Original research article

Development of ready to use pellets from Tamarind (*Tamarindusindica L.*) fruit pulp

ABSTRACT

Tamarind is a widely grown tree in the Indian subcontinent and the fruit pulp plays a major role in south Indian cuisine for enhancing both traditional and contemporary recipes. The tamarind fruit pulp was primarily dried (48 hours) in a solar dryer to achieve a moisture content of 9% (w.b.), and the five treatments were made by combining dried tamarind pulp with corn flour in the ratios of 1:1, 1.5:1, 2:1, 2.5:1, and 3:1. All treatments were analysed for physicochemical, sensory evaluation, and time required for partial and complete solubility of produced tamarind pellets under varied temperature settings (55℃, 65℃, and 100℃) and with and without stirring. The sensory evaluation results indicate that a 3:1 sample ratio has higher overall acceptance (8.4±0.1316). The pH and acidity of each sample show an inverse relationship. The most accepted sample (3:1) had a higher acidity value of 17.2±0.13127% and a lower pH of 2.74 ±0.13139% compared to other treatments.The time required to dissolve all treatments decreased as the temperature increased throughout the stirring technique. The 3:1 sample took 5.1 and 8.5 minutes to achieve partial and entire solubility at 100 ℃ with stirring. Tamarind content has a significant impact on tamarind pellet solubility. Ready-to-use tamarind pellets were produced as a result of efficient tamarind utilization. It can be used instantly during the cooking process, saving time on making tamarind paste.

Keywords: Tamarindfruit pulp, multipurpose plant,pellets

INTRODUCTION

Tamarind belongs to the dicotyledonous Leguminosae family, the third largest flowering plant family, with 727 genera and 19,327 species [1]. Tamarind is a multipurpose plant, seasonal and perishable agricultural food source and important cash crop for India, ranking sixth in terms of export revenues.Tamarind may be grown in virtually any kind of soil, including poor and marginal soils. Because its life cycle is prolonged, deep loamy soils with good soil moisture holding capacity are optimal. The whole tamarind fruit have three major parts, such as pulp (55 %), seed (34 %) and shell and fibre (11%) [2][3]. It contains numerous nutritional benefits. Tamarind pulp is mostly composed of carbohydrate (50.07 g) and moisture (35.29 g), with a high fibre content (4.13 g) [1].

Thehigh antioxidant activity of the tamarind fruit pulp can be attributed to its abundant polyphenol and flavonoid content. The antioxidant properties of a rich-fibre powder extract derived from tamarind pulp using several solvents (methanol, water, and dimethylsulfoxide (DMSO)) were studied [4]. The study found that DMSO tamarind extract contains the greatest phenolic (4.24 mg GAE/g) and flavonoid (127.16 mg RE/g) components. The methanolic extract of tamarind demonstrated good antioxidant activity in the DPPH experiment (92.62% radical inhibition). The predominant antioxidant property of tamarind fruit pulp was to inhibit the lipid oxidation in breadfruit seed and dhal with addition of tamarind pulp. It was evident from the mean of thiobarbituric acid (TBA) value which decreased with increasing concentrations of the fruit pulp [5].In a sensory evaluation, the product demonstrated acceptable acceptability with the 10% substitution of tamarind pericarp powder in cookies resulted in a considerable increase in fiber content (fourfold) and phenolic component content (2.6 fold) [6].

Anthocyanin, a water-soluble polyphenolic flavonoid pigment, is responsible for colouring in different plant sections.Low density lipoprotein (LDL), triglycerides, and total cholesterol are all reduced by the water extract from the pulp of tamarind. The Organization for Economic and Cultural Development (OECD) and the World Health Organization (WHO) recommend that tamarind pulp extract be deemed safe, as its lethal dose (LD50) is larger than 5000 mg/kg bw and it is practically non-toxic[7].

