Natural Food Dye
Annatto and its potential in international market

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Introduction

Annatto is a red or orange coloured food dye obtained from the seeds of *Bixa orellana* Linn. (Family Bixaceae). It is known as *Achiote* in Spanish and *Urucum* in Portuguese. It grows throughout South and Central America and Caribbean and is found in some parts of Mexico as well. In India the plants are cultivated to a small extent in Gujarat, Karnataka, Tamil Nadu and Andhra Pradesh. The natural dye has International market and the sustainable cultivation of this plant in tropical regions of India will ensure substantial European market.

The bixin and nor-bixin present in the Annatto dye is useful for colouring food and is employed in food industries in USA, Western Europe and Japan. The traditional major colouring applications have been in hard cheese, butter, and other dairy products. Since it is non-cancerous and non-toxic there is demand for the application of the dye in fish products, salad dressings, confectionary, bakery, ice creams, beverages (colouring citrus juice concentrates, drinks), snack foods, in flour polishes, shoe polish, hair oils, etc.

Indigenous tribes possess rich knowledge of not only the seed but also the other parts of the plant. The seeds are used by these people for painting their body during festivals, for colouring toys, murals, etc. Now-a-days the colouring substance is used in cosmetics. The antioxidant property of the carotenoid pigment is useful in the skin care products as it is capable of giving protection from UV rays. The leaf decoction is used by the indigenous people as a remedy for hypertension and high cholesterol.

Annatto of commerce is the dried seed of *Bixa orellana* Linn., an evergreen perennial shrub or small tree indigenous to Central and South America. It has been introduced widely in tropical regions of India and grows well in southern states. The pigment occurs in the coat of the seed which displays a deep red colour. The principal pigment is bixin, the cis-form of the mono-methyl ether of a carotenoid carboxylic acid (R= CH₃ – bixin; R= H – nor-bixin). Bixin is an oil soluble compound and it is the base of oil soluble products. The dicarboxylic acid nor-bixin that is formed from the saponification of bixin is the main component in watersoluble products. The best quality of seed contains over 3% bixin, but supplies often have only about 2 per cent.


Cultivation

Annatto can adapt to any range of conditions in the tropics and grows well in frost free areas. It is a very hardy plant and does not require high nutritive soils and can be grown on a variety of soil types provided the drainage is good. It thrives best in temperatures ranging between 20-30°C in average rainfall, with a dry season for seed ripening. The Southern states of India are suitable for the cultivation of *Bixa orellana*. Annatto fits well into an agroforestry system provided it is not shaded by large trees. Intercropping can be carried out on plantations in the first one or two years and this assists suppression of weeds besides economic benefit.

Propagation

There are no named varieties in this crop. Propagation is commonly undertaken with seed either sown directly or raised in a nursery. Best time for raising the nursery is during April-May months. The crop also can be raised by stem cuttings preferably by selecting high yielding elite material. Seedlings are raised in nursery beds containing a mixture of soil, sand and organic fertilizer. The seed germinates within a fortnight and after one month these are transferred to polythene bags. The field for raising the crop is given rough ploughing in the early rains. The land is ploughed after rains and shallow pits are dug in ploughed field in 30 cm deep and 30 cm in diameter at distance of 2.5 m from each other both ways. The pits are filled with the well weathered soil from the ploughed field and manured with cattle manure sprinkled with super and neem cake. One year old healthy seedlings that are grown in the bags are planted in the main field in the dug out pits with the onset of rains. For one hectare 1100-1200 seedlings are required.

Artificial fertilizer application is not necessary if the soils are of medium fertility. Weeding is necessary in the first two years. Water requirement is also not high and the plants thrive well with drip irrigation. The plant is hardy in nature and is not browsed by animals nor attacked by pests or diseases of serious nature. The most important operation is pruning in order to produce good canopy. Regular pruning ensures bushy growth having many branches. The tip of each branch produces bunch of flowers. Shaping of the plant is necessary for easy harvest and to prevent disease entering broken branches.

