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Optimization of enzymatic concentration in tamarind pulp extraction

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Abstract
Tamarind (*Tamarindus indica* L.) is the most widely cultivated and economically important spice of India. Raw tamarind cannot be used to added value products, so is converted into tamarind pulp. For large scale production and to get benefits from manufacturing of tamarind pulp, highest pulp recovery should be considered with less %age of wastes. The present study was undertaken to study the effect on amount of enzyme, soaking time and soaking temperature on the pulp recovery with the properties of tamarind pulp. The study assessed with physio-chemical properties of tamarind pulp which is essential for design and development of different equipment's. The study was taken at a temperature of 37 ^{o}C and 55 ^{o}C for soaking time of 2hrs. 4hrs. and 6hrs. at different enzyme concentration 0.005ml., 0.010ml. and 0.015ml. The Total Soluble Solid (T.S.S.), consistency, pH and color are found to the effect the properties of tamarind. The result suggested that hot enzymatic enzyme method at 55 ^{o}C for 4hrs with enzyme concentration of 0.015ml gives highest pulp recovery (78.69%) of tamarind, total soluble solid (26 ^{o}B), consistency (6.5 cms/30 sec.), pH (2.42) and color (L-22.87, a-7.88, b-1025) with less percent (%) of waste which increases the efficiency (Soluble Solid Recovery-204.59%).

Keywords: Enzyme concentration, soaking time, physico-chemical properties, pulp recovery

1. Introduction
The name Tamarind is derived from the Arabic- 'Tamr-Hindi', which means or translates into being 'Date of India'. One of the first tamarind trees in Hawaii was planted in 1797. The tamarind tree belongs to the family of 'Fabaceae', its scientific name, Tamarindus Indica. Tamarind fruit is hugely popular because of its health benefits and medicinal benefits. Leaves, bark, seeds, and flowers of tamarind to have medicinal uses. A mature tree is capable of producing between 175- 250kg tamarind fruit per year. Flowers and leaves of tamarind are edible and have a delicious flavour.

In India, there are extensive tamarind orchards producing 275,500 tons (250,000 MT) annually. It is cultivated all over India, especially in the South Indian states of Karnataka, Andhra Pradesh, and Tamil Nadu. Extensive tamarind orchards in India produce 275,500 tons (250,000MT) annually.

Tamarind juice/ pulp is a natural antiseptic that is used with herbal ingredients to cure Scurvy that arises from a deficiency in Vitamin C. Diluted tamarind paste is an excellent home remedy for sore throat infection. Tamarind fruit has powerful antioxidants that protect against harmful chemicals that cause cancer. Tamarind should be included in your diet because minerals present in this fruit are good for bone health.

Therefore, maximum pulp recovery is the basic key parameter for any manufacturing industry to earn better profits. Earlier in homemade methods of soaking tamarind in hot water is adopted, for extraction of pulp but it is used in small scale only and it is unhygienic too. Therefore, the mechanical method with hot enzymatic extraction is adopted to get more pulp recovery and maintain hygienist/hygienic characteristics with analyse the effect of enzyme concentration, soaking temperature and time on the physico-chemical properties of tamarind pulp.

Waldt and Mahoney (1967), In the conventional process of preparing juices from soft fruits, the pulp is boiled with water and the extract is further processed, which increases the extraction of pulp soft fruits. Villettaz (1993) [10], by pectinase enzyme treatment, there is an increase in the yield of juice from grapes up to 30%. The juice yield increases as the

concentration of pectinase increases from 0.05 to 1.5%. Yusof and Ibrahim (1994) [12], Enzymatic Extraction & clarification juice from various fruits. Results revealed that the use of pectinase enzyme increases the T.S.S. within the first hr. of incubation, but constant for 2 to 3 hr. Jaleel *et al.* (1978) [2], the mixture of pectinase, cellulase and hemicellulose enzymes which were effective in viscosity reduction and filterability improvement in the preparation of clarified juices. Joshi *et al.* (2012) [4], studied the techniques that are much suitable to improve the recovery of pulp. After a specific period of soaking, homogenization was made by hand crushing, then filtered. In hot water extraction and hot enzymatic extraction after a specific period of soaking, it was followed by heating at 50 ºC for 10 min. The result revealed that soaking in hot water + 0.25% Pectinase for 41/2 hours pulp recovery (92.30%), TSS (34.51%), pH (2.89) and total sugars (25.52%). There was complete removal of pulp adhering to the skin by heat and enzymatic treatment. Finally, it can be concluded that the pulp extracted by hot enzymatic process contained a high amount of TSS, sugars, and low amount of ascorbic acid, however, enzyme-treated pulp was found better in respect of the quality of juice. Kotecha and Kadam (2002) [6], in tamarind, reported that pulp from matured and healthy tamarind pods were extracted by four methods viz. cold, hot, cold enzymatic and hot enzymatic extraction. The results on the of extraction method on the yield of tamarind pulp revealed that the among the hot enzymatic extraction method 0.5% enzyme concentration obtained maximum recovery (92.4%) of pulp while 2.0% had less recovery of pulp (80.5%) in hot enzymatic extraction method 1.5% concentration of enzyme recovered.

