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Mahua: A Boon for Pharmacy and Food Industry

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Abstract

Mahua (*Madhuca longifolia)* belongs to family *sapotaceae*, is known for its sweet flowers which possess a lot of ethnic values among the tribal people for the development of various fermented and non-fermented food products. The non-fermented products include *halwa, meethi puri, barfi* whereas fermented products include *mahua daaru* or *mahuli*. Because of its numerous phytochemical attributes traditionally it is also used as a medicine for many diseases including headache, diarrhoea, skin and eye diseases. The present review highlights and explore the composition (dry and fresh flowers), utilization, medicinal and nutritive important along with its future prospective to improve the livelihood of the tribal people with the increase chances of the employment.

Article History

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Keywords

Mahua,
Medicinal value,
Sapotaceae,
Traditional uses,
Value added products.

Introduction

Nature has blessed us extensively with the wide range of diversified plants used for various purposes like decoration, flowering, fruiting and medicinal, etc. Adoption and utilization of medicinal uses of many plants for commercial purposes have become emerging trend among most of the people and because of that, underutilized plants which are being utilized traditionally have gathered potential focus by researchers and industry people. India is known for wide diversity of such plants, which are utilized traditionally and have significance of being commercialized such as *mahua, rhododendron, kachnar, moringa, gulmohar, palash,* etc. *Mahua* is one of those plants which is occupying novel space in the ethnic as well as economical life of the traditional people.

Mahua (Madhuca longifolia) belongs to family *sapotaceae* and finds origin in different regions of India, Sri Lanka, Myanmar and Nepal[1]. It is a multipurpose tree which fulfils three fundamental needs of tribal individuals i.e. Food, Fodder and Fuel[2]. Flowers of plant are edible and have high nutritive value majorly high amount of sugars and subsequently having good amount of vitamins, proteins, minerals and fats[2]. Because of the higher amount of sugar, the flowers are utilized as a

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sweetener in preperation of numerous traditional dishes like *halwa, kheer, meethi puri* and *barfi* in *mahua* production belt of India[3].

India is considered as a treasure of various medicinal and aromatic plant species which are being utilized since ancient time. According to WHO (2003)[4] approximately 65% of the world's population integrate the medicinal plant for treatment. *Mahua* is one of the naturally occurring plants which possess numerous health benefits. Tribal people use *mahua* flowers for curing of skin diseases, headache, pitta and bronchitis[5]. Flower juice is supplemented to lactating women for augmentation of breast milk[6]. Due to the availability for short time at limited places and highly perishable nature of this flower, it is not yet much explored by researchers and food processors except few for its value addition. Therefore, this review has been designed in such a way to focus on recent advancement in utilization of *mahua* flowers as food and medicine and its future prospective regarding its value addition.

Area and Production

Mahua is a frost resistant species that can grow in marginal areas of dry tropical and subtropical forests up to an altitude of 1200-1800 m, in India. It requires mean annual temperature of 2-46^{0}C, mean annual rainfall ranging from 550-1500 mm and mean annual humidity from 40-90 percent[37]. Mahua trees are distributed from India to other Asian countries like The Philippines, Pakistan, Sri Lanka to Australia[7].

