Eco. Env. & Cons. 28 (4) : 2022; pp. (1993-1996)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i04.050

By-product Utilization of Eri Silkworm Host Plant Tapioca (*Manihot esculenta* Crantz.): A Review

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Received 8 May, 2022; Accepted 6 July, 2022)

ABSTRACT

Manihot esculenta Crantz., cassava also called tapioca, is a woody tuberous shrub, native to South America. It belongs to the family Euphorbiaceae. The leaves of tapioca plant serve as a secondary host plant in eri culture i.e. rearing of eri silkworm, *Samia ricini* Donovan, particularly practiced in the north-eastern region of India. Besides the utilization of tapioca tubers for human consumption and as feed for animals, the leaves and tubers of this wonder plant can be used for diversified purposes as in food industry, pharmaceuticals, textile industry, cosmetic industry, explosive industry, paper industry, etc. The ethyl acetate extract of cassava can be used as a potential grain protectant against red flour beetle *(Tribolium castaneum)* and rice weevil (*Sitophilus oryzae).* Tapioca is not only of low cost but also serves as a wonder plant for sustainable future. The use and exploration of tapioca has much more vivid scope besides its utilization in eri silkworm rearing. In tapioca producing regions of India, tapioca can be utilized for dual purpose of eri silkworm rearing and for other industrial products which will help to grow tapioca based industry. It will also help for the sustainable development of eri silkworm rearers. Indigenous traditional knowledge (ITK) strongly proves that tapioca plants are endowed with pesticidal properties that can be widely explored in agriculture and related fields. Therefore, this article strongly supports and highlights the use and exploration of tapioca in various agricultural and industrial practices.

Key words: *Eri silkworm, Food plant, Human consumption, Sustainable, Tapioca*

Introduction

North-eastern region of India is the chief producer of eri silk (Anon., 2021a). The eri silkworm, *Samia ricini* Donovan (Lepidoptera: Saturniidae) is a polyphagous insect. Eri silkworm feeds on a number of plant species. Tapioca or cassava (*Manihot esculenta* Crantz.) is a secondary food plant of eri silkworm (Chowdhury, 2006). Tapioca has been found to be equally suitable for large scale eri silk production and also feasible for additional remuneration to about 1.6 lakhs tapioca growers in the country, mainly in southern states including Tamil Nadu, Kerala and Andhra Pradesh (Sakthivel, 2012). Chowdhury (1982) reported that tapioca leaves containing less cyanogenic substance is preferred by eri silkworm. Borgohain *et al.* (1987) and Dutta and Kalita (1997) reared eri silkworm on different varieties of tapioca viz., H-2304, CO 1, H-1423, M-4 etc. Joshi (1985) and Govindan *et al.* (1992) reported that eri silkworm can be reared on castor leaves up to 3rd or 4th instar and subsequently on leaves of cassava without compromising the yield and qualitative character.

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Tapioca was introduced to India by the Portuguese in the Malabar region of Kerala during the 17th century from Brazil. Nigeria is the highest producer of cassava tuber in the world. Kerala is the largest producer of tapioca in India. A few cassava varieties developed by CTCRI, Thiruvananthapuram, Kerala are: H-97, H-226, Sree Sahya, Sree Jaya, Sree Harsha, Sree Spoorva, Sree Pavithra, Sree Prabha, etc.

Tapioca (*Manihot esculenta* Crantz.) or (*Manihot utilissima* Pohl.) belonging to the family Euphorbiaceae is also commonly known as cassava, simalu alu, Brazilian arrowroot, manioc and yucca. It is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world like Asia and Southern Africa (Yefriadi *et al.*, 2020). It grows well in laterite sandy loam or red loam soil. The optimum range of pH required to grow cassava is 4.5-6.5. The genus *Manihot* is reported to contain various toxins such as acetone, hydrocyanic acid, oxalic acid, saponin, and tryptophan (Kirtikar and Basu, 1935). It grows wild in hills and also in plains. The cassava plant grows to a height of 1-3 m with erect stems and spirally arranged simple leaves of 5-10 lobes with petioles. It produces flowers on a raceme. It has broad, shiny leaves which roughly resemble the shape of a human hand. It has attractive white and pink flowers. Tapioca can be propagated through stem cutting. The tubers of tapioca are usually cylindrical, tapered and brown in color and can be harvested 5-12 months after planting. Tapioca is not suitable for ericulture in all seasons especially in autumn. Besides using the tapioca leaves for rearing eri silkworm, the leaves and tubers can be utilized for production of various products. Recently, The Eri Silk Development Project was inaugurated by Smt. Smriti Irani, the Minister of Textiles, Govt. of India, which aimed at utilization of tapioca plantation for dual purpose, i.e. the tuber for food and the leaves for eri silkworm.

Cassava cultivation is an entry point for employment and income creation for small farm owners and landless farmers as well as for countless processors and traders worldwide. Cassava thrives in poor soils with unpredictable rainfall; thus, it is an ideal crop to grow on marginal lands where cereals and other crops have limited or no options to succeed. In most parts of the tropics, cassava production is now labor intensive and subsistence-oriented, with low levels of technology uptake, high production costs and postharvest losses, and weak linkages to markets, despite being a feedstock for numerous industrial applications, including food, feed, and starch (Anon., 2019). This article highlights the diversified purposes of tapioca in the present day context.