Harvesting

Plants start flowering after first or second year of planting. To encourage good vegetative growth, the flowers are plucked off the first two years. First crop is obtained after two years of planting and plants continue to give economic yield up to 15-20 years under good management. The plants flower in the last week of August and the flowering continues up to middle of October. Seed capsules appear 30 days after flowering and ripen over a further 1-2 months; their colour varies from green to red. Seed capsule production and harvesting patterns vary according to local climatic conditions. After 90 days of capsule formation the maturation starts and the capsules dry up between Feb-March. On maturity the dried capsules make a rattling sound and should be harvested when they commence to split open, before there is a risk of rain and loss by natural dispersal. The entire clusters of ripe capsules are cut with knife or secateur.

Seed yield reaches its peak when the tree is 4-5 years of age and declines after 15 years. There is a variability in seed yield and it is influenced by spacing, growing conditions, management practices and the variety of stock. Yields of dried seed are reported to range from 1500 to 3000 kg/ha/yr for established plantations. For individual tree the seed yield may vary between 1 and 3 kg/yr.

Post harvest treatment

The capsules should be dried after keeping them packed in gunny bags for about 2-3 days. After the short interval the capsules are sun dried for about 3-10 days on mats or concrete barbecues. Artificial driers are introduced to speed up the process and to reduce spoilage. Temperatures of 55-60°C are recommended for artificial drying; over drying should be avoided. Each capsule may contain between 10-50 seeds which are distributed between two valves. In India seeds are separated from the dried capsules by beating them with sticks. After that the seeds are sun dried, cleaned and packed. In Kenya and Peru various machines have been developed to achieve capsule breaking, sieving and winnowing in large scale operations. Sale of the crop should be made as soon as possible since the pigments deteriorate on storage. Clean double jute or Hessian bags (50-70 kg) are employed for export and ocean shipment is carried out in containers (18 tonnes capacity) having ventilation facility.

Extraction of dye

Annatto pods are borne in clusters and the capsules are harvested when they commence to split open. The pods are cut and spread out on mats to
dry in the sun. The seeds are removed mechanically by threshing the dried pods. The particular type of extract employed is dependent on the food product. Water soluble extracts are employed in water-based food products. The extracts contain a mixture of the sodium or potassium salts of nor-bixin. Oil soluble extracts are used in food stuffs containing high fat content. It may contain bixin or nor-bixin or a combination of both in the free acid form. The water soluble dye is imported in the form of aqueous paste or dried powdered products. The oil soluble extracts are sold in dried state or as readily used solutions or suspensions in edible vegetable oils. Solid products contain up to 99% bixin while vegetable oil solutions may be as low as 0.1%.

Two processing methods are used for the manufacture of colouring compounds from the seeds.

**Water soluble products**

The water-soluble fraction is produced by direct extraction of seed with aqueous alkali i.e sodium or potassium hydroxide. The seed is soaked or stirred in dilute alkali in a stainless steel vessel for about 10 minutes at room temperature. The natural bixin in the seed coat turns into a water-soluble salt of nor-bixin. The final extract is acidified with dilute sulphuric acid or hydrochloric acid to precipitate free nor-bixin. The precipitate is dewatered in a filter press to get the paste. It can be marketed as paste by evaporating the water or as a powdered product after dehydration. Bixin is obtained by extraction of seeds with vegetable oil.

**Oil soluble products**

Crude drug is obtained by steeping the seeds in hot water and then filtering and concentrating the extract to a paste. Oil soluble Annatto can be extracted with food grade vegetable oils, normally below 70°C by mechanical abrasions. Bixin crystals are produced by making an extract with an organic solvent hexane, methylene chloride, acetone or alcohol. The extract is concentrated to get the crude crystals. The crystals are sold directly or steeped in vegetable oil.

The processing of Annatto has been fairly well researched and published since the late 1970s in Latin America and especially in Brazil. The research needs are country specific and adaptive. The extract production for the International market depends on the usage in food industries. The dosage levels of bixin/nor-bixin in food products usually ranges from 0.1% to 0.5%. The main competitor for the dye in food application is synthetic beta-carotene.

**Chemical constituents**

The plant contains many phytochemicals, the major ones being bixaghanene, bixein, bixin, bixol, crocetin, ellagic acid, ishwarane, isobixin, nor-bixin, phenylalanine, threonine, tryptophan, salicylic acid and tomentosic acid.

