
ACHIOTE

Bixa orellana L.

A natural food color and dye

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CONTENTS

Scientific name	Chemical action of the dye
Synonym	Common uses
Origin	Industrial uses as dye
Introduction into Guam and Micronesia	Silk
Common names	Wool
Description	Other uses
Climatic requirement	Ornamental value
Soil requirement	Limitation
Propagation	Varietal differences
Planting	Extraction
Fertilizer requirement	Marketing
Harvesting	Imports
Insect pests	References
Diseases	

ACHIOTE

Achiote is a dicotyledonous plant of the Bixaceae (Arnotte) family which has only one genus, *Bixa* L., (Bailey, 1963).

Scientific name: *Bixa orellana* L.

Synonym: *Bixa arborea* Huber.

Origin: Achiote is native to Mexico, Central and Tropical South America and is now naturalized throughout the tropics (Bailey, 1977).

Introduction into Guam and Micronesia: The introduction of achiote in the region is uncertain. According to Fosberg et al. (1979), achiote could have been introduced by the aboriginal inhabitants prior to the landing of Magellan in the year 1521, whereas Moore and McMakin (1979) suggest that it may have been introduced by the Spanish from Mexico.

Common name: The Mexican, Aztec name 'achuete' for achiote still persists (Merrill, 1981). On Guam the local name is achiote (Stone, 1970) or achote. It is also known in different parts of the Pacific as annatto, anatto, achuete, alaea, achiot, apatut, asute, atsuete, chanang, sotis (Brown, 1921) and the 'lipstick tree' (Marie, 1965).

Description: The plant is an ever-green bush or a small tree that grows to a height of 3 to 6 meters, and 10 cm trunk diameter, depending on the soil type and fertility. The bark is light brown and smooth with many warty dots (lenticels). It has orange sap in the inner bark and the twigs are ringed at nodes (Little, Jr. and Wadsworth, 1964). The twigs are green with minute, rusty, reddish brown scales, dark brown as they mature. The alternate leaves are thin, entire, ovate, with pointed apexes, more or less heart shaped with a moderately long petiole, about one-third to one-half the length of the blade. Young leaves have minute scales when young, becoming hairless or remaining slightly scaly

on the lower surface and are green on upper surface and brownish green beneath. The dark to light green leaves are usually 8 to 20 cm long and 5 to 19 cm wide, depending on the cultivar. Sometimes the leaves have reddish veins (Purseglove, 1976).

The flowers are perfect, fragrant, white to light pink in color. They are born in branched terminal panicles on scaly stalks. They are 4 to 6 cm across, resembling wild rose, apple or peach flowers. They are a favorite of honeybees, which pollinate them. The flowers have five calyx lobes, which are imbricate (overlapping), and deci-duous (falling off after the flower opens) which alternate with exterior glands. They have five spreading petals, numerous stamens with yellow anthers, and an elongated stigma with a superior one celled ovary.

The fruits occur in terminal clusters and are flat when young. They are 2-valved capsules, ovoid to somewhat round in shape, conical to heart shaped in some cultivars. They are 3 to 7 cm long and 2 to 5 cm broad. The color of the fruit varies from green through greenish brown to scarlet-red. The mature fruit is a soft-spiny pod which splits into two parts, exposing the seeds while still on the tree. Between the seeds and the outer shell of the capsule is a layer of translucent parchment. The soft spines resemble those of chestnut burs and harden to some extent on drying. The fruit contains 20 to 50 seeds attached to a central core. The seeds are angular, wedge-shaped and are enclosed in the aril (arillate seeds) which is a thin layer of orange pulp. When the fruit matures, the seed dries and the aril is seen as a thin, bright-red covering. The aril is the valuable economic product of the plant. Pigment yield is 5 to 6 % of the seed weight.

Climatic requirement: Achiote requires a frost-free, warm, humid climate and a sunny location. It can grow in wide variety of tropical to subtropical climates and needs little care. In places where rainfall is not distributed equally throughout the year, irrigation may be necessary. On Guam the plant needs little care.

Soil requirement: Achiote grows on almost all types of soils, with a preference for deep, neutral and slightly alkaline soils. It grows into a larger tree when planted in deeper and more fertile soil with sufficient organic matter. However it does well on limestone, where the top soil is only a few centimeters thick and overlies a coral base.

Propagation: The plant can be propagated from seeds or stem cuttings. Seed-grown plants take longer to flower and do so sparingly; they are very tall and exhibit a lot of variation. Plants propagated by stem cuttings, which allows selection of high yielding, rapid growing cultivars, flower early, profusely and bear fruit within two years. The plants are also more uniform in growth and external characteristics.

Planting distance: For commercial production achiote should be planted in rows 4 m apart, and 3 m within the row. Periodic pruning, thinning, removal of dead, dried and weak stems, and balancing the shape of the plant are required to increase economic yield.

