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Evaluation of chemical parameters of tamarind (*Tamarindus indica* Linn)

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Abstract
India is the world's largest producer of tamarind. Nutritional composition of tamarind fruit varies considerably. The tamarind fruit contains about 55 per cent pulp and 34 per cent seeds, and shell (pod) and fiber. The fruit is a good source of calcium, phosphorous and iron, excellent source of riboflavin, thiamin and niacin, but contains small amount of Vitamin A and C. The most outstanding characteristic of tamarind is its most acidic nature with total acidity range varying from 12.2 to 23.8 per cent as tartaric acid. When fruits are ripe, the pulp is rust-coloured and contains 38 per cent moisture. The tamarind pulp is either sun-dried or mixed with sugar and stored for several months with no table alteration in quality. It is used, especially for food preparation and for medicinal purposes. Traditional processing for household food preparation is widespread, whereas its commercial uses as pasteurized juices, tamarind paste are still relatively unknown and undeveloped. The edible pulp of ripe fruits is used as flavoring agent in soups, jams, chutneys, sauces and juices. The fruit pulp is the richest natural sources of tartaric acid and is the main acidulate used in the preparation of foods in India and other Asian countries.

Keywords: tamarind, pulp, acid, jam.

1. Introduction

Tamarind (*Tamarindus indica* Linn) belonging to leguminosae family, is an important tree spices grown in the tropics. It is multipurpose tree of which almost every part finds at least some use, either nutritional or medicinal (El-Siddig *et al*., 2006) [7]. Tamarind is indigenous to tropical Africa, but it has been introduced and naturalized worldwide in many countries.

At present, tamarind is cultivated in 54 countries of the world, 18 in its native range and 36 other countries where it has become naturalized (Singh *et al*., 2007). The tamarind is mainly grown in South Africa, Afghanistan, Australia, Costa Rica, Bangladesh, Brazil, China, Malaysia, Mexico, Pakistan, Phillippines, Srilanka and India. Among these countries, Thailand, Mexico and Costa Rica are the biggest producers of tamarind (El-sidding *et al*., 2006) [7].

India is the world's largest producer of tamarind. The tree mostly grows wild, although it is cultivated to a limited extent. The tamarind production in India is concentrated in the drier southern states and the produce is collected by the villagers and sold in the open market. In some parts of India, it is naturally regenerated on wastelands and forest lands. Since ancient times, India has been exporting processed tamarind pulp to western countries and more recently to the United States of America. The annual export of tamarind to the US exceeds 10,000 tonnes earning about 100 million Indian rupees. In India, the area and production of tamarind is 59 thousand ha and 188 thousand MT in the year 2014-2015, respectively (Anon., 2014) [3].

Nutritional composition of tamarind fruit varies considerably. The tamarind fruit contains about 55 per cent pulp and 34 per cent seeds, and shell (pod) and fiber. The fruit is a good source of calcium, phosphorous and iron, excellent source of riboflavin, thiamin and niacin, but contains small amount of Vitamin A and C. The most outstanding characteristic of tamarind is its most acidic nature with total acidity range varying from 12.2 to 23.8 per cent as tartaric acid (Morton, 1987; Chapman, 1984 and Persueglove, 1987) [12, 4, 9].

When fruits are ripe, the pulp is rust-coloured and contains 38 per cent moisture. The tamarind pulp is either sun-dried or mixed with sugar and stored for several months with no table alteration in quality. It is used, especially for food preparation and for medicinal purposes. Traditional processing for household food preparation is widespread, whereas its commercial uses as pasteurized juices, tamarind paste are still relatively unknown and undeveloped.

The edible pulp of ripe fruits is used as flavoring agent in soups, jams, chutneys, sauces and juices. The fruit pulp is the richest natural sources of tartaric acid and is the main acidulant used in the preparation of foods in India and other Asian countries (Singh *et al*., 2007).

Tamarind is valued highly for its fruits, especially the pulp which is used for a wide variety of domestic and industrial purposes (Kulkarni *et al*., 1993) [10] especially for food and beverages (Ajayi *et al*., 2006) [14]. Tamarind fruit pulp is used for seasoning, as a food component, to flavour confections, curries and sauces, and is a main component in juices and certain beverages. Tamarind fruit pulp is eaten fresh and often made into a juice, infusion or brine (El-Siddig *et al*., 1999; El-Siddig *et al*., 2006) [6, 7]. It can also be processed into jam and sweets. The refreshing drinks are popular in many countries around the world, though there are many different recipes. In some African countries, the juice obtained from the fruit pulp is mixed with wood ash to neutralize the sour taste of the tartaric acid. However, the most common method is to add sugar to make a pleasantly acid drink.