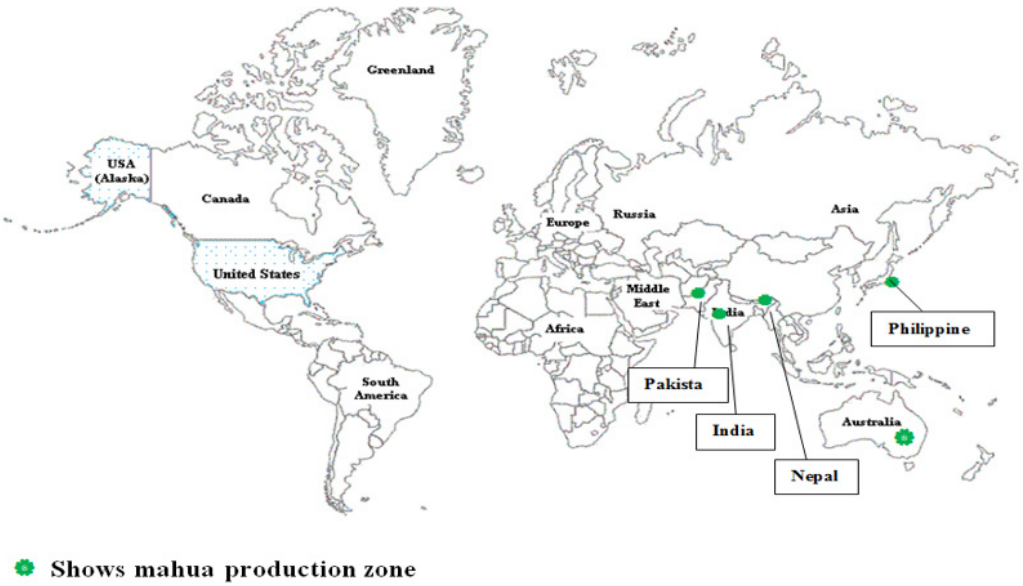

Fig. 1: (a): Distribution of *mahua* tree in world

It can be found scattered in pasture lands in central India, and on river banks in semi-evergreen forests[6]. In India, large quantities of *mahua* trees are found in the states of Uttar Pradesh, Madhya Pradesh, Orissa, Jharkhand, Chhattisgarh, Andhra Pradesh, Maharashtra, Bihar, West Bengal, Karnataka, Gujarat, Rajasthan and the evaluated annual production of mahua flowers is 45000 Million tonnes during[7]. The yield of *mahua* flowers varies from 80-320 kg for every tree[2]. Madhya Pradesh is the most astounding *mahua* developing state with average trade volume of 5,730 metric tonnes and worth about Indian rupees 8.4 million[8]. A complete detail of geographical distribution of *mahua* tree is given in fig. 1 (a, b).

Fig. 1: (b): Distribution of *mahua* tree in India

Composition of Flower

Mahua flowers are rich source of sugars which is responsible for its sweet taste and can be utilized to make indigenous or modern alcoholic beverages. *Mahua* flowers contains good amount of Vitamin-C which is responsible for its antioxidant activity[9]. *Mahua* flower contains carotene which is precursor of Vitamin-A. Flowers also contain good amount of minerals like Calcium and Phosphorus. Few amounts of proteins and fats are also present in *mahua* flowers. Brief composition of *mahua* flower is given in Table 1. Various researches have been done to find out medicinal properties of *mahua* flowers like antihelmenthic, antibacterial, analgesic, hepatoprotective, antioxidant, and anticancer (Table 2).

Table 1: Composition of *Mahua* flower

Sr. No	Constituents	Fresh Flowers	Dry Flowers
1	Moisture	73.6-79.82 (%, d.b.)	11.61-19.8 (%, w.b)
2	pH	4.6	…..
3	Starch (g/100 g)	0.94	…..
4	Ash (%)	1.5	1.4-4.36
5	Total sugars (g/100 g)	47.35-54.06	41.62
6	Total Inverts (%)	54.24	…..
7	Cane sugars (%)	3.43	…..
8	Reducing sugars (g/100 g)	36.3-50.62	28.12
9	Proteins (%)	6.05-6.37	5.62

10	Fats (%)	1.6	0.09-0.06
11	Fibers (%)	10.8	…..
12	Calcium (mg/100 g)	45	0.14-8
13	Phosphorus (mg/100 g)	22	0.14-2
14	Carotene (µg/100 g)	307	…..
15	Vitamin-C (mg/100 g)	40	7

[Source: Gopalan *et al.,* (2007)[10]; Swain *et al.,* (2007)[11]; Hiwale, (2015)[12]; Patel *et al.,* (2011)[2]]