Fertilizer requirement: The achiote plant grows easily and normally does not exhibit any nutritional deficiencies. It is usually not fertilized. However, application of nitrogenous fertilizer with a combination of the macro-elements phosphorous and potash, will encourage faster early growth and higher yield. Nitrogen is important for formation of proteins. It is an essential element of chlorophyll, the green portions in plants that manufacture starch and sugars.

Phosphorous is essential for flowering and seed formation. As phosphorous locks up in the soil and becomes immobile it should be applied in excess in deeper layers during initial land preparation. Potassium is usually available in the soil, but soil bound potash is of little use to the plant. Potash is an important catalyst in photosynthesis, helps in the movement of sugars in the plant, plays a role in seed formation, and helps the plant to better utilize nitrogen.

Periodic application of these macro-elements is essential. No information is available on the nutrient requirement of this plant.

Harvesting: The capsules should be harvested after they start turning brown and before they split open. The harvested pods are dried in the shade and threshed by gently beating the pods with a stick. The seeds can then be collected, cleaned to remove dust and other plant parts, dried again and stored.

Insect pests: Insect pests are of minor importance to achiote. The pests present in Micronesia include

- 1) Spiraling whitefly (*Aleurodicus dispersus*),
- 2) Pink wax scale (*Ceroplastes rubens*),
- 3) Transparent scale or Coconut scale (*Aspidiotus destructor*),
- 4) Seychelles scale (*Icerya schellarum*), and
- 5) Red banded thrips (*Selenothrips rubrocinctus*) Stout, 1982.

Diseases: A foliar disease of minor importance, caused by a fungus (*Phyllosticta bixina*), has been recorded for Guam (Russo et al., 1985). In other parts of the world, achiote is infected by powdery mildew (*Oidium bixae*) and another fungus (*Oidium heveae*), which also causes powdery mildew on rubber (Cook, 1975).

Chemical action of the dye: According to Gardner (1912) achiote is more completely soluble in alcohol than water. It is less soluble in solutions of alkali hydroxides and carbonates of borax and soap, forming a liquid of orange red color which produces an orange-red precipitate with acids. It gives orange flakes with alumina (aluminum oxide, Al_2O_3) and ferrous sulphate ($FeSO_4$), a yellowish-brown precipitate with salts of copper, and a lemon yellow with tin salts. Concentrated sulphuric acid dissolves achiote to give a deep blue color which changes to green and violet. Upon adding water a deep green precipitate is formed.

Uses: The main commercial product obtained from the achiote plant is a harmless organic dye called 'bixin' which is a carbohydrate with the chemical formula $C_{28}H_{34}O_5$.

The extract from achiote is commercially called annatto, and is widely used in the food industry for coloring rice, candy, margarine, oils, butter, ice cream and bakery products. It is also used in floor-wax, furniture, shoe-polish, nail gloss, brass lacquer, wood stain, hair oil, lip-stick and soap (Singh, et al., 1983). The dye is used to paint the body as a decoration, and when used this way, it is believed to repel insects.

Use of achiote in the fabric industry: For dyeing cotton, achiote is dissolved in boiling water and a solution of carbonate of soda. The cloth is soaked in it for about 20 minutes, then squeezed dry and washed in acidulated water or alum solution and dried in the shade.

For dyeing silk, a solution is made of equal proportions (by volume) of achiote and sodium carbonate in water (soap is usually added). The dyeing is continued at 50° C for about an hour (longer duration gives a darker color). The color can be made more yellow by passing the fabric through a weak solution of tartaric acid.

Wool is dyed at 80 to 100° C in the water solution of achiote, without addition of other compounds. The dye resists degradation by soap and dilute acids (Brown 1921).

Other products of interest from this plant are the fibers extracted from the bark, which can be used for cordage, and gum, which is similar to gum arabic. The wood from the aged tree makes good firewood. Fire can be created by rubbing the wood. Bulls are fed with extract from achiote before the bull fight, to give extra strength and energy. The seeds and leaves have been used as a domestic medicine.

Ornamental value: The heart-shaped leaf, white and pink flowers, and red pod enhances the aesthetic value of the plant in a home garden or a public park. The plant is beautiful to look at when planted alone in a home garden or in groups in a public park. It requires little maintenance.

Limitation: Presently its use in the dye industry is superseded by chemical dyes. The orange-red color was once extensively used. Demand is once again increasing due to the carcinogenic reports on the use of certain chemical colors and other substances.

Varietal differences: Cayenne achiote is considered to be richest in coloring matter, with 10 to 12 percent of pure dye and about 5 percent ash. In the achiote from Bengal the coloring matter is only about 6 percent (Brown 1921). People on Guam prefer seeds from plants with small leaves and pods.

Extraction: The dye is extracted from seeds by soaking them in water and squeezing to dissolve the aril (on the outer surface of the seed), which contains the dye. It is only partially soluble in water and produces a turbid solution. The solution of bixin is heat concentrated and cooled to form red crystals.

An old method of preparing the dye (Perkin and Everest, 1918), is to thresh out of the mature fruits, collect the seeds, macerate them with water and leave the mixture to ferment. The product is strained through a sieve and the coloring matter that settles out is collected, partially evaporated by heat, then placed in boxes and sun dried. This product is called annatto; it is used in dyeing and in the 'Calico printing' industry (Brown, 1921).