Tamarind is a rich source of pectin. However, unlike other fruit pectins, tamarind pectin can form gels over a wide pH range, including neutral and basic conditions. Tamarind polysaccharides, contrary to fruit pectin, are not affected by boiling in neutral aqueous solutions, even if boiled for long periods. Therefore, it can be useful as a gel formation agent and substituted for fruit pectins. Tamarind polysaccharides (pectin) do not contain galacturonic acid and methyluronate, and is therefore, not regarded as true pectin, being termed as 'jellose' (Rao, 1948) [16].

2. Review of litrature

2.1 Chemical parameterstamarind

2.1.1 Moisture

Kotecha and Kadam (2002) studied the physico-chemical characteristics of tamarind fruit and pulp and observed 13.60 per cent moisture content in tamarind fruit.

Rasala *et al*. (2011) [17] studied the chemical composition of fresh tamarind. They recorded 20.15 to 24.50 per cent moisture in the fresh pulp of tamarind varieties. Shinde (2014) [18] studied the chemical composition of tamarind pulp and recorded 13.38 per cent moisture content.

2.1.2 Total soluble solids

Kotecha and Kadam(2002) studied the physico-chemical characteristics of tamarind fruit and pulp. They observed 32.20 ^{0}B total soluble solids content in tamarind fruit pulp.

Rasala *et al*. (2011) [17] reported 18 to 48 ^{0}B total soluble solids in the fresh pulp of tamarind varieties.

Joshi *et al.* (2012) studied the TSS of tamarind pulp used for preparation of commercial value added products and was found to be 31^{0}B in local tamarind, followed by 27 ^{0}B and 26 ^{0}B in Ajanta and Thailand varieties, respectively. Shinde (2014) [18] studied the chemical composition of tamarind pulp and recorded 20.70 ^{0}B total soluble solids. Chavan (2016) [5] studied the chemical composition of tamarind pulp and observed 19.80 ^{0}B of total soluble solids.

2.1.3 Titratable acidity

Kotecha and Kadam (2002) reported that the titratable acidity in tamarind fruit pulp was 4.06 per cent.

Joshi *et al.* (2012) studied the chemical composition of tamarind pulp and recordedthe tartaric acid in highest quantity of 3.9 per cent in local tamarind, followed by 1.8 per cent in Ajanta cultivar and 1.1 per cent in Thailand cultivar, respectively which indicates that the Ajanta and Thailand cultivars are comparatively sweeter than the local variety. Shinde (2014) [18] studied the chemical composition of tamarind pulp and recorded 4.04 per cent of the titratable acidity. Chavan (2016) [5] studied the chemical composition of tamarind pulp and observed 4.14 per cent acidity.

2.1.4 Reducing sugar

Morton (1958) recorded 30 to 41 per cent reducing sugar content in tamarind pulp of different varieties. Kotecha and Kadam (2002) observed 16.20 per cent reducing sugars in tamarind fruit. El-sidding *et al*. (2006) [7] recorded 30 to 40 per cent reducing sugar content in tamarind varieties. Joshi *et al.* (2012) studied the reducing sugar content of tamarind fruit and was found to be in the range of 16.60 to 17.70 per cent. Shinde (2014) [18] studied the chemical composition of tamarind fruit and recorded 15.70 per cent reducing sugars. Chavan (2016) [5] studied the chemical composition of tamarind pulp and observed 16.10 per cent of reducing sugars.

2.1.5 Total sugars

Kotecha and Kadam (2002) observed that the total sugar content in fresh tamarind fruit was 20.40 per cent. El-sidding *et al*. (2006) [7] recorded 21.40 to 30.85 per cent total sugar content in tamarind varieties.

Joshi *et al.* (2012) reported that the total sugar content of Thailand variety was highest (43.80%) as compared to local tamarind (34.60%) and Ajanta (38.80%).

Shinde (2014) [18] studied the chemical composition of tamarind pulp and recorded 19.42 per cent of the total sugars.

Chavan (2016) [5] studied the chemical composition of tamarind pulp and observed 18.92 per cent total sugars.

