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Rahul Sahu
Krishi Vigyan Kendra,
Bastar Chhattisgarh, India

Dushyant Pandey
Krishi Vigyan Kendra,
Bastar Chhattisgarh, India

Corresponding Author:
Rahul Sahu
Krishi Vigyan Kendra,
Bastar Chhattisgarh, India

Sustainable livelihood security through processing and value addition of tamarind (*Tamarindus indica* L.)

Rahul Sahu and Dushyant Pandey

Abstract
Tamarindus indica L., commonly known as tamarind, is a multipurpose long-lived tree best known for its fruit. Tamarind is one of the most important spices in Indian food due to its sweet and sour test. Tamarind fruit pulp has been an important culinary ingredient in India for a very long time. Around 21430 metric tons of Tamarind is produced annually in Basar region of Chhattisgarh state. During the last few years, demand of processed products of tamarind has been increased at urban as well as city market. So, the tamarind can be easily transformed in various value-added as well as in convenient forms. The higher production should be transformed into value added products and is present need across the globe. Considering this phenomenon targeted tribal people are trained and enabled in this direction. Therefore, by involving scientific intervention by Krishi Vigyan Kendra, Bastar working in area of improving the livelihood of farmers, an effort has been made to enhance income source of tribal farmers. The women of three Self-Help Groups (SHGs) of viz. Maa Lakshi, Bajrangbali and Maa Parvati of block-Bastanar from Bastar region of Chhattisgarh, were trained for utilization of tamarind into production of various value-added products. Hygienic, good quality, nutritious tamarind bricks and sweet-sour tamarind candy malt were prepared by the groups and sold *via* local wholesale system. Remarkable result revealed and earned profit worth of INR 85 to 400 from per kg of the processed products. This effort has shown a way for enhancing the economic potential of tribal farmers in the Bastar region.

Keywords: Tamarind, *Tamarindus Indica* L., tamarind candy, tamarind bricks, livelihood security

1. Introduction
Tamarindus indica L. (syns. *T. occidentalis* Gaertn, *T. offi cinalis* Hook, *T. umbrosa* Salisb) belongs to the family leguminaceae (syns. Fabaceae) and subfamily Caesalpinaceae. The genus Tamarindus is monotypic, i.e., it contains a single species. Commonly, *Tamarindus indica* is known as tamarind (the trade and English name). In Spanish and Portuguese, it is called tamarindo; in French, tamarinier, tamarinde; in Dutch and German, tamarinde; in Italian, tamarindizio; in Hindi, it is known as tamarind, tamrulhindi and it has other local names as well (e.g., ambli, imli, chinch, etc.). In the eighteenth century, Linnaeus gave it the name *Tamarindus indica*, inspired by the Arabic name tamar-ul-Hind, meaning date of India (Yahia and Salih, 2011) [10].
Tamarind is a very common large tree with a short massive trunk, ferny pinnate leaves, small yellow flowers and fat reddish brown pods. The tree can get 90-feet tall but is usually less than 50-feet. It has a short, stocky trunk, drooping branches and a domed umbrella shaped crown about as wide as the tree's height. The leaves are about 10-inch long with 10-18 pairs of 1-inch oblong leaflets. The tree is found throughout most of the tropical region.
In India, the tree is found abundantly in Chhattisgarh, Madhya Pradesh, Telangana, parts of Maharashtra, Tamil Nadu, Orissa, Bihar and Bengal. Bastar division is southern part of Chhattisgarh. Tamarind is economically valuable and multi-purpose insofar as almost every part of the tree has a use, but the tree is best known for its fruit (Fig. 1) and the marketability of tamarind fruit has increased consistently over the years. Poor peoples of Bastar collect fruits of tamarind in the month of January to April and engaged in related work up to June. Jagdalpur Krishi Upaj Mandi is the largest auction centre of tamarind in Asia. According to an estimate of Forest Department of Bastar, average production of tamarind fruit is 21430 metric tons which values about INR 10.35 crores. These productions generate employment of 24000 man-days in the month of January to April. Besides this about 5660 tons of tamarind seed worth about INR 3.02 crore @ 550/- quintal is transported from Jagdalpur (Gupta *et al.*, 2017) [2].