Tamarind has more application in food preparation and preservation. The higher acidity range of the tamarind (8 to 18 %) was used as a coagulant in soy cheese production (AWARA) and increase in the yield (11.53 %) of the end product [8]. In the aim of improving storage stability, the tamarind was dried. The mechanical drying of tamarind at 70°C had highest moisture removal rate followed by mechanical drying at 60°C in the tray dryer [9].The products from this commodity can preserve and improve health benefits. Different form of tamarind products are available, such as candy and sweetened syrup. There are three types of tamarind fruit pulp: raw pods (which are the least processed and can be easily opened to remove the pulp), pressed blocks (which have the shell and seeds removed and the pulp compressed into a block), and concentrates (which are boiled and may contain preservatives). The quality of tamarind was consider by color of the dehulled tamarind. Brownish red of tamarind is the acceptable colour in the market and treated as fresh from farm [10].

The objective of this study was to develop the tamarind pellets for instant use in cooking in ready- to- use form and the physico-chemical and solubility characteristics were studied. The tamarind pellets are reducing the time consumption from the conventional preparation of tamarind paste and also it is easy to use during cooking. The shelf life of the product will be increased by removal of moisture through the drying process.

MATERIAL AND METHODS

Collection of ingredients: The seedless fresh tamarind fruit andcorn flour was brought from the local market. Corn flour and the purified water was used to make the tamarind pellets.

Preparation of Tamarind Blend: The tamarind pulpy paste was prepared by blending the seedless tamarind fruit with the water in the ratio of 8:2. The fruit was well blended with blender and the fine smooth paste was obtained from filtration process. The filtration process removed the undesirable matters from the paste and pure paste was obtained [11].

Drying: After obtaining the tamarind pulpy paste, it must be spread on trays in the thickness of 1-2 mm and undergo for drying. The conventional method of drying (sun drying) was used to remove the moisture from the fine tamarind paste. The sun drying was conducted upto 48 hours efficiently until the tamarind paste reach 9 % of moisture content as mentioned by [12]. The purpose of drying was usually to reduce the moisture content and to get better consistency of the tamarind paste. In sun drying, the solar radiation heats up the thin layer of paste in the tray as well as the surrounding air and thus increases the rate of water evaporating from the sample.

Pressure Moulding: After sun drying the dried tamarind pastewas taken away from the trays with the use of sharp knife. The five treatments are carried out by adding thetamarind with corn flour in the ratio 1:1, 1.5:1, 2:1, 2.5:1 and 3:1.Corn flour have the excellent binding properties with water and it facilitates the higher solubility, because it has 10 copies of the Amylopectin molecule and three of the Amylose molecule were used to most closely resemble the amylose/amylopectin ratio reported by [13]. The tamarind and corn flour wasthoroughly mixed.The different treatments were moulded manually. Small amount of paste (1g) from each treatment was taken and it was filled in the circular pellet mould (similar in shapes of pro-circle). For the hygienic purpose hands are covered by the hand gloves. The pressure was usually applied through hands and the excess pasty compounds that was removed from the mould.

Drying of tamarind pellets:

The moulded pellet was againdried under sun for a week to attain 8.7 % moisture content. The secondary sun drying was usually done to further reduction of moisture and also to increase the product's shelf life without the use of any chemical preservatives. The dryness of the pellet was checked by visual observations that the pellets get loosened from the mould surface(shrinkage) due to the reduction in moisture and reduction in stickiness.

Unmouldingand packaging of dried tamarind pellets

The dried pellets were removed from the mould and the final dried pellets are showed in the Fig 1.

Fig 1. Tamarind pellets

After unmoulding, the dry tamarind pellets were packed in air tight plastic packaging material. The air tight LDPE ziplock cover was used to avoid the moisture absorbance from the atmosphere as shown in Fig 2.

Fig 2. Packaging of tamarind pellets

Titratable acidity and pH

Titratable acidity in the dried tamarind pellet was measured in terms of tartaric acid following the method described by [14]. For measuring titratable acidity,1 pellet (1 g) from each treatments were taken and diluted with 95 mL of distilled water making the volume to 100 mL, then filtered through Whatman no. 41 filter paper and titrated against 0.1 N NaOH using phenolphthalein indicator. The tamarind pellet samples (1 g) was diluted with 45 mL distilled water, and pH was measured with glass electrode (SUSIMATechnologiesPrivateLimited,Chennai).

