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Study of Tamarind

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The tamarind (*Tamarindus indica*) is a commercially significant but underutilised tree crop that is grown all over the world. The tree and its processed products are traded in many cities and villages due to its multiple uses and market demand. Despite its promise, one of its biggest drawbacks is that Ghanaians are ignorant of its uses and nutritional benefits. This study examines and highlights tamarind's health benefits while examining its nutritional profile using empirical data for near-term analysis. The tree, which is native to tropical Africa and has spread throughout most of the world, can be found in more than 50 nations. The tamarind tree or its produce is referred to by a variety of various vernacular names in Ghana and other regions of the world. Almost every part of the tree is used in some capacity, from food—including beverages, jams, and curries—to pharmaceuticals, textiles, wood, livestock feed, and fuel. It contains a lot of vitamins, minerals, and other components. The approximate composition of fruit pulp from locally sourced sources revealed significant amounts of lipids and oils (51.39%) and fibre (15.10%), but other factors including protein, ash, vitamin C, and moisture were comparable to test results from other nations. Based on its advantages and uses, the tamarind plant has unquestionably enormous potential.

Introduction

One of the most widely cultivated trees on the Indian subcontinent is tamarind (Tamarindus indica L.). Except for the Himalayas and western dry regions, it is planted over all of India. It is a huge, spreading-crowned, evergreen tree (ICFRE, 1993; Rao et al., 1999). A versatile plant is a tamarind. In Asian cooking, particularly in the southern region of India, the fruit's pulp has long been utilised as a spice. According to Dagar et al. (1995), George and Rao (1997), Rao and Mary (2001), and Pugalenthi et al. (2004), nearly every portion of the tree finds use in the food, chemical, pharmaceutical, or textile sectors, as well as production of fodder, lumber, and fuel. The pulp and seeds make up the majority of the tamarind fruit. Tartaric acid, reducing sugars, pectin, tannin, fibre, and cellulose make up the majority of the fruit's components, whether it is ripe or dry. Additionally, the whole seeds contain fat, sugar, protein, and carbs. In addition to containing additional minerals including sodium, zinc, and iron, pulp and seeds are both excellent sources of potassium, calcium, and phosphorous (Feungchan et al., 1996a, b; Coronel, 1991; Pino et al., 2004; Soong and Barlow, 2004). The following section goes into detail about the various tamarind ingredients.

Classification

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Mostly consisting of pulp and seeds, tamarind fruit. Tartaric acid, reducing sugars, pectin, tannin, fibre, and cellulose are the primary ingredients of the fruit, whether it is ripe or dry. Aside from carbohydrates and sugars, whole seeds also include protein and fat. Both the pulp and the seeds are excellent sources of potassium, calcium, and phosphorous and also include additional minerals like sodium and zinc. In the section that follows, the different parts of tamarind are described.

PULP: The fruit of the tamarind tree is its most valued and frequently utilised component. 30 to 50 per cent of the ripe fruit is made up of pulp (Purseglove, 1987; Shankaracharya, 1998),11–30% of the weight is made up of the shell and fibre, while 25%–40% is the seed (Chapman, 1984; Shankaracharya, 1998). According to several studies (Meillon, 1974; Anon, 1976; Duke, 1981; Ishola et al., 1990; Parvez et al., 2003), the dried tamarind pulp used in commerce contains 8–18% tartaric acid (2, 3-dihydroxy butanedioic acid–C4H6O6, a dihydroxy carboxylic acid) and 25–45% reducing sugars, of which 70% is glucose and 30% is fructose. Up to 16 per cent of tartaric acid is present in delicate fruits in their free form. The tartaric acid, which has an intensely acidic flavour, outweighs the sweetness of ripe tamarind fruit, though. According to reports, the amounts of sugar and tartaric acid differ from place to location. In Thailand, the sugar level ranged from 5.0 to 40.0% and the tartaric acid amount ranging from 2.5 to 11.3%. The former was as low as 2.0-3.2% in sweet tamarind and the latter as high as 39.1-47.7%. (Feungchan et al., 1966a). Hasan and Ijaz (1972) discovered that in Pakistan, the tartaric acid content of sour tamarind ranged from 8.4-12.4% and the sugar content from 21.4-30.9%. Oxalic acid, succinic acid, citric acid, and quinic acid are among the other organic acids found in tamarind (Lewis and Neelakantan, 1964; Singh, 1973; Anon., 1976). As per reports, tamarind has a very low ascorbic acid value that ranges from 2 to 20 mg/100 g. (Lefevre, 1971; Ishola et al., 1990). Proline, serine, -alanine, phenylalanine, and leucine were identified as free amino acids in the pulp (Lakshminarayan et al., 1954).