Fig 1: Tamarind fruit (Tamarindus indica L.)

In Chhattisgarh state tamarind is being procured at Minimum Support Price (MSP), seeded tamarind is being procured at `3600/q while deseeded tamarind (often called *Phool Imali*) is being procured at `6300/q to help the tribals and other NTFP collectors of the state. The demand for processed tamarind is continuously increasing in urban as well as in the global market. It is expected that this can be double when presented in convenient form. However, proper processing and value addition can help in fetching premium price and can be a possible source of enhancing livelihood of tribal farmers.

2. Materials and Methods

2.1 Study area and methodology

An attempt has been made to increase the income source of tribal farmers, for this purpose three Self-Help Groups (SHGs) from Bastar district of Chhattisgarh state namely, Maa Lakshmi, Bajrangbali and Maa Parvati groups from different villages of block-Bastanar were selected for the study. The villages namely, Kodenar, Badekilepal and Bastanar were purposively selected keeping in view the biophysical diversities, *i.e.*, distance from (i) block headquarter (ii) market growth centers, and (iii) road to bus points (Nag *et al.*, 2011; Sahu, 2023) [8, 9]. The particulars of villages are as follows:

1.	Total village selected for study	:	03
2.	Total SHGs selected for study	:	03
3.	Proximity of village from nearest road	:	0-5 km
4.	Proximity of villages from nearest market	:	0-5 km
5.	Nature of composition of villages	:	Multicast
6.	Total population of sample villages	:	15690
7.	Total households in sample villages	:	3344
8.	Female population in sample villages	:	52.07%
9.	Total literacy rate	:	23.53%
10.	Female literacy rate	:	9.53%
11.	Scheduled tribes' population	:	90.20%
12.	Scheduled caste population	:	0.70%

From these selected villages study was conducted in three targeted groups as mentioned. The groups were structured separately with each village where president and secretary having bank account in name of the Self-Help Groups (SHG).

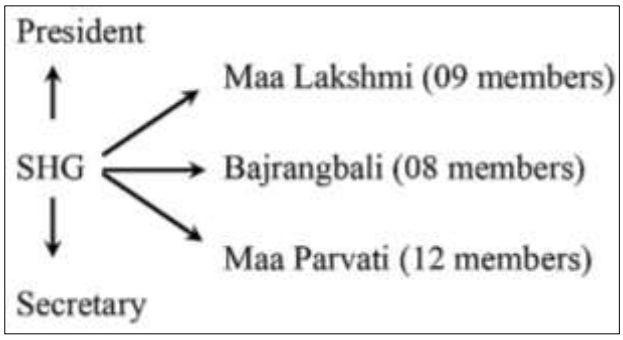

Fig 2: Hierarchy of Self-Help Groups

2.3 Mode of working

Each member of the groups was trained at the processing unit of the Krishi Vigyan Kendra, Bastar which was established to strengthen the tribal people in the field of processing and value addition. Prepared value-added products are sold by the groups in the local market and also under the marketing skill support of the experts by providing the name of Krishi Vigyan Kendra, Bastar on the packaging. The working mode of the groups are briefed in Fig. 3.