Table 2: Medicinal properties of *mahua* flowers

Medicinal properties	Type of extract	Remarks	References
Hepatoprotective activity	Methanolic	Methanolic extract of flower showed potential protective effect by lowering the levels of SGOT, SGPT, ALP and total bilirubin by increasing serum level of total proteins and albumins.	Umadevi *et al.,* (2011)[13]; Patel *et al.,* (2012)[14]; Yadav *et al.,* (2012) (a)[15]; Mishra and Pradhan, (2013)[24]; Sinha *et al.,* (2017)[5]
Antihelmenthic activity	Both methanolic and ethanolic	Among both extracts methanolic extract of flower demostrated best anti helmenthic activity against Indian earth worm.	Katiyar *et al.,* (2011)[16]; Yadav *et al.,* (2012) (a)[15]; Sinha *et al.,* (2017)[5]
Antibacterial activity	Both aqueous and methanolic	Aqueous extract showed more antibacterial activity than methanolic one for Bacillus subtilis and Klebsiella pneumonia	Verma *et al.,* (2010)[17]; Patel *et al.,* (2012)[14]; Yadav *et al.,* (2012)[15]; Sinha *et al.,* (2017)[5]
Analgesic activity	Both aqueous and alcoholic	Analgesic effect was studied through tail flick, hot plate and chemical graded doses on mouse which shows analgesic effect as per dose value.	Chandra, (2001)[18]; Neha and Rekha, (2010)[19]; Saluja *et al.,* (2011)[1]; Patel *et al.,* (2012)[14]; Yadav *et al.,* (2012) (a)[15]; Amia and Ekka, (2014)[20]; Verma *et al.,* (2014)[21]; Sinha *et al.,* (2017)[5]
Antioxidant activity	……	As concentration of flower extract and ascorbic acid increases, the ferric reducing antioxidant power increases.	Indu and Annika, (2014)[9]
Anticancer activity	……	Cell viability was found to decreases as the concentration of floral extract increases and cytotoxic effect was found to increase.	Indu and Annika, (2014)[9]

(SGOT- Serum glutamic oxaloacetic transaminase, SGPT- Serum glutamic pyruvic transaminase, ALP- Alkaline phosphatase)

Utilization of *Mahua* Flowers

Due to its valuable composition, the flower is used traditionally and is still utilized in value-addition of different products. Figure 2 representing a brief description of various uses (Traditional and Value-addition) of *mahua* flowers.

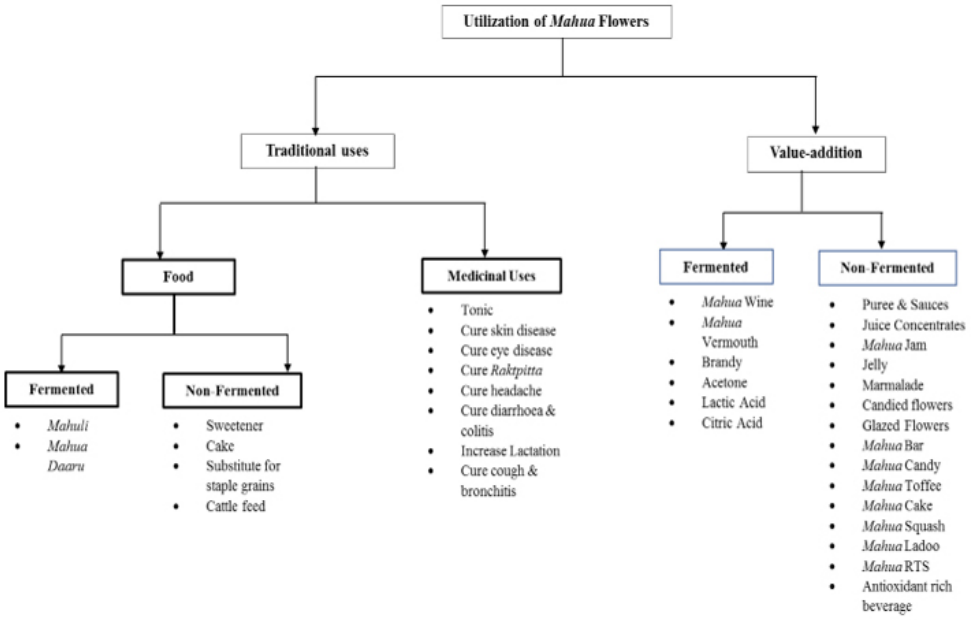

Fig. 2: Utilization of *mahua* flowers

Traditional Uses

Flower bearing period of mahua is March-April, as it is an annual bearing tree. Flower sheds when it gets mature at dawn. Fresh *mahua* Flowers are sweet in taste and contain different phytochemicals. Traditionally, the fresh flowers are collected and dried under direct sunlight for 2-3 days and stored in gunny bags in normal environment.