The tartaric acid level of the tamarind fruit, which gives it its sour flavour and overcomes its high total sugar content, is what stands out about it as one of the most acidic of all fruits, as was previously mentioned. According to Lee et al. (1975), tamarind contains some pyrazines and thiazoles, and its overall aroma is distinguished by its warm, citrus-like notes and some roasted overtones. High-performance liquid chromatography has been used to identify and analyse non-volatile flavour components in the pulp (Khurana and Ho, 1989).

SEED: The testa, or seed coat, makes up 20–30% of the seed, and the endosperm, or kernel, makes up 70–75%. (Coronel, 1991; Shankaracharyan, 1998). In contrast to the pulp, tamarind seeds are high in oil (4.5-16.2%) and protein (13-20%). The seed coat has a lot of fibre (20%). as well as tannins (20%). According to Panigrahi et al. (1989), whole tamarind seeds have a trypsin inhibitor activity (TIA) of 10.8, 131.3 g/kg of crude protein, 67.1 g/kg of crude fibre, 48.2 g/kg of crude fat, and 56.2 g/kg of tannins. The majority of carbohydrates are in the form of sugars. Although the pulp has a stronger trypsin inhibitor activity than the seed, both are heat labile. The seeds contain 63% starch and 4.5–6.5% semi-drying oil, according to Purseglove (1987). The seed also contains 47 mg/100 g of phytic acid, which has only a minor impact on its nutritional value, according to Ishola et al (1990). Additionally, the testa contains 14–18% albuminoid tannins. Marangoni et al. (1988), Sano et al. (1996), Patil and Nadagouder (1997), and El-Siddig et al. (2006) concluded that tamarind seeds are possible sources of food or food ingredients after estimating the content of seeds and evaluating their qualities. The purified product and main component of tamarind kernel powder is tamarind seed polysaccharide (TSP), according to Glicksman (1986), Gidley et al. (1991), and Reid and Edwards (1995). (TKP). According to Glicksman (1986), TSP differed from TKP in terms of its specifications. The main structure of TSP has been extensively discussed in literature over the last 25–30 years (Srivastava and Singh, 1967; Nagaraja et al., 1975; Glicksman, 1986; Gidley et al., 1991; Manjunath et al., 1991; Marry et al., 2003; Nitta and Nishinari, 2005; Mishra and Malhotra, 2009).

Bhattacharyaa *et al.* (1994 a, b; 1997) and Kumar and Bhattacharya (1995) both examined the functional features of tamarind, including its nitrogen solubility index, water absorption capacity, emulsifying capacity, foaming capacity, and foam stability (2008).

Production and cultivation

Tamarind is currently grown commercially in 54 nations, including 36 that it was brought to (El-Siddig et al., 2006), 18 that are in its native range, including countries in central Africa, and many that it has naturalised. Commercial plantations have been observed on the American continent in Belize, Central American nations, and northern Brazil (Sharma and Bharadwaj, 1997). Brazil, the Bahamas, Costa Rica, Bangladesh, Cuba, Burma, Egypt, Cambodia, Guatemala, the Dominican Republic, Fiji, Indonesia, Gambia, Mexico, Kenya, Nicaragua, Pakistan, Puerto Rico, Senegal, Philippines, Tanzania, Sri Lanka, Vietnam, Thailand, Zambia, and Zanzibar are the main producers. However, only a few number of nations, like Thailand and India, have large tamarind cultivation.