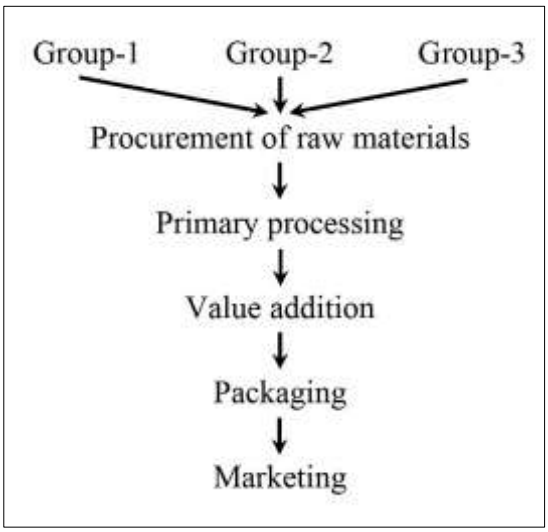

Fig 3: Mode of working of groups

3. Result and Discussion

3.1 Capacity building training

Advanced training was given to SHGs by the experts designated at the Krishi Vigyan Kendra, Bastar working in the area of these aspects like hygienic harvesting/collection of tamarind pods, deseeding, processing, value addition, and quality control. Besides providing processing and production technology the SHGs were also trained for development of production plan, packing, financial management and negotiation skill. Majority of the beneficiaries are middle aged, educated at least up to primary level, having medium land holding with medium annual income and on the basis of one year data results are being discussed. The invest of initial cost for raw material procurement and processing of tamarind value added products among the SHGs was self-arranged by the group. The quality products were successfully prepared by the groups and sold in local market to whole sale merchants (Sahu, 2023) [9].

3.2 Harvesting, collection, grading and primary processing

Tamarind pod is 12-15 cm in length with a hard and brown shell. The fruit has a fleshy, juicy, acidulous pulp. It is mature when the flesh is coloured brown or reddish brown. It is a nutritious fruit with a variety of uses. The tamarind fruit is best described as sweet and sour in taste, and high in acid, sugar, vitamins, and calcium. The pulp constitutes most part 25-50% of the ripe fruit tamarind, shell and fibre account for 10-30% and seed constitutes about 25-45%. Since long time India has been exporting processed tamarind pulp to western country and in inter tropic zone it is commonly consumed in various dishes or drink due to its delicious/mouthwatering sweet-sour taste, nutrient and calorific value. Tamarind pulp is most valuable and commonly used part of the tamarind instead of fibre and seed. The fruit pod is the richest natural source of tartaric acid and is the main acidulant used in the culinary preparation in India (Mishra *et al.*, 2011; Devi and Boruah, 2020) [6,1]. The chemical constituents of the tamarind fruit pulp are shown in Table 1.

Table 1: Chemical/Nutritional composition of tamarind fruit pulp

S. No.	Constituents	Amount per 100 g of edible pulp
1.	Calories (kcal)	115-283
2.	Moisture (g)	20.9-52
3.	Protein (g)	3.10
4.	Fat (g)	0.1
5.	Fibre (g)	5.6
6.	Carbohydrate (g)	51.5-67.8
7.	Invert sugars (g) (70% glucose; 30% fructose)	30-41
8.	Ash (g)	2.9-3.3
9.	Calcium (mg)	35-170
10.	Phosphorus (mg)	54-160
11.	Iron (mg)	1.05-17.0
12.	Sodium (mg)	24-112.76
13.	Potassium (mg)	116-375
14.	Thiamine (mg)	0.16
15.	Riboflavin (mg)	0.07
16.	Niacin (mg)	0.6-0.7
17.	Ascorbic acid (mg)	0.7-3.0
18.	Tartaric acid (mg)	8-23.8
19.	Vitamin A (I.U.)	15
20.	Magnesium (mg)	10.54
21.	Manganese (mg)	0.13

Source: Mishra *et al.*, 2011; Hiregoudar *et al.*, 2011; Morton, 1987; Khairunnuur *et al.*, 2009; Khanzada *et al.*, 2008 [6,3,7,4,5]

Tamarind fruits mature in early summer. They may be left on the tree for as long as 6 months after maturity so that the moisture content will be reduced to 20% or lower. The tree begins to bear fruit at the age of 13-14 years and continues to yield abundant crops for more than 60 years. The flowers appear from June and July and the pods ripen in the cold season. A mature tree may produce up to 125-175 kg of fruit annually. The pods should be allowed to ripen on the tree until the outer shell is dry. Generally, good quality tamarind is harvested by pulling the pods from its stalk between the month of March to April. It is better to pluck fruit through long bamboo attached to the pod collection bag to get hygienic, dust-free, undamaged quality fresh tamarind. Another method of safe and hygienic harvesting can be done by spreading the saree or polyethylene sheets beneath the tree and then plucking with bamboo or any other convenient tools. Similarly, Mishra *et al.*, 2011 [6] reported a method of tamarind fruit harvesting and collection by manual practice way.