Utilization in Food Production

Due to high content of sugar (sucrose, glucose, fructose, arabinose, few amount of maltose and rhamnose) tribal people are utilizing *mahua* flowers as a sweetening agent in numerous local and traditional dishes like *halwa, meethi puri, kheer* and *burfi*[3]. Behera *et al.,* (2016)[10] referred that tribal people are also utilizing the *mahua* flowers along with some grains (rice, ragi, jowar) or root crops (sweet potato) for preparing cake. Sundried flowers are boiled with seeds of Tamarind and Sal, taken as substitute of grain staples by poor tribal people[20]. Apart from this, flowers are likewise utilized as cattle feed which helps in improvement of health of cattle and increase in milk production[5].

In term of fermented products flowers are also used as crude material for production of alcohol and alcoholic beverages. Local people of North-West India used to collect and dry the *mahua* flowers for preparation of "*mahua daaru*" which contains 20-40 (%) alcohol[22]. Mahua flowers are mixed with water and kept aside for fermentation. During the fermentation *Navshar* (Ammonium chloride) and jaggery are added. Sometime black pepper is added to develop a strong hot flavour. After fermentation, the mixture is kept in a container having traditional distillation setup. It is reported that one kilogram of dried flowers yields 300-400 ml of daaru by this method[22].

Mahua flowers are also utilized by the tribal people of Orissa to make a Country liquor called *mahuli*[7]. The method of *mahuli* preparation is similar to earlier described method of *mahua daaru* but only the difference found in distillation process and ingredients i.e. at the time of fermentation *bakhar tablets* [Tablet consists of *Asparagus racemosus* (roots), *Cissampleos pareira* L (roots), *Clerodendrum serrautum* (roots), *Dipteracanthus suffruticosus*

(roots), *Elephantopus scaber* L (roots), *Lygodium flexuosum* (roots), *Ochna obtisata* (roots), *Phoenix acaulis* (roots), *Holarrhena pubescens* (bark), *Homalium nepalense* (bark), *Woodfordia fruticose* L (flower), *Xantolis tomentosa* (fruit), *Madhuka* indica Gmel (seeds)] is added[7]. Fermented flowers are kept for distillation and alcohol content which found in distillate is about 30-40 (%)[22]. A brief description of various non-fermented and fermented traditional products is described in Table 3.

Table 3: Traditional uses of mahua flowers

Sr. No	Uses	Key points	Remarks	References
			Non-fermented flowers	
1	As a sweetener	*Mahua* flower used as a sweetener in many dishes like halwa, meethi puri, barfi.	Due to presence of high amount of sugars (sucrose, fructose, arabinose, maltose, rhamnose.	Patel, (2008)[3]
2	Preparation of cake	It is made from *mahua* flowers rice or other cereals or root crops.	Pre-soaked rice and mahua flowers are mixed and grinded, paste is covered with Sal leaves and burned on fire to make cake.	Behera *et al.*, (2016)[7]
3	As a substitute for staple grains	It is generally used by poor tribal people.	Sundried flowers are boiled with seeds of tamarind and Sal and stored.	Amia and Ekkka, (2014)[20]
4	As a cattle feed	Spent flowers (Flowers left after fermentation and distillation) are used.	Spent flowers are fed to cattle, reported improvement in cattle health and increase in milk production.	Sinha *et al.,* (2017)[5]
			Fermented flowers	
5	Preparation of "*mahua daaru*"	Produced from dried *mahua* flowers by	Alcohol content of "*mahua daaru*" ranges from 20-40 (%). tribal people,	Kumari *et al.,* (2016)[22]
6	"*Mahuli*" preparation	Traditionally made by local people of Orissa.	Alcohol content of "*mahuli*" is reported between 30-40 (%).	Kumari *et al.,* (2016)[22]; Behera *et al.,* (2016)[7]

Utilization for Medicinal Purposes

In Ayurveda, *mahua* flowers are considered as to be cooling agent, carminative, galactagogue, and astringent[5]. It is also reported to be beneficial for heart, skin, and eye diseases[20]. *Mahua* flowers are used traditionally as a remedy of many diseases by tribal people. Fresh juice of flower is utilized as tonic and also cure skin diseases, eye diseases, raktapitta and headache due to “pitta”[5]. Sunita and Sarojini, (2013)[23] referred that tribal people offer raw flowers to lactating mothers for increasing their lactation. Roasted flowers are consumed to cure cough and bronchitis by local people[24]. Acharya and Srivastava, (2008)[25] reported that *mahua* flowers can cure impotency and general debility when consumed with milk. Flowers fried in ghee act as a cooling agent and help to cure piles[5]. Table 4 provides brief description of utilization of *mahua* flower as remedy for various diseases by traditional people.