2. Material and method

2.1 Sample Preparation

This project was conducts in B.E.C. Foods Chandkhuri, (Durg). The raw material (Mixed variety of tamarind) were purchased from the local market or exported from Jagdalpur. Generally, tamarind fruits are available on store in the form of lumps due to compact packaging so, before soaking the product (tamarind) is delumped manually. This process is required for proper soaking of product and during delumping of tamarind stone, mud and other foreign matters are removed.

2.2 Experimental Work

150 g of weighed samples (by electrical weighing machine) were used for each treatment. Double amount (300ml) of water was added to the tamarind and then enzyme is added. The tamarind were soaked in water at different temperature for various periods of time and enzyme amount (Table 1). The tamarind pulp was extracted by sieving at room temperature (28-32 °C). After extracted, the pulp different physico-chemical properties and pulp recovery were measured.

The tamarind is soaked in water, in the ratio of 1:2. Where, 1 portion of tamarind and 2 of water. 150g of tamarind for soaked in 300ml water. After that pectinase enzyme is added on sample by pipette and agitate the sample for proper mixing. Enzyme is added at different amount on different sample.

In incubation process, soaked Tamarind sample was placed in incubator for specific time. Incubator maintain constant controlled temperature atmosphere. After that soaked tamarind is sieved through 2 mm sieve size and extracts their pulp by manually.

Table 1: Process Parameters and their levels

Parameters	Levels
Sample Weight (g)	150
Water Temperature (°C)	37, 55
Soaking time (hrs.)	2, 4, 6
Enzyme concentration (ml)	0.005, 0.01, 0.015

2.3 Measurements of Processing Parameters

2.3.1 Pulp Recovery

Pulp recovery is"the amount of pulp extracted for the sample." After that weighing of pulp by using the following formula we calculate the pulp recovery of that batch. The percentage (%) of pulp recovery (%w/w) is calculated as the weight of smooth pulp divided by the weight of sample.

$$\text{Pulp recovery} = \frac{W_1}{W_2} \times 100$$

Where,

W_1 =Weight of smooth pulp extracted from sample after sieving (g).

W_2 = Weight of sample (g)

2.3.2 Soluble Solid Recovery

Soluble solid recovery was calculated by compony standard method, following equation is used for calculation,

$$\text{Soluble solid recovery} = \frac{\text{Pulp recovery (\%)} \times \text{T.S.S. (°B)} \times 10}{100}$$

2.3.3 Physico-chemical Properties

2.3.3.1 Total Soluble Solids (TSS)

Total soluble solid was determined following the method described by Monohar *et al*., (1991) for tamarind paste using analog refractrometer. A drop of the pulp was placed on the prism and TSS value was noted in ºBrix.

2.3.3.2 pH

The pH of the extract was measured by using a digital pH meter. 10 g of sample was taken and dissolved in 20 ml of distilled water. The mixture was allowed to stand for 5 to 10 min at room temperature and the sample was filtered using a muslin cloth. The extract was then used for determining the pH value (Ameh, 2012).

2.3.3.3 Consistency

Consistency of material is flows against itself due to the force of gravity. The consistometer (Bostwick Consistometer) were used to measures the consistency or thickness of product like pulp or puree. It's the simplest, most accurate way of conducting a flow test.

2.3.3.4 Colour

The colour of the pulp was measures using a Digital Hunter Colorimeter D25 optical sensor (Hunter Associates Laboratory, Trestoa, VA, USA) on the basis of three variables (L, a, b value) by standard method. The L value indicates the lightness, a value represents greenness and redness while the b value signifies changes from blueness to yellowness.