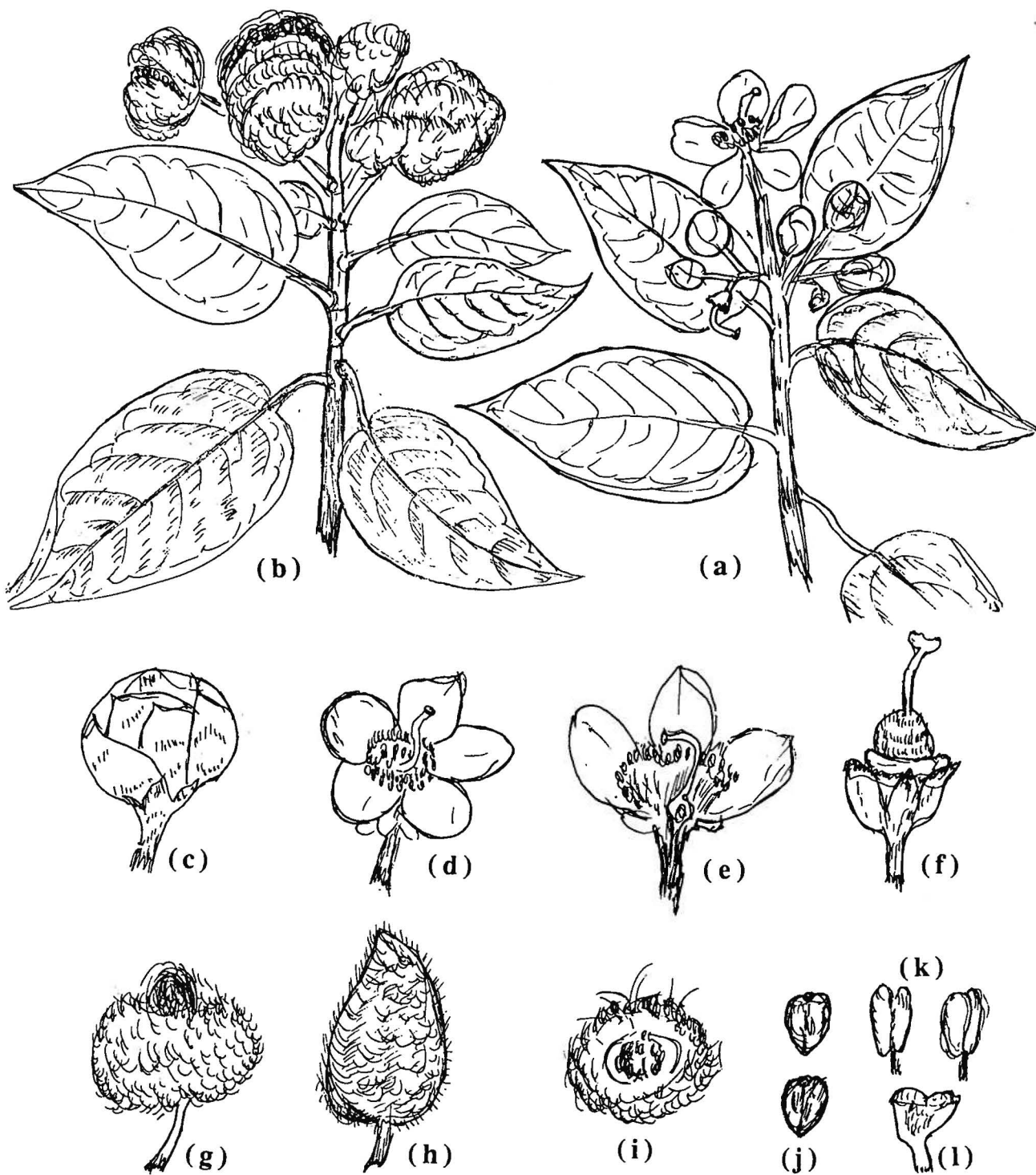
Another method for the preparation of the dye without fermentation, is to wash the pulp out of the capsules and the seeds and then concentrate the extract by drying. This product is called 'bixin' and prized 5 to 6 times more than annatto (Brown, 1921).

Marketing: Achiote is sold as dried whole seeds or as powdered seeds for use in the preparation of traditional food. For industrial use it is sold as cakes. According to Brooks (1910) the annatto supply used in the United States was mostly grown in West Indies.

Import: Presently Guam imports achiote from the Philippines as seed. Imported material has less color compared to the local cultivars, and 3 to 4 times the quantity of seed has to be used for coloring the same quantity of rice.

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Achiote. *Bixa orellana* L.: (a) flowering branch, (b) a branch with fruits, (c) flower bud, (d) open flower, (e) cross-section of the flower, (f) calyx, ovary and base of the style, (g) round fruit, (h) conical fruit (i) cross section of round fruit, (j) seeds, (k) anthers two views, (l) stigma. (Bailey, 1977, Sproat, 1968)

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