Solubility of dried tamarind pellets

It is defined as the maximum quantity of a drug dissolved in a given volume of a solvent at a certain temperature. Solubility information is very important when designing food based pellets.The partial solubility and complete solubility of the dry tamarind pellets were analyzed in the following method given by [15] with some modifications. The tamarind pellet 1 g (1 pellet) was added into the 100 ml of distilled water and immersed in water bath. The dissolution process was carried out in water bath at three differential temperatures such as 55 □, 65 □ and 100□ with and without stirring of the solution with a glass rod. The solubility tested samples were illustrated in the Fig 3. Thetime duration taken for the complete and partial solubility of the dried tamarind pellets at each and every temperature conditions was noted.

Fig 3. Solubility testing of dried tamarind pellets

Sensory evaluation:

Sensory evaluation was conducted to the different sample ratios of dried tamarind pellets and to find which sample was excellent among the 5 samples. The sensory attributes of the tamarind pellets were evaluated by semi-trained panel with 9 point hedonic scale. The appearance, color, sourness, size, shape, mouth feel, texture and overall acceptability are the attributes considered for the sensory evaluation.

RESULT AND DISCUSSION

The results obtained from the physico-chemical analysis of the tamarind pellet samples with different ratio of tamarind and corn flour are presented in Table 1. The pH of the tamarind pellet samples were analyzed ranged from 2.74±0.13339 to 2.96±0.13320. The ratio of 3 part of tamarind paste and 1 part of corn flour (3:1) had the lowest pH value of 2.74±0.13339, due to having higher quantity of tamarind content from other treatments and 1:1 ratio had the highest pH value of 2.96±0.13320. The pH has an inverse relationship with the proportion increasing of tamarind content in every treatments.

The reverse was observed in the results for acidity, in which 3:1 ratio had the highest value of 17.2±0.13127 %, while 1:1, 1.5:1, 2:1and 2.5:1had the acidity values of 13.12±0.13139, 14.25±0.13135, 15.00 ±0.13133 and16.15±0.13129%, respectively.

Table 1. Mean values of pH and acidity of tamarind pellet with different treatments

S. No	Treatments (Tamarind paste: Corn flour)	pH	Acidity (%) of Tartaric Acid
1.	1:1	2.96±0.13320	13.12±0.13139
2.	1.5:1	2.93±0.13322	14.25±0.13135
3.	2:1	2.87±0.13327	15.00±0.13133
4.	2.5:1	2.81±0.13333	16.15±0.13129
5.	3:1	2.74±0.13339	17.20±0.13127

Tartaric acid is the main acid in tamarind juice, and it influences the dominant microflora in the tamarind as well as the shelf stability of the tamarind pellets. The acidity of the product reduces its susceptibility to bacterial action while increasing its susceptibility to yeasts and molds. The result obtain from this study isin accordance with [16] who examined physico-chemical properties and sensory qualities of juices extracted from five selected fruits and their peels and found similar outcomes.

Solubility of dried tamarind pellets

The experiment was investigated on fivedifferent sample ratios. A linear relationship exists betweenamount of tamarind content in tamarind pellets and its solubility. The time required for dissolution of tamarind pellets ranged from 19.2 min to 24.2min against stirring of solution and 25.1to 30.3 min against non-stirring of solution for partial solubility at 55 □. For complete solubility of tamarind pellets, stirring process required 34.1 to 29.7min and non-stirring recorded 40.3 to 45.1 min at55 □ as given in Table 2.

The solubility time of tamarind pellets was decreased with increased ratio of tamarind paste content in total sample ratio, which is shown in Table 3. The time required for complete solubility of tamarind pellets with stirring at 65 □, in which 1:1 sample ratio had the highest value of 20.1, while 1.5:1, 2:1, 2.5:1 and 3:1 had the values of 19.3, 18.7, 17.9 and 15.5 min., respectively.

Table 2and 3 explain the effect of different temperature combinations with stirring and without stirring (non-stirring process with glass rods) on partial and complete solubility of the tamarind pellets. In pharmaceutical industries, stirring is important parameter to evaluate the solubility of theTablets [17]. Table 2 clearly indicates a substantial change in time that consume for partial and complete solubility of tamarind pellets in water solvent with respect to temperature and with /without stirring of solution.