The majority of tamarind products are produced in India. Madhya Pradesh, Bihar, Andhra Pradesh, Karnataka, Tamil Nadu, West Bengal, Orissa, and Kerala are among the Indian states where tamarind is widely accessible (Jambulingam and Fernandes, 1986; Rao, 1995; Anon., 1997; George and Rao, 1997; Vennila and Kingsley, 2000 tonnes and 193 873 tonnes of tamarind were produced in India in the years 2007–2008 and 2008–2009, respectively, from 55 682 ha and 54 222 ha of land (Spice Board, 2011a). India sells tamarind pulp that has been processed to western nations, primarily to European and Arab nations and, more recently, to the USA. India exported 12 200 tonnes of various tamarind products for Rs 4705.50 lakhs in 2009–2010 (Spice Buded, 2011b).

As a result of the cultivation of tamarind in Thailand, the country has emerged as a significant producer of both sweet and sour tamarind varieties. According to reports from the Department of Agricultural Extension in 1998, there was 105 785 ha of tamarind plants planted in Thailand, of which 60 451 ha were used for production and 45 335 ha were not. According to records, Mexico also engaged in commercial tamarind production, generating more than 37 000 tonnes of pulp on a total area of 4400 ha. A modest quantity of processed pulp was sent to the USA, Central and South American nations, and (Hernandez-Unzon and Lakshiminarayana, 1982). Another country in Central America, Costa Rica, has demonstrated potential for growth by producing 200 tonnes yearly.

Main uses of tamarind

Pulp: In India, tamarind is primarily utilised as pulp. In the majority of India, fruit pulp is the primary source of sourness in curries, sauces, chutneys, and some beverages. Children and adults in India frequently eat immature green pods as a snack while dipping them in salt. In India, it is also used to prepare the exquisite "tamarind fish," a shellfish pickle. Unripe, soft pods are used to make delectable sauces for ducks, waterfowl, and geese, as well as a seasoning for cooked rice, meat, and fries. According to reports, tamarind fruit is also utilised as a raw ingredient to make drinks that resemble wine. Although it is mostly utilised in Indian regional cuisine, spice is also widely used in Asian, Latin American, and South African meals. Caluwe has written an analysis of the traditional applications of tamarind in sub-Saharan Africa (2009).

Tamarind is frequently used in Sri Lankan cuisine as a substitute for lime and in pickles and chutneys (Jayaweera, 1981). In the Bahamas, fully developed but unripe fruits are roasted in coal, and the skin is peeled back to reveal the sizzling pulp, which is subsequently covered in wood ash and consumed (Morton, 1987). In Egypt, tamarind is used to make a sour beverage throughout the summer, and it is also added to a Middle Eastern beverage with a similar lemon flavour. In Mexico, where the beverage is also known as agua fresca (refreshing water) or agua de tamarindo, it is also used for this purpose.

Concentrate: Produced and marketed in both India and other countries is tamarind juice concentrate (Raghuveer, 1997). The device is marketed as being particularly practical for the food industry and use in the kitchen. Processes for producing pulp powder and juice concentrate have been developed by the CFTRI in Mysore (Shankaracharya, 1998). The fruit pulp was boiled with water to extract all the water solubles, which were then concentrated to roughly 65-70% solids and packaged in appropriate containers.

After cooling, the final product's fluid viscosity hardened into that of jam. According to Manohar et al. (1991), tamarind juice concentrate is more viscous than sucrose solutions. There are also recorded recipes for making spiced drinks and sauces from the pulp (Patil and Nadagouder, 1997). According to a CFTRI report, the concentrate's estimated composition is as follows: Invert sugars 50%, pectin 2%, protein 3%, cellulosic material 2%, total tartaric acid 13%, and moisture 30%.

Seeds: The primary ingredient in the production of (TKP), polysaccharide, glue, oil, and tannin is tamarind seed. Historically, the tamarind pulp industry's underutilised byproduct was tamarind seed. However, recent studies (Mishra and Malhotra, 2009) on their application in the food, pharmaceutical, and textile industries demonstrate that their potential has been increasingly explored. Tamarind seeds are said to produce linseed-like amber-coloured oil that is odourless and delicious to the taste. According to reports, it can be used to make paints and varnishes, as well as to light lights (Lewis and Neelakantan, 1964; Rao, 1975; Anon., 1976; Salim et al., 2008).

It is claimed that the oil is delectable and of gourmet quality (Morton, 1987). Although tamarind jealous, a pectin-like material produced from tamarind seeds has not yet been completely utilised, it has the potential to replace fruit pectins in many industries due to its abundance and low cost.