Value Addition of *Mahua* Flowers

Nowadays the researchers and food processors are getting attracted toward the underutilized crops for the development of new products. Because of this few products are developed from *mahua* flowers also. But these are very limited at limited research

institutes, universities, and industries, which might be due to limited availability in limited space and perishability. Some of the possible products which has been prepared from *mahua* flowers by various researchers scientifically are described here in this section which will become a novel approach for researchers and processors to utilize this flower commercially for its value addition in term of fermented foods and nonfermented foods.

Table 4: Traditional medicinal uses of *mahua* flowers

Medicinal Uses	Way of consumption	Remarks	References
Used as tonic	Flower juice	Flower juice having high. amount of protein so it is used as tonic	Mishra and Pradhan, (2013)[2]6; Amia and Ekka, (2014)[20]; Sinha *et al.,* (2017)[5]
Cure skin diseases		Flower juice rubbed on skin for oleation to relieve from itching	Mishra and Pradhan, (2013)[23]; Amia and Ekka, (2014)[20]; Sinha *et al.,* (2017)[5]
Cure eye diseases		Flower juice is used for treatment of eye diseases.	Amia and Ekka, (2014)[20]
Cure Raktapitta		Flower juice is used to arrest bleeding	Sinha *et al.,* (2017)[5]
Cure headache due to "pitta"		Flower juice is used as nasal drops	Sinha *et al.,* (2017)[5]
Cure diarrhoea and colitis	Flower powder	Flower act as an astringent to cure diarrhoea and colitis	Amia and Ekka *et al.,* (2014)[20]; Sinha *et al.,* (2017)[5]
Increases lactation	Raw flowers	Flowers act as a galactogouge which can help in augmentation of breast milk.	Mishra and Pradhan, (2013)[23]; Sinha *et al.,* (2017)[5]
Cure cough and bronchitis	Roasted flowers	……	Palani *et al.,* (2010)[24]; Chandra, (2011)[26]; Mishra and Pradhan, (2013)[23]; Sinha *et al.,* (2017)[5]
Cure impotency and general debility	Flower mixed with milk	……	Acharya and Shrivastava, (2008)[25]; Amia and Ekka, (2014)[20]
Cure piles	Flowers fried in ghee	*Mahua* flower act as a cooling agent to cure piles	Sinha *et al.,* (2017)[5]

Sinha *et al.,* (2017)[5] reported that fresh flower juice is concentrated and used as liquid sweetener in bakery and confectionary products. Fresh flowers are also utilized for making puree and sauces by crushing the flowers[3]. Pulp of ripe flowers can be utilized to make intermediate moisture foods (IMF) like jam, jelly, marmalade[3,5,26].

Recently Orissa University of Agriculture and Technology, Bhubaneshwar have developed many value-added products from dry *mahua* flowers like candy, cake, RTS, toffee, squash and ladoo[28]. Mishra *et al.,* (2013)[29] reported the storage study of *mahua* RTS in combination of ginger and fennel extracts. Other value-added products like candied flower, glazed flower and *mahua* bar are also developed from dried mahua flowers[30].

Because of having high amount of fermentable sugars, *mahua* flowers are utilized for making wine by various researchers scientifically using *Saccharomyces cerevisiae*[22,31-32]. Freshly prepared mahua wine has been fortified with traditional Indian herbs (Black pepper, cinnamon, clove, cumin, fenugreek, nutmeg, fennel and Indian cassia) for development of new value-added product, called *mahua* vermouth[33],. Malavade and Jadav, (2000)[34] reported that dry flowers are also utilized to make

fermented products like brandy, acetone, and lactic acid. Beside that all *mahua* flowers can be successfully used as a substrate for surface fermentation using *Aspergillus niger* for production of citric acid[35]. But in these aspects the availability of the documentation is still very low which need to be explored by the researchers and food processors. The complete detail of the utilization of *mahua* flower recently by various researchers for preparation of value added products is given in table 5 along with them specific remarks.

