, -8.22 to -3.24, 6.57 to 24.98, 9.03 to 12.21 mm, 10.00 to 14.66 ml, and 0.78 to 0.96 g/ml, respectively. There was significant variation (P 0.05) in pH and titrable acidity between tender (3.62 and 8.28 %) and mature tamarind leaves (3.99 and 7.25 %). A significant variation was observed (P 0.05) for moisture, protein, ash, energy, vitamin C, and calcium between tender and mature tamarind leaves.

They ranged from 71 62.28 to 78.25 per cent, 4.77 to 10.29 per cent, 3.26 to 9.29 per cent, 85 to 148 Kcal, 15.21 to 19.28 mg/100g, and 98.60 to 160.43 mg/100g, respectively It can be concluded that physico-chemical composition viz., length, volume, bulk density, pH, protein, fat, ash, energy, vitamin C, calcium content of mature tamarind leaves was higher compare to tender tamarind leaves.

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