Kernal Powder: TKP was widely utilised in the textile sector as a sizing substance and in the food business. Additionally to the manufacturing sector (Rao and Subramanian, 1984; Bal and Mukherjee, 1994; Patil and(1997, Nadagouder). When making confections, TKP used to be advised as a stabilising agent in cheese, mayonnaise, and ice cream (Morton 1987; Patil and Nadagouder, 1997). use of white TKP in foods such jams, marmalades, and jellies Bhattacharya (1997) and also discussed fortified bread and biscuits. Bhattacharya and others (1991, 1994b). There are more industries outside the food and textile ones. been utilised in adhesives, insecticides, and medicinal formulations bookbinding, the production of cardboard and plywood, and sizing and weighing. In the leather business, compositions (Daw et al., 1994; Patil and Nadagouder, 1997).

Seed testa: It is said that the testa contains 40% water solubles, of which 80% is a mixture of tannin and colouring pigment (FRI, 1955). Large amounts of testa are left behind as a residual by-product in the manufacturing of TKP or the jellose. usage of testa as a dyeing likewise, tanning has been advocated (El-Siddig et al., 2006). When properly combined, the 23% tannin found in seed testa is used to tan leather and give wool colour-fast hues. In tests on leather tanning, tamarind tannin produces a rough and intensely coloured leather that might be utilised for heavy soles, luggage, etc.

Several authors (including Tsuda et al., 1994, 1995; Glicksman, 1986; Rao and Srivastava, 1974; Seed coat, a by-product of the tamarind gum industries, has been proposed by Sankaracharya (1998) as a safe and inexpensive antioxidant that can be utilised to prolong the shelf life of foods by inhibiting lipid peroxidation. The edible mushroom Pleurotus Florida was grown using the wasted (detanned) tamarind seed testa in tests done by Madhulatha and Pitchai in 1997. They asserted that the wasted mixture was suitable as organic manure and that the wattle-tamarind seed testa substrate was effective for growing the mushroom.

Medical Uses: Products made from tamarind are frequently utilised as health treatments throughout Asia, Africa, and the Americas. Traditional African medicine and Indian Ayurvedic medicine both make substantial use of tamarind products, including leaves, fruits, and seeds (Jayaweera, 1981; Parrotta, 1990). The therapeutic worth of there are references to tamarind in classical Sanskrit literature. After being brought to Europe by Arab traders from India, tamarind fruits were well renowned for their therapeutic powers (Rao, 1975). In a thorough assessment of the ethnopharmacology of T. indica in the African environment, Havinga et al. (2009) proposed variations throughout the ways tamarind is utilised in indigenous medicine in several African regions. Anon. (2008) provided information on the medicinal benefits of tamarind in Africa, including its use as an anthelminthic (expels worms), antimicrobial, antiseptic, antiviral, sunscreen, astringent, and to promote wound healing in the following conditions: asthma, bacterial skin infections, boils, chest pain, cholesterol metabolism disorders, colds, colic, conjunctivitis, constipation (chronic or acute), diabetes, diarrhoea According to Sadik (2010), consuming enough of the popular tamarind-fruit beverage known as "poha beer" in Northern Ghana, Africa, may help lower the incidence of iron deficiency anaemia. This was predicated on the vitamin C present in it, which improves non-haem iron absorption.

In Southeast Asia, tamarind fruit is frequently used as a poultice applied to fever sufferers' foreheads (Doughari, 2006). The tamarind fruit is used in traditional Thai medicine as a blood tonic, expectorant, laxative, and digestive aid (Komutarin et al., 2004). Modern medical science has confirmed the laxative and diuretic qualities of the leaf sap and pulp, respectively (Bueso, 1980). Tamarind has been used to treat a variety of illnesses, including the relief of sunstroke, Datura toxicity, and the effects of alcohol and "ganja" (Cannabis sativa L.) that cause intoxication (Gunasena and Hughes, 2000). It is applied to wounds as a dressing and used as a gargle for sore throats (Benthall, 1933; Dalziel, 1937; Eggeling and Dale, 1951; Chaturvedi, 1985). In Mauritius, the pulp is applied as a liniment for rheumatism, and the pulp is given in Southeast Asia to treat the side effects of chaulmoogra (Hydnocarpus anthelmintica Pierre), a drug used to treat leprosy (Morton, 1987). Boils and dysentery have been treated with tamarind seed powder in India and Cambodia (Rao, 1975; Jayaweera, 1981). According to reports, boiled, pounded seeds can be used to cure bladder stones and ulcers, and powdered seed husks can be used to treat diabetes (Rao, 1975).