Fig 4 and 5 showed the minimum time required for partial and complete solubilityof the tamarind pellets in water with stirring was observed at 5.1min. and 8.5min. at 100 □, respectively. The dissolution time of the pellets were increased, when reducing the temperature of the solvent without stirring. The sample dissolved at 55 □ had the higher dissolution time as 25.1min. and 40.3min. for partial solubility (without stirring) and complete solubility (without stirring) in the water, respectively.

The above analysis showed the result that the solubility of tamarind pellets increased when temperature increased. It is well understood that the temperature is one of the main factorsthat affect the solubility. The observed phenomena can be related with [18] who advocated that the heat released during the dissolving process is less than the heat required to break apart the material, the net dissolving reaction is endothermic (energy required). The use of additional energy speeds up the dissolving reaction by supplying energy to break down solid bonds. Here, the tamarind content in pellets influenced the solubility conditions i.e. the higher ratio of tamarind content will reduce the time required for solubility.The condition of with & without stirring also showed various results on solubility time under partial and complete solubility.

Table 2. Mean value of time taken for partial and complete solubility of tamarind pellets at 55 □

Temperature (55 □)		**Partial solubility**		**Complete solubility**	
S.No	Sample ratios	With Stirring (min.)	Without Stirring (min.)	With Stirring (min.)	Without Stirring (min.)
1	1:1	24.2	30.3	34.1	45.1
2	1.5:1	23.8	29.6	33.7	44.4
3	2:1	22.4	28.2	32.2	43.1
4	2.5:1	21.6	27.8	31.5	42.7
5	3:1	19.2	25.1	29.7	40.3

Average of six trials

Table 3. Mean value of time taken for partial and complete solubility of tamarind pellets at 65 □

Temperature (65 □)		**Partial solubility**		**Complete solubility**	
S.No	Sample ratios	With Stirring (min.)	Without Stirring (min.)	With Stirring (min.)	Without Stirring (min.)
1	1:1	15.3	25.1	20.1	39.9
2	1.5:1	14.5	24.7	19.3	39.2
3	2:1	13.8	23.1	18.7	38.1
4	2.5:1	12.1	22.4	17.9	37.3
5	3:1	10.9	20.2	15.5	35.7

