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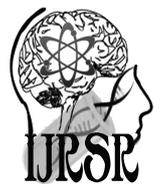
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Review Article

MULBERRY AND SILKWORM AS A HEALTHY FOODSTUFF – A REVIEW

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ABSTRACT

The bulk of the commercial silk produced in the world is mulberry silk that comes from the domesticated silkworm *Bombyx mori* L. which feeds solely on the leaves of the mulberry (*Morus* sp.) plant. In addition to the major utilization of mulberry leaves as silkworm feed, it is being used for many other purposes such as animal feed, nutritional and medicinal uses. Mulberry is a powerhouse of nutrients and is an excellent source of protein. Mulberry is rich in protein and also rich in poly-nutrients like anthocyanin, flavonoids, lutein, zeaxanthin, beta-carotene and alpha carotene. The growing mulberry leaves contain 6 – 6.8% crude protein. Vitamin A, B, C and D are also found in mulberry leaves. Especially they are rich in vitamin C. In addition, mulberry leaves contain 4% soluble carbohydrates, 0.6% crude fat and several compounds of calcium, phosphorus, silicon, manganese, magnesium, iron, copper, zinc etc., are found in mulberry leaves. Hence, mulberry leaves satisfy the dietary requirement of human beings and contain all the elements required for the body.

Silkworm and pupae provide a source of human food. Their nutritional values are astonishingly high, containing large quantities of proteins, fats, carbohydrates and vitamins. It appears that silkworm pupae have a high dietary value, much more than fish and other animal proteins and on par with meat from various animal sources. The fleshy larvae, prepupae and pupae of non-mulberry silkworms such as muga, tasar and eri are preferred as food by Garo, Mikir and Khasi tribes of India. They are in high demand in local markets of North-Eastern states. In view of the above the paper highlighted the nutritional significance of mulberry and silkworm as a healthy foodstuff.

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INTRODUCTION

Mulberry is a hardy plant belonging to family Moraceae. It is distributed in tropic, sub-tropic and temperate regions of the world. Mulberry can be grown as a tree and also can be trained as a bush for the purpose of cultivation. There are more than half a dozen *Morus* species distributed in different ecological areas. Mulberry is a powerhouse of nutrients and is an excellent source of protein. Mulberry leaf is commonly used for sericulture in almost every part of the world but its potential to be utilized for human consumption is not well recognized.

Silkworm *Bombyx mori* is a lepidopteron insect and completely domesticated tiny insect with economic significance. The larvae are caterpillars, which, at the end of the larval stage, spin a cocoon of silk, and transform into pupae and finally into adult moths. The silk proteins are synthesized in the silk glands. A tiny cute worm is the basis of the silk industry, which is providing livelihood for 7.9 million people in India in various stages of the production process. Silkworm is a good source of protein, fat and minerals. The pupae are the storehouses of fats and proteins.

The modern interest on the cultivation of mulberry and use of silkworms for non-textile uses has been started due to search for alternative uses of mulberry, once the sericulture decayed due to industrialization and competition from foreign countries in case of Japan and Italy (Machii 2000 and Cappellozza 2000). In addition to the major utilization of mulberry leaves as silkworm feed and silkworm for silk production, they have many excellent and beneficial functions to do. This has opened a new vista to think about other uses such as: medicinal and nutritional significance of mulberry and silkworm. With this background, the authors reviewed the nutritional significance of mulberry and silkworm for the human consumption.

Mulberry for Nutrition

Mulberry leaf is rich in protein calcium, iron, phosphorus, potassium, carotene and vitamins. The amino acids found in mulberry leaves are aspartic acid, methionine, threonine, lysine, arginine, histidine, leucine, proline and tryptophan. The utilization of mulberry in food industry is very well-established in South Korea and China. The leaves and leaf powder are utilized for preparation of various products to supplement human diet viz., noodles, biscuits, bread, baked bread, bean

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curd, broth, bukumi, cake, yogurt, sauce, salad, omlet, cookie, pudding, ice creams etc. In India, there are reports of mulberry leaf being utilized in food preparation like, curry and parothas. The fresh and healthy mulberry leaves along with tender twigs are utilized for preparation of recipes viz., idly, dosa, parotha, chapatti and other bakery items like cakes and biscuits.

In India, the major nutritional problems are protein energy malnutrition, vitamin A deficiency and anemia. Protein is an essential component of human tissues including body fluids. Sources of animal origin like milk, egg, meat and fish are expensive for supplementation because of their inadequate production and hence, vegetable proteins of conventional sources can be used for most of our protein requirement. Of the non-conventional sources, leaf protein can be best exploited. The advantages of using mulberry as protein source are, high protein and low fibre content, succulency, high extractability, low mucilage, low anti-nutritional factors, easy cultivation and availability of leaf through-out the year under varied agro-climatic conditions.