**Market demand**

According to the Natural Resources Institute (UK) estimates major importers of Annatto seed and its extracts are USA, Canada, Western Europe and Japan. Both seeds and extracts are in trade. The total World trade is 7000-9000 tonnes of seed. Peru and Kenya are the major exporters accounting for 80% and the rest is from other countries. From the early 1980s the extract is traded mostly and the water soluble (nor-bixin) type is in demand followed by vegetable oil extracts and with solvent-extracted bixin. Japanese market in particular has grown considerably in recent years since all synthetic or nature-identical colourings are banned in food products. Japan mainly sources Annatto seed and extracts from Kenya. USA is the largest single market for Annatto. It sources over 60% of its requirements from Peru and the bulbs of the reminder from Caribbean region. Western Europe, the UK and the Netherlands are the largest importers of Annatto seed and extracts mainly sourced from Peru accounting for more than 700 tonnes in 1990. The major consumers in Western Europe are the UK and France and they account for 30-40 % of the total European demand. Rest of the world imports are estimated as up to 1000 tonnes in seed.

**Qualities and prices**

There are no published standard specifications for Annatto seed or its extracts, other than the cleanliness requirement of the American Spice Trade Association (ASTA). The moisture content accountable is up to 10% for the seed. The important criterion is the content of bixin and the range from 2.5-3.5 % is considered to be of superior quality. According to traders the Indian seed is considered relatively poor in quality. Annatto trade according to 1988 estimates is about US$ 1,500 / tonne, bixin was valued at about US$ 1000/tonne/1% bixin i.e US$ 30,000/tonne for a 30% extract. Bixin crystals were valued at US$ 107,000/ tonne.
Indian market

In India cultivation started only two decades back. Gujarat and Andhra Pradesh entered into national market but it is highly unorganized and secretive. The collection and harvesting is not up to the mark and seed is also considered of inferior quality where bixin content is below 2%. The Integrated Tribal Development Agency (ITDA) of Government of Andhra Pradesh made efforts to introduce the plants in Araku region of Visakhapatnam. Recently some NGOs in Andhra Pradesh started giving counselling in the cultivation and marketing of Annatto. More than 500 ha are on the line. The trade in India is very little that too with the smaller companies through intermediate brokers or dealers.

Market prospect for new suppliers

There is considerable demand for natural food colourants in the market. Awareness on health and environmental issues has increased significantly over the last few years. The increase in stringent legislation against the use of artificial colours will certainly increase the demand for natural food colourants. The growth of food industry in sectors like readymade snacks, prepared meals, bakery products, etc. has increased industrial demand for Annatto dye. The market will be sustainable only when the supply is stable and qualitative with competitive pricing. This would provide an alternative to the developed country market.

Commercial production

There is greater scope for the export of seed/pigment to European countries. Since it is a tropical plant, the Southern states of India should take up extensive cultivation based on the market demand. Greater care is necessary in selection of good planting stock with high pigment content in the seed. Development of processing industries along with sustainable supply of raw material should be ensured to catch the International market. Good cultivation practices, adoption of good handling methods to avoid post-harvest deterioration is needed to develop the natural food dye industry in India.

Economics of cultivation and income/year *

| Cost of the seedlings                  | Rs 7200.00 (one time investment) |
| Preparation of field                  | Rs 4000.00                      |
| Digging pits (1200 pits)              | Rs 6000.00                      |
| Farm yard manure (25 tonnes) and Neem cake (50 kg) | Rs 5000.00 |
| Planting cost                         | Rs 1500.00                      |
| Irrigation                            | Rs 3000.00                      |
| **Total cost**                        | Rs 26700.00                     |

Approximate Income/year after three years

| Cost of seed (variable) Rs 30-50 /Kg | 1500kg- 3000kg |
| Yield/year/ha after three years     | 1500kg- 3000kg |
| Net income                           | Rs 45000- 75000/ha(minimum income in the National market) |

*Source: Herbal Folklore Research Centre (HFRC), Tirupati, published trade data, interviews with traders and farmers.

References