

Plant Based Nutraceuticals Efficacious in Protein Energy Malnutrition (PEM), Especially in Children

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ABSTRACT

Malnutrition is a dietary condition caused by deficiency or excess of one or more essential nutrients in the diet. It is characterized by a wide array of health problems, including extreme weight loss, stunted growth, weakened resistance and impairment of intellect. Severe cases of malnutrition can lead to even death. Children suffer from the effects of starvation more quickly than adults. According to the United Nations Children Fund (UNICEF), malnutrition contributes to the death of more than six million children under the age of five each year. Typically starving children develop a condition called PEM (Protein Energy Malnutrition). According to Hudson et al. (2000), PEM is defined as an unintentional loss of 10% or more of body weight in a period of six months or less and/or serum albumin levels of less than 3.5 grams per decilitre (g/dl). The two most common forms of PEM, Marasmus and Kwashiorkor, occur in all developing countries and are life-threatening conditions. Marasmus occurs when a child is weaned earlier than normal and receives foods low in nutrients. The child may also suffer repeated infections such as gastroenteritis due to poor hygiene. A child with Marasmus is very underweight, with no body fat and wasted muscles. Kwashiorkor occurs when a child is weaned later than normal and receives starchy food low in protein. In this disease, the child's abnormally low body weight is often masked by water retention, which makes the face moon shaped and the belly swollen.

Keywords: Protein Energy Malnutrition, Nutraceuticals, Marasmus, Kwashiorkor.

INTRODUCTION

In the present health scenario, PEM is a significant threat to health, especially among the children of developing countries. Animal proteins are relatively expensive, available in short supply, and consumed by non-

vegetarians only. Hence, herbal nutraceuticals can play a vital role in treating PEM diseases. Recent research has revealed that some algae and mushrooms are highly proteinaceous and might be used as protein sources.

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Good nutrition is the basic concept of health. Malnutrition is widely prevalent in many parts of the world and is one of the day's most significant international health problems. Its association with infection, its complex links with fertility, family size, mental growth and development, and the body's immunity mechanism are new dimensions of malnutrition.

Food is the chief source of essential nutrients which the body needs for its well being. The dietary constituents of the food are proteins, fats, carbohydrates, vitamins, minerals and water. The food's main functions are providing energy, bodybuilding and repair, maintenance and regulation of tissue functions.

One of the important constituents of food is protein. Proteins are complex nitrogenous compounds composed of carbon, hydrogen, oxygen, nitrogen and sulphur in varying amounts. Proteins are necessary macronutrients of food that supply essential and non-essential amino acids needed for tissue growth, repair and maintenance (Singh et al., 2017). According to Donald (2009), every adult requires a minimum of 30 gm of protein on a daily basis just to maintain healthy muscles and bones. There are two main dietary sources of proteins - animal sources (eggs, milk, meat, fish etc.) and plant sources (pulses, cereals, nuts, beans, oil seeds etc.).

In the present health scenario, protein energy malnutrition is a great threat to health, especially among children of developing countries. Plant based protein sources dominate among all the prevailing sources of dietary protein (57%), while the remaining 43% consists of meat (18%), shellfish and fish (6%), other products from animals (9%) and dairy products (10%). Animal proteins are relatively expensive and in short supply, and on religious grounds also, certain communities in India avoid animal protein. Hence, the plant becomes the main protein giving the source for Indians.

PROTEIN ENERGY MALNUTRITION

Protein energy malnutrition is a major public health problem in India. It is measured in

terms of being underweight (low weight for age) and wasting (low weight for height). The prevalence of stunting among under five is 48%, and wasting is 19.8%, with an underweight prevalence of 42.5%. It is the highest in the world (Bhutia, 2014). PEM occurs frequently among infants and young children between one to three years of age. The most serious forms of PEM are Marasmus and Kwashiorkor. The Indian Council of Medical Research indicates that PEM is prevalent in all the states of India. The basic etiological features of PEM are –

1. Inadequate diet both in quality and quantity. This is basically due to poverty and ignorance.
2. Infectious and parasitic diseases like diarrhoea, respiratory infections, loss of immunity power etc. In fact, it is a vicious circle-infection of contributing to malnutrition, which contributes to infection by weakening the child.
3. Other contributing factors in the web of causation - persistent regurgitation or vomiting, anorexia, malabsorption e.g. small intestine disease, increased basal metabolic rate e.g. Hydrotoxicosis, prolonged infections, trauma, illness, poor maternal health, failure of lactation, premature termination of breast feeding etc. Two types of severe malnutrition are there, but many cases show features of both types (Kwashiorkor and Marasmus). Marasmus is more common than Kwashiorkor.

MARASMUS - this refers to severe undernutrition in infants or young children. The cause is a diet deficient in energy, protein and essential nutrients. Typically it is a disease of infants of poor parents living in the cities of developing countries. The combination of malnutrition and poor hygiene predisposes gastroenteritis, further depleting the child's energy resources. The abdomen shows gaseous distensions, and diarrhoea is usual.

In contrast to Kwashiorkor, there is no oedema, and skin and hair changes are mild or absent. The child often appears alert.

Marasmic children usually have a voracious appetite.

KWASHIORKOR - This type of malnutrition occurs most often in the second stage of life in a child weaned from the breast onto a starchy diet deficient in protein or cereal that has been refined and diluted. Two essential clinical features of Kwashiorkor are that the growth is markedly retarded, and the dependent parts are oedematous. Acute protein depletion mainly affects the liver, pancreas and gut.