Table 5: Value-added products of mahua flowers

Sr. No.	Products	Way of Utilization	Remarks	References
			Non-fermented flowers	
1	Puree & Sauces	Fresh flowers	Fresh flowers are crushed into puree after removal of stamens manually and processed to make puree.	Patel, (2008)[3]; Sinha *et al.,* (2017)[5]
2	Juice Concentrates	Fresh flower juice	Used as a sweetener in bakery and confectionary.	Sinha *et al.,* (2017)[5]
3	Mahua Jam	Pulp of ripe flowers	Jam is made with addition of citric acid.	Patel, (2008)[3]; Jha *et al.,* (2013)[27]; Bakhara *et al.,* (2016)[31]; Sinha *et al.,* (2017)[5]
4	Jelly		Combined with guava to reduce astringency of mahua flower.	Sinha *et al.,* (2017)[5]
5	Marmalade		By addition of citrus peels.	Sinha *et al.,* (2017)[5]
6	Candied flowers		……	
7	Glazed flowers			
8	*Mahua* bar			Bakhara *et al.,* (2016)[31];
9	*Mahua* candy			Dash, (2017)[28]
10	*Mahu*a toffee			
11	*Mahua* cake	Dry flowers		
12	*Mahua* squash			
13	*Mahua* ladoo			
14	*Mahua* RTS		RTS blended with ginger extract @ 10 (%) have TSS of 18° Brix and with fennel extract @ 5 (%) have TSS of 14.8° Brix.	Mishra *et al.,* (2013)[29]
15	Antioxidant rich beverage	Mahua flower and Amla juice	The blend showed TPC of 15.94 (mg GAE/ml) and 91.22 (%) DPPH radical scavenging activity.	Patel *et al.,* (2016)[36]
			Fermented flowers	
16	*Mahua* wine	Fermentation of flower juice	Fermentation at 16° C favours wine quality and increase alcohol content (up to 9.9 %). Sensory evolution	Yadav *et al.,* (2009) (a)[31] Kumari *et al.,* (2016)[22]

			reported that addition of yeast during fermentation is acceptable but tannin addition is not required.	
17	*Mahua* Vermouth	Fortification of young mahua wine with spices	Mahua vermouth is having 18.4 (%) alcohol and 1.26 (mg/100 g) tannin. There is no deterioration was found during one year of storage.	Yadav et al., (2012) (b)[33]; Kumari *et al.,* (2016)[22]
18	Brandy			
19	Acetone	Fermentation of dry flowers	……	Malavade and Jadav, (2000)[34]; Sinha *et al.,* (2017)[5]
20	Lactic acid			
21	Citric acid	Surface fermentation of mahua flowers by *Aspergillus niger*	At 14 (%) sugar, 0.07 (%) Nitrogen. level and 4 (%) methanol level, citric acid production was found highest. At this condition, high production of CA found by A. niger NCIM-595 than NCIM-545	Thorat and Patil, (2016)[35]

Economic View

The major factors affecting the quality of *mahua* flowers and their food products, are poor post-harvest storage and lack of modern technologies for the value addition of *mahua* flowers[7]. As a result, the poor tribal people and small local entrepreneurs are facing lots of economic problems due to low profit market of *mahua* flowers and their products. The described value added products in this review, will play an important role for the sustainable development of tribal economy and wellness of local folks.

Conclusion

Due to its multipurpose use it is satisfying the basic need of tribal people in the form of 3F i.e. feed, fodder and fuel because of its vital components and abundant availability in that particular areas. But due to its limited availability at the limited places for the short span only it is still untouched by the processors, researchers and consumers beside those places and particular time. Based on the current review knowledge the quality attributes of the flower are getting deteriorated because of the malpractices followed by tribal people for its preservation. To overcome these issues, there is a strong need for the commercial utilization of this flower along with advance technologies for the development of various valuable food products along with their availability throughout the year, which will definitely help in upliftment of tribal people economy and their sustainable development. A development of efficient technologies and awareness among the tribal people will definitely help in improving the quality attributes of the flower which may help in enhancement of employment and income of those societies.

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