Available online at http://www.ijabbr.com

International journal of Advanced Biological and Biomedical Research

Volume 1, Issue 11, 2013: 1302-1308

Cochineal (Dactylopius coccus) as one of the most important insects in industrial dyeing

Hamze Esalat Nejad[1], Ahmad Esalat Nejad[2]

[1] Graduate of Master Textile Engineering, branch Tehran, Islamic Azad University, Tehran, Iran

2 Specializing in the affairs herbal and industrial dyeing crude materials for exquisite carpet weaving, Kashan, Iran

ABSTRACT

Cochineal is the name of both crimson or carmine dye and the cochineal insect (Dactylopius coccus), a scale insect from which the dye is derived. There are other species in the genus Dactylopius which can be used to produce cochineal extract, but they are extremely difficult to distinguish from D. coccus, even for expert taxonomists, and the latter scientific name (and the use of the term "cochineal insect") is therefore commonly used when one is actually referring to other biological species. D. coccus itself is native to tropical and subtropical South America and Mexico. This insect lives on cacti from the genus Opuntia, feeding on moisture and nutrients in the cacti. The insect produces carminic acid which deters predation by other insects. Carminic acid can be extracted from the insect's body and eggs to make the dye. Cochineal is primarily used as a food coloring and for cosmetics.

Key word: Cochineal, dyeing, Dactylopius coccus, wool, carpet

Corresponding Author E-mail: Amir9002001@yahoo.com

INTRODUCTION

Cochineal is primarily used as a food coloring and for cosmetics. After synthetic pigments and dyes such as alizarin were invented in the late 19th century, natural-dye production gradually diminished (Castillo, 1993). However, current health concerns over artificial food additives have renewed the popularity of cochineal dyes, and the increased demand has made cultivation of the insect profitable again. One reason for its popularity is that, unlike many commercial synthetic red dyes, it is not toxic or carcinogenic. However, the dye can induce an anaphylactic-shock reaction in a small number of people (Claps et al., 2001).

Biology

Cochineal insects are soft-bodied, flat, oval-shaped scale insects. The females, wingless and about 5 mm (0.2 in) long, cluster on cactus pads. They penetrate the cactus with their beak-like mouthparts and feed on its juices, remaining immobile. After mating, the fertilized females increases in size and give birth to tiny nymphs.

The nymphs secrete a waxy white substance over their bodies for protection from water and excessive sun. This substance makes the cochineal insect appear white or grey from the outside, though the body of the insect and its nymphs produces the red pigment, which makes the insides of the insect look dark purple(Schiebinger, 2004). Adult males can be distinguished from females by their small size and pressure of wings. The cochineal life cycle was showed in Fig (1).

Fig1.The cochineal life cycle

It is in the nymph stage (also called the crawler stage) that the cochineal disperses. The juveniles move to a feeding spot and produce long wax filaments. Later they move to the edge of the cactus pad where the wind catches the wax filaments and carries the cochineals to a new host. These individuals establish feeding sites on the new host and produce a new generation of cochineals. Male nymphs feed on the cactus until they reach sexual maturity; when they mature they cannot feed at all and live only long enough to fertilize the eggs. They are therefore seldom seen.

Cochineal-infested pads of the cactus Opuntia indicamil.

Dactylopius coccus is native to tropical and subtropical South America and Mexico, where their host cacti grow natively. They have been introduced to Spain, the Canary Islands, Algiers and Australia along with their host cacti. There are 150 species of Opuntia cacti, and while it is possible to cultivate cochineal on almost all of them, the best to use is

Opuntia ficus-indica. Feeding cochineals can damage the cacti, sometimes killing their host (Flores, 2002). Cochineals other than D. coccus will feed on many of the same Opuntia species, and it is likely that the wide range of hosts reported for the former species is because of the difficulty in distinguishing it from these other, less common species.

Farming

There are two methods of farming cochineal: traditional and controlled. Cochineals are farmed in the traditional method by planting infected cactus pads or infecting existing cacti with cochineals and harvesting the insects by hand. The controlled method uses small baskets called Zapotec nests placed on host cacti. The baskets contain clean, fertile females which leave the nests and settle on the cactus to await insemination by the males. In both cases the cochineals have to be protected from predators, cold and rain. The complete cycle lasts 3 months during which the cacti are kept at a constant temperature of 27 °C. Once the cochineals have finished the cycle, the new cochineals are ready to begin the cycle again or to be dried for dye production.