Antioxidant activity: Numerous studies on the antioxidant activity of tamarind show that the fruit has a high antioxidant capacity and high phenolic content, both of which are beneficial to human health. It also contains biologically significant mineral components (Gayathri et al., 2004). According to Tsuda et al. (1994), the tamarind seed coat includes phenolic antioxidants such as epicatechin and 2,hydroxy-30, 40-dihydroxyacetophenone as well as methyl 3,4, dihydroxybenzoate. Osawa et al(1994) .'s research on tamarind seeds showed that the seed coat exhibits antioxidative activity as determined by the thiocyanate and thiobarbituric (TBA) technique.

The seed coat's ethyl acetate extracts demonstrated significant antioxidant activity as well. Both Lourith et al. (2009) and Luengthanaphol et al. (2004) reported extracting antioxidant chemicals from the seed coat of the sweet Thai tamarind. If alternative herbal remedies might be more efficient, Ramos et al. (2003) stated that tamarind seed coat, a by-product of the tamarind gum industry, could be used as a safe and inexpensive source of antioxidants. According to Soong and Barlow (2004) indicates tamarind seeds have greater antioxidant activity than tamarind pulp. Martinello et al. (2006) found that T. indica fruit pulp extract reduced total serum cholesterol and increased HDL in hypercholesterolemic hamsters when given at a concentration of 5%, suggesting that it may reduce the risk of atherosclerosis in humans. Against linoleic acid emulsion systems, Siddaraju (2006) found that tamarind seed coat extracts had good antioxidant and radical-scavenging properties. Analytical high-performance liquid chromatography was used by Sudjaroen et al. (2005) to carry out a quantitative examination of the polyphenolic chemicals in tamarind seeds and pericarp. The total phenolic compound produces were 6.54 and 2.82 g/kg (dry weight), respectively, in the seeds and pericarp.

Other Uses: Data efficiently documented unrelated uses for tamarind fruits and other substances from the tree are still in common usage today. In Sri Lanka (Jayaweera, 1981), India (Benthall, 1933; Eggeling and Dale, 1951; Coates-Palgrave, 1988), West Africa (Morton, 1987), South Africa, and Somalia, tamarind pulp combined with sea salt has reportedly been used to polish brass, copper, and silver (Mahony, 1990). When colouring goat hides in West Africa, the whole pod is infused into the dye. The fruit pulp is employed in the manufacturing of ethanol and acts as a fixative when combined with annatto (Bixa Orellana) and turmeric (Curcuma longa) in dyeing processes. It also serves to coagulate rubber latex (Menon et al., 2010).

Additionally, the seed husk has been discovered to be a potent fish toxin (Roy et al., 1987). Even at modest concentrations of 5–10 mg/L, powdered seed husks were found to kill various species of fish in water after two hours of application, according to Jena (1991). The best method for maintaining the quality of salted dried fish was discovered to be TKP's treatment (Shetty et al., 1996).

Minor uses: In many nations, the young seedlings, flowers, and fragile leaves are consumed as vegetables and added to curries, salads, stews, and soups (Benthall, 1933; Coronel, 1991). According to reports, the leaves are high in thiamine, riboflavin, niacin, and vitamin C as well as minerals and vitamins like calcium, magnesium, phosphorus, iron, copper, chlorine, and sulphur (Anon., 1976; Karuppaiah et al., 1997). According to Ramanujam and Kalpana (1992), the flowers are a good source of honey, which is richly golden in colour but has a small acidity that is unique to its flowers. The tree also produces high-quality lumber, which is mostly used for turnery, tool handles, wheels, mallets, rice pounders, and oil mills (Chaturvedi, 1985; Coates-Palgrave, 1988). Malachite green can be removed from aqueous solutions using tamarind fruit shells, according to Saha et al. (2010) and Abhijit et al. (2010).

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