For best price Tamarind should be deseeded. For the deseeding purpose the tamarind requires two-days of sun drying (Fig. 4) so that in deseeding process pulp will remain intact. While sun drying the tamarind for deseeded purpose, the following precaution must be observed. Over drying must be avoided result loss a colour pigment and flower portion must keep upside. Bastar tribes defines the deseeded tamarind as "*Aati Imali*" which could be graded in to three categories on the basis of fruit collection period. Table 2 shows the grading and quality parameters of tamarind fruits.

Table 2: Grading of tamarind fruits

S. No.	Grade/quality	Collection period	Fruit colour	Moisture content (%)	Physiology
1.	Grad-I/Good	March-April	Red-dark brown	20-30% (low)	Long and well matured
2.	Grade-II/Medium	May-June	Light red	30-52% (high)	Fruit contains low pulp
3.	Grade-III/Low	January-February	Light red to blackish	30-52% (high)	Small and wet fruits

3.2.1 The following primary processing steps should be taken in to consideration to avoid deterioration

- Removal of seed from well dried tamarind fruit and convert it in to block/briquettes or cake form to fetch better price and to make it convenient during transportation, handling as well as during storage.
- The shelf life of the tamarind could be increased by adding small amount of salt and get sun dried.
- It should be properly dried under sunlight since high moisture tamarind fruit get deteriorates the quality of tamarind very quickly and adversely.
- Deseeded and defibered tamarind, known as "*Phool imali*" at Bastar, can be stored for 6-8 months below 10ºC when packed in high density polyethylene bags. Storability can be extended up to 1 year when "*Phool imali*" is treated/coated with salt.

Fig 4: Sun drying of *Phool imali*

3.3 Processing and value addition

The intrinsic value of raw tamarind can be further enhanced through value addition activities and there is a good market for these processed products both in the domestic as well as in international markets. The SHG members were trained to prepare the following value-added tamarind products:

3.3.1 Tamarind bricks

Deseeded and defibered tamarind is converted in the form of 0.5 to 1.0 kg bricks according to the market demand and requirement. Brick formation is being done in batch wise process using brick making machine. Tamarind bricks or briquettes (Fig. 6) are formed by placing white portion of tamarind manually at outer side and pressure is applied adequately through machine to get compact brick. Finally, the tamarind bricks are wrapped in polyethylene bags for sell. SHGs are fetching INR 85-100/kg by selling tamarind bricks locally at Bastar. Process flow chart for the preparation of tamarind brick is given in Fig. 5.

3.3.2 Tamarind candy

Tamarind candy is prepared by following the process of soaking "Phool imali" in water in the ratio of 3:5 for 6-8 hours. Soaked tamarind is then processed in the pulper machine to prepare smooth and uniform thickness pulp. Total solid content of the pulp is maintained between 37-40°Brix. The prepared pulp is then mixed thoroughly with 300% sugar, 1% salt and 0.1% red chilli powder by cooking in slow flame following continuous stirring/agitation until sugar melts properly. Finally, the prepared slurry is cooled, small balls are prepared manually and rolled the balls on sugar crystals for packaging (Fig. 8). SHGs are fetching INR 350-400/kg by selling tamarind candy locally at Bastar. Process flow chart for the preparation of tamarind candy is given in Fig. 7.