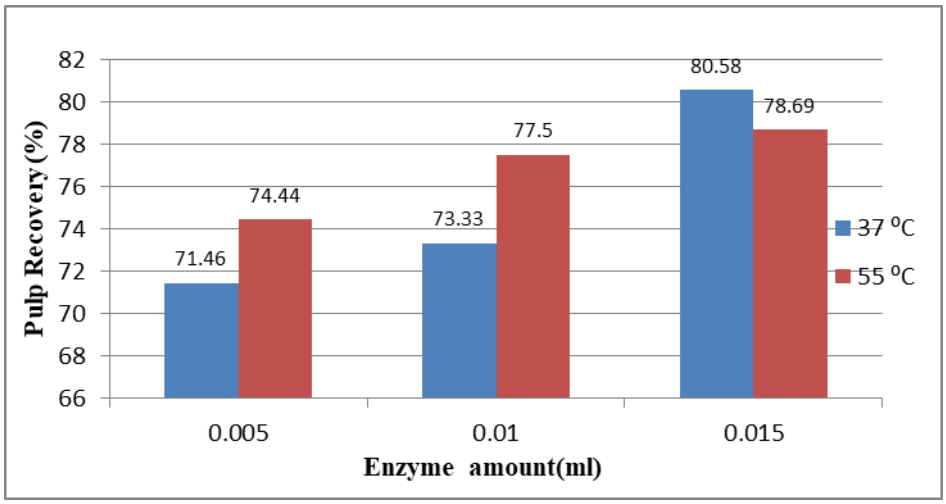
3. Result and discussion

3.1 Physico-chemical characteristics of Tamarind pulp

3.2 Effect of enzyme amount

3.2.1 Effect on Pulp Recovery

The results show that on effect of enzyme amount on pulp recovery stated that at constant time of 4hrs, with the increase in enzyme amount from 0.005ml to 0.015ml and increase in temperature increases the pulp recovery from 71.46% to 80.58% at 37º and at 55 ºC the recovery increases from 74.4% to 78.7%. It has been seen that as with the increase in the amount of enzyme, pulp recovery at 55 ºC gives better results than 37 ºC but with further increase in amount of enzyme decreases the soluble solid recovery.



Graph 1: Effect of enzyme amount on pulp recovery

3.2.2 Effect on Consistency

The results show that on effect of enzyme amount on consistency stated that at constant time of 4 hrs, with the increase in enzyme concentration from 0.005ml to 0.015ml and increase in temperature increases the consistency at 0.005ml concentration. Consistency at 37 ºC is 4 and at 55 ºC is 4.5 similarly from 5 to 5.5 thereafter for 0.015ml remains constant to 6.5. It has been seen that as with the increase in enzyme concentration, consistency at 55 ºC gives a better result than 37 ºC but with further increase in concentration decreases the consistency of pulp.

3.2.3 Effect on TSS

The effect of enzyme amount on TSS (Total Soluble Solids) results stated that at a constant time of 4hrs, with the increase in enzyme concentration from 0.005ml to 0.015ml and increase in temperature increases the T.S.S i.e.at 0.005ml and 0.010ml concentration. TSS at 37 ºC is 23ºB and at 55 ºC is 24ºB similarly from 24ºB to 26ºB at 0.015ml concentration. It has been seen that as with the increase in enzyme concentration, consistency at 55 ºC gives better result than 37 ºC there by increasing the soluble solid recovery %age.

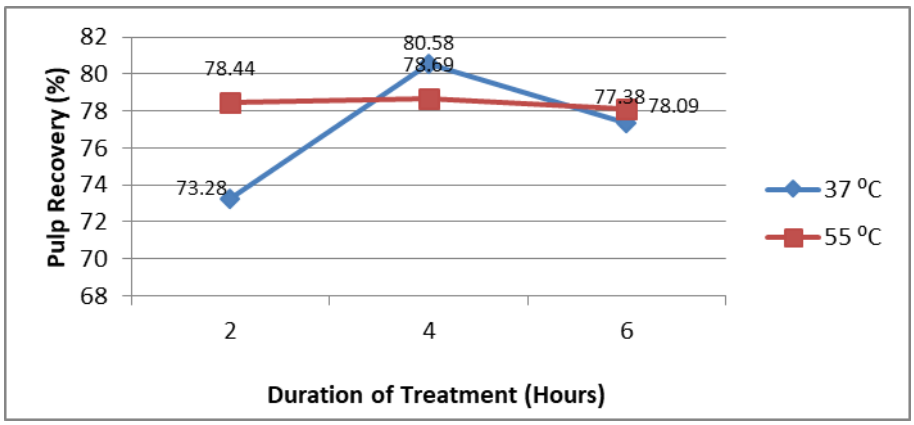
3.2.4 Effect on L value of Color

The result on the effect of enzyme amount on L value stated that at constant time of 4hrs, with the increase in enzyme concentration from 0.005ml to 0.015ml and increase in temperature increases the T.S.S. at 0.005ml and 0.010ml concentration. L value at 37 ºC is 23.38 and at 55 ºC is 23.49 similarly from 22.24 to 22.87 at 0.015ml concentration.