Dyeing

A deep crimson dye is extracted from the female cochineal insects. Cochineal is used to produce scarlet, orange and other red tints too. The coloring comes from carminic acid. Cochineal extract's natural carminic-acid content is usually 19–22%. The insects are killed by immersion in hot water (after which they are dried) or by exposure to sunlight, steam, or the heat of an oven. Each method produces a different color which results in the varied appearance of commercial cochineal(Eastwood, 1984). The insects must be dried to about

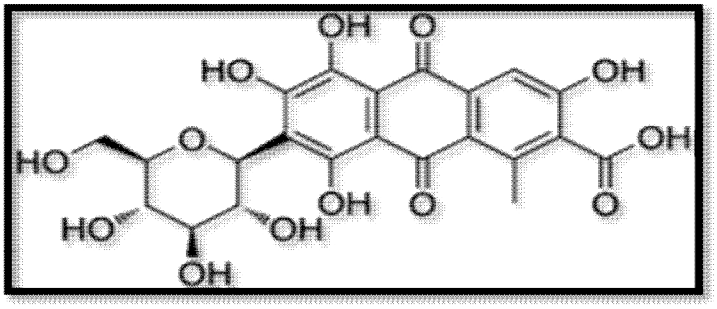
30 percent of their original body weight before they can be stored without decaying. It takes about 155,000 insects to make one kilogram of cochineal.

There are two principal forms of cochineal dye: cochineal extract is a coloring made from the raw dried and pulverized bodies of insects, and carmine is a more purified coloring made from the cochineal (Lillie, 1979). To prepare carmine, the powdered insect bodies are boiled in ammonia or a sodium carbonate solution, the insoluble matter is removed by filtering, and alum is added to the clear salt solution of carminic acid to precipitate the red aluminum salt. Purity of color is ensured by the absence of iron. Stannous chloride, citric acid, borax, or gelatin may be added to regulate the formation of the precipitate. For shades of purple, lime is added to the alum.

As of 2005, Peru produced 200 tons of cochineal dye per year and the Canary Islands produced 20 tons per year. Chile and Mexico have also recently begun to export cochineal. France is believed to be the world's largest importer of cochineal; Japan and Italy also import the insect. Much of these imports are processed and re-exported to other developed economies. As of 2005, the market price of cochineal was between 50 and 80 USD per kilogram, while synthetic raw food dyes are available at prices as low as 10–20 USD per kilogram.

Wool dyed with cochineal

Traditionally cochineal was used for coloring fabrics. During the colonial period, with the introduction of sheep to Latin America, the use of cochineal increased, as it provided the most intense color and it set more firmly on woolen garments than on clothes made of materials of pre-Hispanic origin such as cotton, agave fibers and yucca fibers. Once the European market had discovered the qualities of this product, their demand for it increased dramatically (Ford et al., 1987). Carmine became strong competition for other colorants such as madder root, kermes, Polish cochineal, brazilwood, and Tyrian purple, as they were used for dyeing the clothes of kings, nobles and the clergy (Francis, 2002). It was also used for painting, handicrafts and tapestries. Cochineal-colored wool and cotton are still important materials for Mexican folk art and crafts.so this color can to provide coloring wool for weaving carpets. To produce dye from cochineals, the insects are collected when they are approximately ninety days old. Harvesting the insects is labor-intensive as they must be individually knocked, brushed or picked from the cacti and placed into bags. The insects are gathered by small groups of collectors who sell them to local processors or exporters. Chemical structure of carminic acid, the predator-deterring substance found in high concentration in cochineal insects. The insoluble aluminum and calcium salts of this acid form red and purple dye called carmine.



REFERENCES

Castillo Valadez, J.J. 1993. Relation between some morphological characteristics of {Opuntia} spp. in the breeding of {Dactylopius coccus} C.Universidad Autonoma Chapingo, Chapingo, Mex. (Mexico). Departamento de Fitotécnia .

Claps, L.E. & de Haro, M.E. 2001. Coccoidea (Insecta: Hemiptera) associated with Cactaceae in Argentina. Journal of the Professional Association for Cactus Development.

Eastwood, G.M. 1984. Egyptian dyes and colours. Dyes on Historical and Archaeological Textiles.

Flores Flores, V.I. 2002. Physical-chemical characterization of cochineal {Dactylopius coccus} Costa producer areas in the Andean Trapeze Bar Departments: Huancavelica, Ayacucho and Apurimac, Peru. CACTUSNET NEWSLETTER (FAO International Technical Cooperation on Cactus) .

Ford, G.P., Gopal, T., Grant, D., Gaunt, I.F., Evans, J.G. & Butler, W.H. 1987. Chronic toxicity/carcinogenicity study of carmine of cochineal in the rat. Food and Chemical Toxicity .

Francis, F.J. & Watson, D.H. 2002. Colorants. Food Chemical Safety.

Lillie, R.D. 1979. Red dyes used by ancient dyers: their probable identity. Journ of the Society of Dyers and Colourists.

Schiebinger, L. L. (2004). Plants and Empire: Colonial Bioprospecting in the Atlantic World. Cambridge, Mass.: Harvard University Press. ISBN 0-674-01487-1. p. 44.