Food: Many varieties of tapioca which can be divided into two groups: sweet and bitter tapioca are cultivated in the tropics for their starchy, tuberous roots. Among the staple crops, tapioca is the highest producer of carbohydrates. Cassava root contains more than 80% starch and is rich in vitamin C, carotenoids and minerals. The very low protein and lipid content is an important factor which differentiates tapioca starch from cereal starches (Charoenthai *et al.*, 2018). The small amount of phosphorus present in tapioca starch is partially removable and therefore, not bound as the phosphate ester as in potato starch (Shigaki, 2016). According to United Nations Food and Agriculture Organization (FAO), tapioca ranks fourth in food crop in developing countries after rice, maize and wheat (Krishnakumar, 2019).

Fig. 1. Tapioca plant

The most popular processed products of tapioca are known as "Gari", a dry granular meal made

from moist and fermented cassava, "lafun" a sun-dried cassava product and "foufou", which is a sticky or heavy soup made from fermented cassava. In Tanzania, peeled roots are usually sun-dried for one or two weeks and subsequently processed into storable products called "makopa", "kivunde" or "kondowole". Other methods use fermentation to enhance mould growth in products such as "nyange" and "bada"(Anon., 2021a). In other countries, cassava is commonly consumed in the form of flour, called "attiéké" and "chickwangue". Dried cassava can also be stored and subsequently milled or pounded into flour for making stiff porridge and consumed with different relishes such as meat, fish, beans, green leafy vegetables and cassava leaves (Anon., 2021a).

Pesticide: Recently, the ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram has developed potent bio-pesticides against certain sucking and borer pests of horticultural crops by isolating the insecticidal molecules from cassava leaf. The ethyl acetate extract of *Manihot esculenta* could be used as a potential grain protectant against *Sitophilus oryzae* (rice weevil), the most common and destructive pest of stored grains (Thambi and Cherian, 2015) and *Tribolium castaneum* (red flour beetle), a worldwide pest of stored products, particularly food grains (Cherian and Thambi, 2017). Botanical materials are not only of low cost but also have no hazardous impact on the environment as insecticides.

Industrial products: Tapioca starch is widely used in several confectionery industry as thickeners, gelling agent, strengthening foam apart from using as film forming and glazing. Low viscosity tapioca starch is used in the preparation of jellies and gums. While casting, powdered starch is used as a mould release. Sucrose can be replaced by tapioca starch in beverages. Tapioca starch has no taste or smell. So, adding color, flavor, eggs, milk, cream and sweeteners can be used in a variety of products especially sweets (Herceg *et al.,* 2013). Many value added products of commercial importance are produced using cassava such as starch, sago, chips, flour etc. Besides these, tapioca starch is also used in many non-food industries. In explosive industry tapioca starch is used as binding agent. Paper industry also utilizes tapioca starch for filler retention, internal sizing, surface sizing and paper coating. Also, it is used in the production of diapers and women sanitary products. In construction industry, tapioca starch is used to bind concrete block, clay, limestone, plywood and also as paint filler. Tapioca starch is used in dry cell batteries, leather finishing, and printed circuit boards also. From this starch, ethanol is also made that is used as a fuel. Seven hundred twenty litres of ethanol is produced from 1 ton of tapioca starch (Edison *et al.,* 2006).

Textile Industry: The starch of tapioca is extensively used in many textile processes such as during sizing of yarn, finishing cotton as well as polyester fabrics and producing textile during its process of mixing, printing and finishing. Also it makes the colors of the fabric very sharp and durable (Edison *et al.,* 2006).

Pharmaceuticals: Tapioca starch can be used as diluent, binder and disintegrant in tablet and capsule formulations. Tapioca starch is used in Paracetamol tablets, Diclofenac sodium tablets and Ibuprofen 400 mg tablets for less friability and fast disintegration time. Few modified tapioca starches are: Carboxymethyl tapioca starch, acid-modified tapioca starch, cross-linked tapioca starch, enzyme-catalyzed tapioca starch, grafted tapioca starch, pregelatinized tapioca starch, hydroxypropyl tapioca starch (Charoenthai *et al.,* 2018).

Tapioca contains cyanoglycosides, linamarin, lotaustralin and methyl linamarin. The leaves of tapioca are used to cure measles, small pox, chicken pox, skin rashes, etc. The leaf sap latex is used for eye condition, rheumatism; fresh rhizome can be applied to ulcers. Leaves are also used for headaches, colds, fever and to treat constipation. It can also used in the treatment of ringworm, tumor, conjunctivitis, sores and abscesses. Amino acid present in cassava leaves are helpful in wound healing of the skin, replacing damaged cells, bone health, enhancing memory power and help in the body's metabolic system (Rahalison *et al.,* 1993). Chlorophyll present in the leaves serve as antioxidants and anticancer agents (Thambi and Cherian, 2015).

Fodder: Cassava leaves are used as animal feed. Tapioca tuber is also increasingly used for animal feed. The tuber can be processed or ground to produce manioc or tapioca meal (Brazilian arrowroot), which is used as animal fodder (Krishnakumar, 2019). Roots and leaves are fed mainly to pigs in the cassava producing areas, either fresh or cut and dried. Cassava chips are also fed to cattle and poultry (Anon., 2021a).

Conclusion

Plant- based products are cheap and biodegradable and are therefore environmental friendly. Thus, it can be said that tapioca holds a massive opportunity to be better explored by doing vigorous research and detailed chemical analysis for the active compounds present in it and by understanding the mechanism involved in its role in management of field crops and stored grains.

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