Mulberry leaf tea is rich in a variety of nutrients and trace elements that are beneficial to the human body and it is 100 percent caffeine and tannin free. Mulberry tea is great for refreshment and for health. Mulberry leaf tea is quite simply one of the best things, one can consume for health. Recently Thai and Japanese scientists found that mulberry has nutritional value and vitamins which give more advantages than just a nice tea to drink. To use mulberry green tea for health, it needs to be of a good quality, color, fragrance, in addition to a satisfying taste. The organic mulberry tea is used to cure hypertension, hyperlipidemia and hypercholesterolemia. Drinking mulberry green tea reduces the risk of hardening of the arteries causing heart attacks and increases blood circulation and flow of other liquids of the body, i.e. lung, stomach, intestines, kidney and the urinary tract. The health drinks/green teas prepared from mulberry are popular in Japan, China, Thailand and South Korea. Mulberry leaves contain antioxidants that help the body to detoxify harmful excess free radicals. Antioxidants promote heart health and help to combat and guard against diseases like diabetes, blood pressure, intestinal problems and others. In East Asia mulberry leaf tea is known as a possible aid to decreasing cholesterol, hypertension and the control of blood sugar levels. Powerful glucose blocking agents prevents the body from absorbing many common sugars so it's a great aid to manage diabetes and also weight loss. Additionally mulberry tea is chock full of antioxidants, which are key in strengthening the immune system and in reducing the bad cholesterol.

Mulberry fruit

Mulberry bears delicious fruits, which are popular in many countries of the world. The mulberry fruit colour varies from white to pinkish white, purple or dark purple to black. Mulberry fruits are edible and well known for its delicious taste. The fruits of the mulberry are sweet and soft. Because of their sweetness, they are of little value for culinary uses. They can be consumed directly or can be used in the preparation of wine, jam or soft drinks. Fresh, ripe mulberry fruits contain 85-88% of water, 7.8-9.2% carbohydrate (sugars, mainly glucose and fructose), 0.4-1.5% protein, 0.4-0.5% fat (mainly fatty acids, such as linoleic, stearic, and oleic acids in the seeds), 1.1-1.9% free acids (mainly malic acid), 0.9-1.4% fiber and

0.7-0.9% minerals. Besides using directly and as juice, fruits are also used in preparation of jam, jelly, squah and wine. In India, many commercial products of mulberry fruits are marketed at Panchagani, Maharashtra.

“Da 10” is the most popular mulberry fruit variety, which is planted in Zhejiang, Guangdong and Jiangsu provinces of China (Ye 2001). Mulberry fruit research has become more active in the Sericulture Research Institute of Yunna province, China is utilizing many species in cross breeding for fruit production, the result of which is DL- number 1 (Chu *et al* 2001). Mulberry fruits have many excellent characters like nice taste, attractive color and high nutritive and medicinal values. Fresh mulberry fruits are rich in amino acids, vitamins and minerals, such as Zn, Mn, Fe, Ca that are indispensable for the human body, in addition mulberry fruits also rich in pectin and fibrin. Ascorbic acid content is as high as 20mg/100g in fresh fruit (Chu *et al* 2001). Fruits can be used as coloring and flavoring agent (Shiva Kumar *et al* 1996). Fruits are eaten fresh and used for pickle preparation too. It contains malic acid, citric acid, pectin, mucilage and a coloring matter. In addition, mulberry leaf and fruits are also eaten as fresh or dried vegetable or mixed in confectionery stuff as noodle, soybean curd, cakes, ice-cream, yogurt, beverage, wine, rice-cake etc.

Silkworm

Silkworms are lepidopteron insects. The larvae are caterpillars, which, at the end of the larval stage, spin a cocoon of silk, and transform into pupae and finally into adult moths. The tiny insect is an engine to convert plant protein into animal protein to yield proteinaceous silk fibre, the basis for entire sericulture industry. In addition, silkworms are a high source of Calcium, Protein, Iron, Magnesium, Sodium, and Vitamins B1, B2, and B3. Silkworm and pupae provide a source of human food. Their nutritional values are astonishingly high, containing large quantities of proteins, fats, carbohydrates and vitamins. In countries like Hong-kong, China, Korea and Japan, the healthy silkworm larvae are sterilized and vacuum dried and sold as commercial food. Silkworm in powder form is used as a common source of animal protein in soups and sauce preparations. It is used in special diets for cardiac and diabetic patients because of its low cholesterol content. With the production of silkworm powder, the sericulturists can earn 5 times more income than the conventional cocoon production.

It appears that silkworm pupae have a high dietary value, much more than fish and other animal proteins and on par with meat from various animal sources. The fleshy larvae, prepupae and pupae of non-mulberry silkworms such as muga, tasar and eri are preferred as food by Garo, Mikir and Khasi tribes of India. They are in high demand in local markets of North-Eastern states. Like many insect species, silkworm pupae are eaten in some cultures. In Assam, pupae are boiled for extracting silk and the boiled pupae are eaten directly with salt or fried with chilli pepper or herbs as a snack or dish. In Korea, they are boiled and seasoned to make a popular snack food known as *beondegi*. In China, street vendors sell roasted silkworm pupae. In Japan, silkworms are usually served as a *tsukudani*, i.e. boiled in a sweet-sour sauce made with soy sauce and sugar. In Vietnam, this is known as *con nhông*. Silkworms have also been proposed for cultivation by astronauts as space food on long-term missions.

The inner layer of the silkworm cocoon shell is known as pelade, has now become a valuable ingredient of human food in China and Japan. Pelade can be obtained from the reeled cocoons after removing the pupae. Chemically, it has the same properties of silk. One Kg. of pelade is obtained from about 10 kgs of reeled cocoons. This product is used in protein and amino acid extraction. Being proteinacious in nature, it is found quite effective in overall development of the human body.

Obviously mulberry and silkworms are important components of good nutritive diet for human consumption without side effects. Appropriate utilization of mulberry leaf and silkworm offers wide scope to check malnutrition especially in the sericulture tract in addition to economic empowerment of sericulturists. However, this needs special attention for the future endeavours and still there is a vast scope to explore the tiny insect for the welfare of the mankind in different dimensions.

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