3. Material and Methods

3.1. Chemical parameters of tamarind

3.1.1. Moisture

Themoisture content was measured directly by using Contech moisture analyzer (model CA-123) at 100^{0}C temperature and expressed as per cent moisture content on electronic display directly.

3.1.2 Total Soluble Solids

The total soluble solids were determined by using Hand Refractometer (Atago Japan, 0-32^{0}B) and the values were corrected at 20^{0}C with the help of temperature correction chart (A.O.A.C., 1975) [1].

3.1.3 Titratable acidity

A known quantity of sample was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator (A.O.A.C., 1975) [1]. The sample of known quantity with 20 ml distilled water was transferred to 100 ml volumetric flask, made up the volume and filtered. A known volume of aliquot (10 ml) was titrated against 0.1N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator (Ranganna, 2003) [15]. The results were expressed as per cent anhydrous citric acid.

$$\text{Titratable acidity}(\%) = \frac{\text{Normality of alkali X Titre reading X Volume made X Equivalent weight of acid}}{\text{Weight of sample taken X Volume of sample taken for estimation X 1000}} X100$$

3.1.4 Reducing sugars

The reducing sugars were determined by the method of Lane and Eynon (1923) as described by Ranganna (2003) [15]. A known weight of sample was taken in 250 ml volumetric flask. To this, 100 ml of distilled water was added and the contents were neutralized by 1 N sodium hydroxide. Then 2 ml of 45 per cent lead acetate was added to it. The contents were mixed well and kept for 10 minutes. Two ml of 22 per cent potassium oxalate was added to it to precipitate the excess of lead. The volume was made to 250 ml with distilled water and solution was filtered through Whatman No. 4 filter paper. This filtrate was used for determination of reducing sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' solutions (5 ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis.

$$\text{Reducing sugars}(\%) = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} X\ 100$$

3.1.5 Total sugars

For inversion at room temperature, a 50 ml aliquot of clarified deleaded solution was transferred to 250 ml volumetric flask, to which, 10 ml of 50 per cent HCl was added and then allowed to stand at room temperature for 24 hrs. It was then neutralized with 40 per cent NaOH solution. The volume of neutralized aliquot was made to 250 ml with distilled water. This aliquot was used for determination of total sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' (5ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis.

$$\text{Total sugars } (\%) = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{X } 100$$

4. Result and Discussion

4.1 Chemical parameters of tamarind

The data related to the chemical parameters of tamarind is presented in Table 1.

Table 1: Chemical parameters oftamarind juice

Sr. No.	Parameters	Tamarind
1	Moisture content (%)	13.46
2	Total soluble solids (^{0}Brix)	20.40
3	Titratable acidity (%)	3.98
4	Reducing sugars (%)	15.24
5	Total sugars (%)	18.16

*Values are the average (mean) of three observations.

4.1.1 Moisture

It could be observed from the data presented in Table 1 that the moisture content of tamarind was recorded as 13.46 per cent. Similar result for moisture content of tamarind was observed by Kotecha and Kadam (2002) and Shinde (2014) [18]. They recorded 13.60 and 13.38 per cent moisture content in tamarind, respectively.

4.1.2 Total Soluble Solids

The total soluble solids content of tamarind was 20.40 ^{0}Brix. Similar result for TSS (20.70^{0}B) was recorded by Shinde (2014) [18] in tamarind pulp.

4.1.3 Titratable acidity

The titratable acidity for tamarind was recorded as 3.98 per cent. Similarly 3.9 per cent titratable acidity was also reported by Joshi *et al*. (2012) and 4.04 per cent titratable acidity in tamarind by Shinde(2014) [18].

4.1.4 Reducing sugars

The reducing sugar content for tamarind was recorded as 15.24 per cent. Similarly 15.70 per cent reducing sugar content was also reported by Shinde (2014) [18] and 16.10 per cent reducing sugar in tamarind by Chavan (2016) [5].

4.1.5 Total sugars

It was also observed from the data that the total sugar content of tamarind was 18.16 per cent. Chavan (2016) [5] reported 18.92 per cent total sugars in tamarind.

5. Conculsion

Tamarind fruits were evaluated for chemical composition and observed 13.46 per cent moisture in tamarind. Total soluble solid content of tamarind was 20.40^{0}B. It was observed that the tamarind contained 3.98 per cent titratable acidity. The tamarind showed 15.24 per cent reducing sugar content. However, total sugars content of tamarind was 18.16 per cent.

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