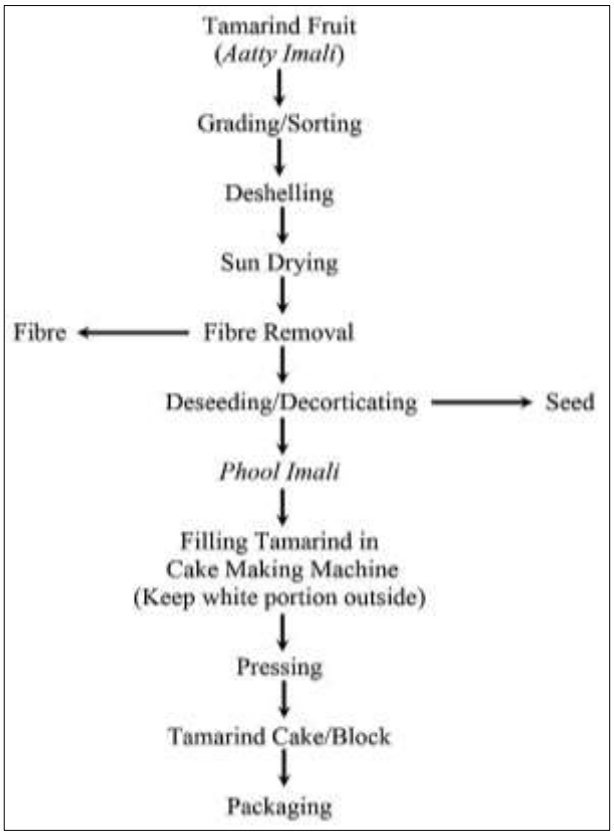

Fig 5: Process flow diagram of tamarind brick preparation

Fig 6: Tamarind brick

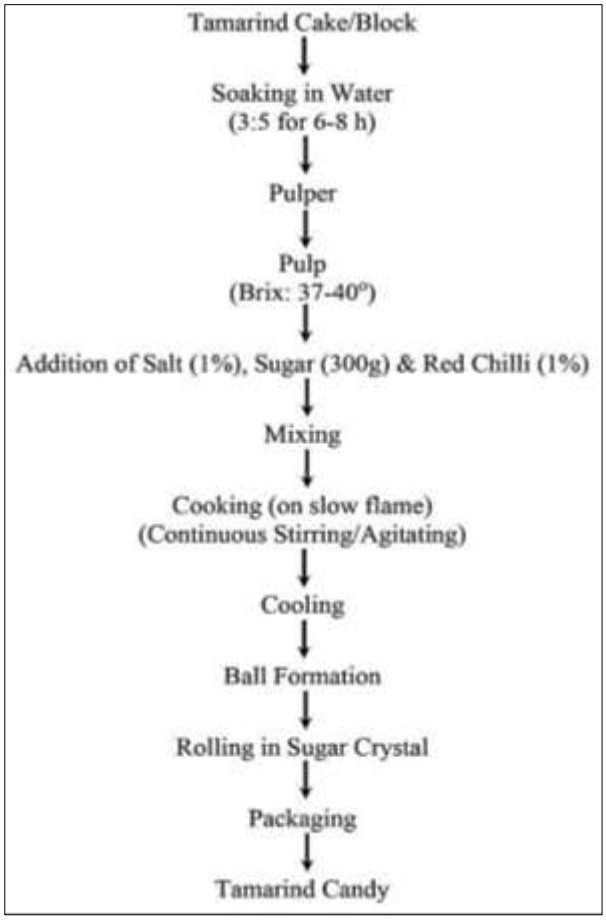

Fig 7: Process flow diagram of tamarind candy preparation

Fig 8: Tamarind candy

3.4 Linking marketing channel

The consolidated initiation of SHGs on value added products like deseeded tamarind bricks and tamarind candy was new ways of self-reliance practices. The Krishi Vigyan Kendra, Bastar also provides the marketing and promotion facility of products through linking up the SHGs by Farmers Produces Organization – Bhumgadi Mahila Krishak Producer Company Limited, Bastar to motivate the involved people for production, processing and value-addition. The impact of improving the SHGs giving support *viz.* financially and technologically boosted the enthusiasm of tribal farmers. Although it is like a deep in ocean yet steps toward self-reliance on own produces.

4. Conclusion

It can be concluded from the study done at various villages of Bastar region of Chhattisgarh that processing and value-addition of tamarind have shown a way for enhancing the economic potential of tribal farmers. Further processing and value addition increased the income of the tribal in many folds. The above-discussed method is very helpful to the farmers by adopting and applying these simple techniques for tamarind-based products processing and thereby increasing the income and improving the livelihood. The large-scale processing unit can also be established in the production catchments with budget availability on a community basis.

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6. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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