MANAGEMENT

The principles of management are -

1. Adequate - The aim is to supply what has been lacking in the diet, viz., energy and proteins.
2. Treatment of infections.
3. Health education of parents and others taking care of child as to how to prevent and relapse.

As a general rule, the child's diet should be something the family can afford, and the herbs prove cheap and easily available.

The protein content and calories of some common proteinaceous herbs is as follows (per 100 gm edible portion) -

SOURCES	PROTEIN CONTENT	CALORIES
(A) PULSES		
1. <i>Cicer arietinum</i> (Bengal gram / chick pea)	22.2	360
2. <i>Vigna radiata</i> (Green gram)	24.0	334
3. <i>Lens culinaris</i> (Lentil)	25.1	343
(B) NUTS AND OIL SEEDS		
1. <i>Arachis hypogea</i> (Groundnut)	25.3	567
2. <i>Cocos nucifera</i> (Coconut)	18.3	662
3. <i>Glycine max</i> (Soyabean)	43.2	432
4. <i>Sesamum indicum</i> (Til)	18.3	569
(C) CEREALS		
1. <i>Zea Mays</i> (Maize)	11.1	342
2. <i>Triticum aestivum</i> (Wheat)	12.1	341
3. <i>Pennisetum glaucum</i> (Bajra)	11.6	361
4. <i>Sorghum vulgare</i> (Jowar)	10.4	349

Besides the above-mentioned nutraceuticals, some other plant sources could also be utilized for the treatment of PEM diseases –

***Pueraria tuberosa* (Vidari)** – it has protein content of 10.9%.

***Cyanodon dactylon* (Conch grass)** – It has **10.47% protein**.

Algae - The high protein level of various microalgal species is one of the main reasons to consider them an unconventional source of this compound. Some algae, *Spirulina*, *Aphanizomenon flos-aquae* (AFA), *Porphyria* and *Chlorella*, are used as good protein sources. According to Lupatini et al. (2017), *Spirulina platensis* stands out for being one of the richest protein sources of microbial origin (460 - 630 g kg⁻¹ dry matter), having similar protein levels when compared to meat and Soybeans.

***Aphanizomenon flos-aquae* (AFA)** – This algae is an exceptionally high source of protein (60%) nearly identical to the human body's protein composition. The quality of the protein in AFA is superior to that of other plant or animal sources, being derived from all 8 essential amino acids.

Spirulina – It is a blue-green algae that is used as a supplement to the diet. The algae is cultured, dried, powdered and then used in the form of one-gram tablets. It contains about 60% protein, essential vitamins and unsaturated fatty acids.

Porphyra – A red algae that is very rich in protein (30-35%) and carbohydrates (40-45%).

Chlorella – a green algae contains a high percentage of protein (30%). The *Chlorella* species' proteins have amino acids fit for human consumption.

Mushrooms – Mushrooms are a delicacy and highly nutritive as they provide good quality protein, vitamins and minerals. Mushroom proteins usually have a complete essential amino acid profile, which may cover the dietetic requirements and have certain economic advantages compared to animal and plant sources (González et al., 2020). They can be used for curing PEM, keeping in view its high protein content of 20 - 35 grams per dry weight, which is higher than other vegetables and fruits. Vegetarians depend mainly on cereals for their protein nutrition. Keeping in view the declining per capita availability of pulses cereals etc., mushrooms fit in very well in the diet of the predominantly vegetarian population of our country for bridging the protein gap as many mushrooms can easily grow in agro-industrial waste, as submerged cultures and can give high yields in a short period of time. Some edible mushrooms like *Agaricus bisporus* have 3.94% protein, *Pleurotus flabellatus* has 2.78%, *Volvariella diplasia* has 3.90%, and Oyster mushroom has 2.9% protein content.

Medicago sativa (alfa-alfa) - It has a high protein content of 32 gm per 100 gm and energy of 1500 kJ per 100 gm. It can also possibly help in treating PEM diseases.

Other than the above-mentioned plant-based sources, several nutraceutical complexes can be made with the help of herbs. Nutraceuticals rich in protein can be formulated at the home level. It consists of roasted whole wheat (40 gram), Bengal gram (16 gram), groundnut (10 gram) and jaggery (20 gram). This energy-rich protein mixture imparts 330 Kcal of energy and 11.3 gm of protein. Many children with PEM have been treated with this food mixture; they were cured of PEM within 3 months.

CONCLUSION

Thus, it can be concluded that people should be informed of the nutritional quality of various locally available herbal nutritives. Nutrition education should be specially directed to those members of the family who make decisions or who can influence other persons in the family. People, chiefly poor

people and those of rural areas where PEM is the major problem should be made aware of the highly proteinaceous foods and new sources of proteins such as mushrooms, alpha alpha and algae etc. These kinds of food should be available to the people by the government and NGO's, so that they know the importance of nutritious food and they may avoid PEM diseases and be healthy.

Hence, herbal nutraceuticals can play a vital role in treating protein energy deficiency because of their easy availability, low cost and, most importantly for, their acceptance by a majority of the vegetarian communities of our country.

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Conflict of Interests

There is no conflict of interest to publish the article in this journal.

Author Contribution:

The paper is based on the clinical studies done by author Dr. Malvika Mathur. Various categories of patients were examined, and special emphasis was given to children of age 2-5 years suffering from PEM. They were treated with natural formulation prepared during the study, and they were cured of PEM within 3 months.

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