Average of six trials

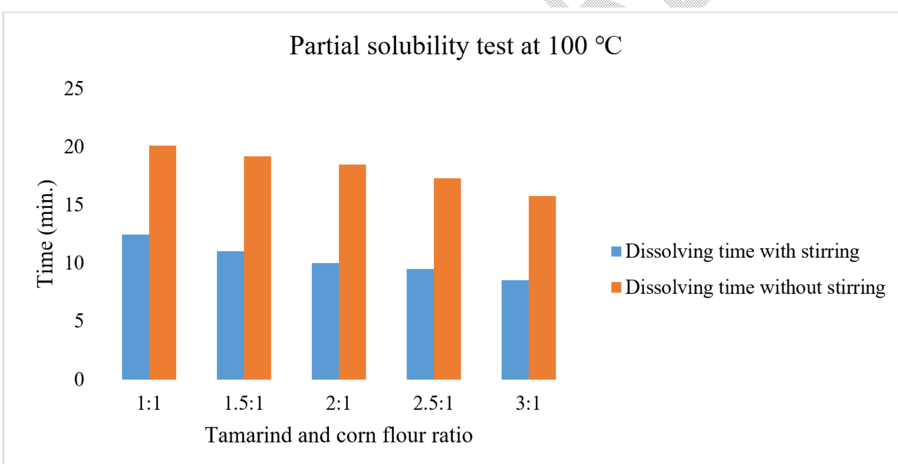

Fig 4. Time taken for partial solubility of tamarind pellets at 100 □

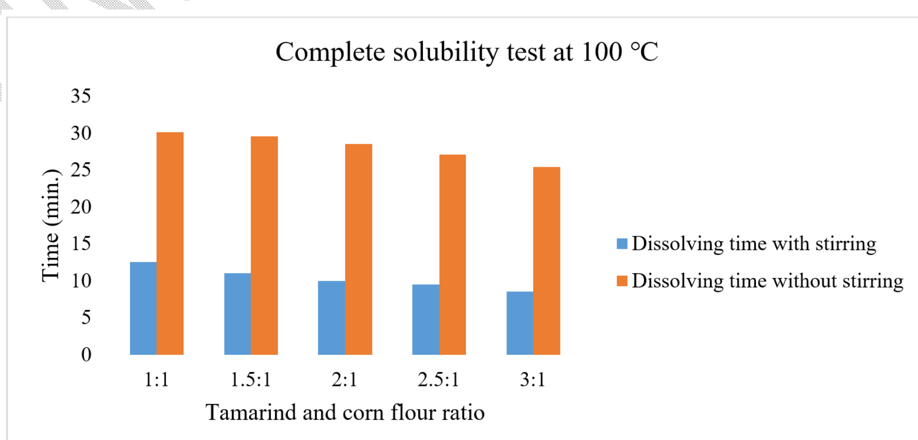

Fig 5. Time taken for complete solubility of tamarind pellets at 100 □

Sensory Evaluation

Table 4 summarizes the results for the sensory evaluation and overall acceptability of the tamarind pellet samples. The statistical analysis revealed that there were significant difference ($p<0.05$) among the tamarind pellets in the sensory attributes observed. The sample ratio of 3:1 (Tamarind:Corn flour)had the highest score (8.3±0.1318), while 1:5 sample ratio had the lowest score (5.5±0.1321) for color. The appearance was based on how the color appeal to the panelists. The color was better, when increasing the concentration of tamarind paste in pellets. Similar trends were observed for the sensory ratings of texture and mouthfeel in the tamarind pellets, 1:1 sample ratio of pellets had the lowest scores (6.1±0.1319) followed by 1.5:1 (6.5±0.1319) for texture and 3:1 had the highest score (8.5±0.1316) followed by 2.5:1 (7.6±0.1317) for mouthfeel. The sensory evaluation was revealed that 3:1 sample ratio of tamarind pellets had the highest overall acceptability ratings of 8.4±0.1316.

Conclusion

The study demonstrated that the development of tamarind pellets which made up into a standardized product under ready – to –use category. The results obtained could be very valuable in decision making for industries that want to take nutritional advantage of tamarind pellets as alternative. Corn flour acts as a thickening or binding agent and has lower cost when compared to other thickeners.Hence, this study is an attempt to acquire the development of tamarind pellets in the best combination of tamarind paste and corn flour at 3:1 was found superior in terms of solubility, pH, acidity and overall acceptability and also it will surely reduce the time consumption to prepare the tamarind paste while cooking.

Table 4. Sensory evaluation (Mean ± SE)of tamarind pellets

S.No	Treatments	Appearance	Color	Texture	Sourness	Size & Shape	Mouth feel	Overall Acceptability
1.	1:1	6.3±.1319^{b}	5.9±.1320^{b}	6.1±.1319^{b}	5.9±.1319^{b}	6.4±.1319^{b}	6.0±.1318^{b}	6.1±.1318^{b}
2.	1.5:1	5.9±.1320^{a}	5.5±.1321^{a}	6.5±.1319^{a}	6.2±.1319^{a}	6.0±.1320^{a}	6.3±.1319^{a}	6.7±.1319^{a}
3.	2:1	6.9±.1318^{c}	6.5±.1319^{c}	7.1±.1318^{c}	7.2±.1318^{c}	7.3±.1318^{c}	7.4±.1317^{c}	7.0±.1317^{c}

4.	2.5:1	7.7±.1317^{d}	7.3±.1318^{d}	7.9±.1317^{d}	7.8±.1317^{d}	7.7±.1317^{d}	7.6±.1317^{d}	7.9±.1317^{d}
5.	3:1	8.7±.1316^{e}	8.3±.1318^{e}	8.0±.1317^{e}	8.8±.1316^{e}	8.6±.1316^{e}	8.5±.1316^{e}	8.4±.1316^{e}
	F value	**72.470****	**72.403****	**40.383****	**60.537****	**61.845****	**41.721****	**37.701****

The superscripts with same letter indicate that the treatments are on par

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