3.3 Effect of time of treatment

3.3.1 Effect on Pulp Recovery

The result shows that with the increase in time at 55 ºC & 0.015ml amount of enzyme pulp recovery is linearly. Where as in 37 ºC with increase in time the pulp recovery increases from 73.28 to 80.58% then decreases from 80.58 to 77.38%



Graph 2: Effect of time on pulp recovery

3.3.2 Effect on Consistency

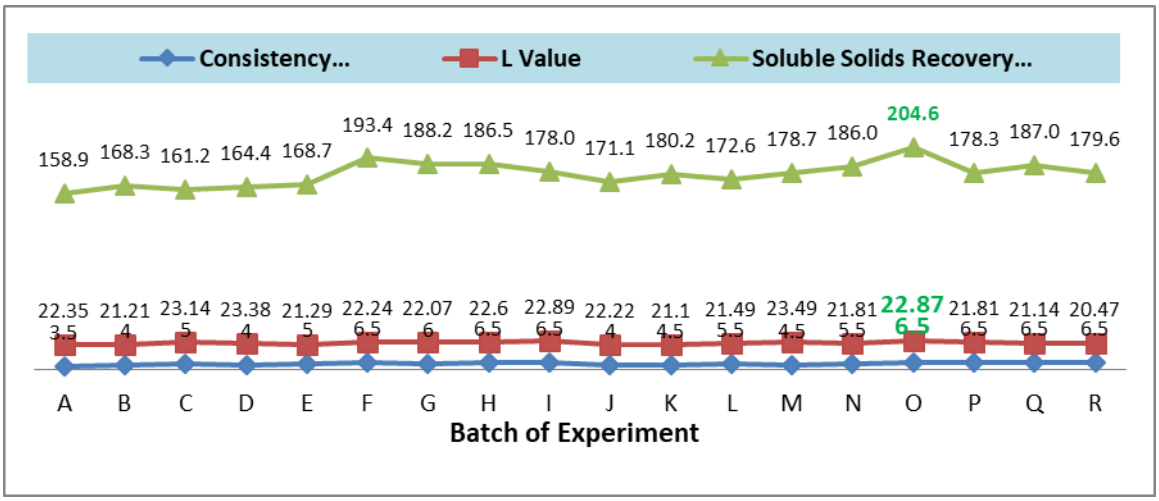
The result shows that with the increase in time at 0.015ml amount of enzyme at both temperatures of 37 ºC and 55 ºC, the consistency of pulp increases and become constant to 6.5 with further increase in time.

3.3.3 Effect on TSS
The result shows that the TSS increases and decreases at 0.015ml amount of enzyme for both 37 ºC & 55 ºC with increasing in time from 2hrs to 4hrs. Highest T.S.S. was 26 ºBrix at 55 ºC in 4 hrs. Therefore, TSS at 55 ºC for 4hrs can be adopted.

3.3.4 Effect on L value of Colour
The results on the effect of time on L value stated that at constant enzyme concentration 0.005ml, with the increase in temperature and time from 2hr. to 6hr., firstly increases (from 21.49 to 22.87) and then decreases (from 22.87 to 20.47) L value at 55 ºC. and at 37 ºC firstly decreases from 23.14 to 22.24 then increases from 22.24 to 22.89. Therefore, L value at 55 ºC at 4hrs. given better results than 37 ºC.

4. Summary and conclusion
Amount of enzyme, soaking time and temperature are the major parameters responsible for the pulp extraction of tamarind. The pulp extraction is done by using the pectinase enzyme to degrade the pectin present in tamarind and get the highest pulp recovery. The samples are kept at incubation temperature of 37 ºC and 55 ºC for enzyme amount of 0.005ml, 0.010ml and 0.015ml for soaking time 2hrs, 4hrs, and 6hrs. The result shows that soluble solids recovery at 37 ºC with increases in time and enzyme up to 193.4gm/kg thereafter decrease. At 37 ºC graph shows a linear increase in pulp recovery at 4hrs soaking time which is acceptable. Similarly, at 4hrs soaking time with an increase in time and temperature, soluble solids recovery is at its highest value of 204.6gm/kg.

Enzyme amount, soaking time and temperature are the major parameters responsible for the different changes in properties of tamarind pulp. The result revealed that with increase in above parameters total soluble solids and consistency of pulp increases to 26ºBrix and 6.5 at 55 ºC & 0.015ml and brightness of pulp for the first 4 hrs increase then decrease., thereby L=22.87 is acceptable.



Graph 3: Combined effect of consistency, L value & soluble solid recovery

Therefore, the study suggests that hot enzymatic extraction method i.e. at 55 ºC is quite effective than at 37 ºC i.e. cold enzymatic extraction method as stated earlier by Joshi *et al.* (2012) [4]. and the enzyme amount of 0.015ml for 4hrs incubation time gives highest pulp recovery of 78.69% and soluble solid recovery of 204.6 gms/kg with 6.5 viscosity, 26ºBrix, pH 2.42 and color L=22.87, a=7.88 and b=10.25.

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