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Preparation, processing and nutritional attribute of spirulina by product

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Abstract
Spirulina is microscopic filamentous alga that is rich in protein, vitamin, essential amino acids, minerals and essential fatty acids like ɣ-linolenic acid. Spirulina by-product such as spirulina power contain a high amount of enhancing substances such as (protein, carbohydrate, essential lipids, vitamins and minerals). The study was carried out to investigate by different processing method for the production of new product by using spirulina by-products which include spirulina powder. The determination of nutrient composition of the products were tested by 6 parameters such as fat, protein, carbohydrate, energy, moisture, and ash contain. The utilization of spirulina by-product has become an important aspect in nutrition and supplements management to contribute to more production in food industries as well as pharmaceutical, nutraceutical and supplement industries. The utilization of spirulina by- products enhances due to the quality of spirulina by products that are rich source of many utilizable component. The product formation by using the spirulina by-products contain many health enhancement substances for a balance diet. These products optimize the availability of energy, protein, carbohydrate and fat. As the result of phytonutrient and Nutrient analysis per 100gm of product formation revealed 381 kcal, 13.73g protein in spirulina breakfast soup sticks. Thus, conforming that the developed product is nutritious and healthy innovation.

Keywords: spirulina, processing, nutritional analysis

1. Introduction
Spirulina - cyanobacteria has been used as food for centuries by different populations and only rediscovered in recent years. Once classified as the blue-green algae, it does not strictly speaking belong to the algae, even though for convenience it continues to be referred to in that way. It grows naturally in the alkaline waters of lakes in warm regions. Measuring about 0.1mm across, it generally takes the form of tiny green filaments coiled in spirals of varying tightness and number, depending on the strain. (Abdulqader & Tredici, 2000) [1].

Spirulina is cultivated worldwide, used as a dietary supplement as well as whole food and is available in the forms of cakes, tablets, powder. It is also used as a food supplement in the aqua culture, aquarium and poultry industries (Vonshok, 2001) [2].

Spirulina is commonly found in aquatic ecosystems like lakes, ponds and tanks. It is one of the nature's first photosynthetic organisms capable of converting light directly for complex metabolic processes. Spirulina is used for food from time immemorial by tribes living around Chad Lake in Africa. The predominant species of phytoplankton of the lake is Spirulina platensis. The algae Spirulina was eaten in Mexico under the names 'Tecuitlatl' (Farrar, 1996) [3]. Spirulina grows optimally in pH range of 9-11 and there is least chance of contamination of other microbes (Supramaniyan, 1992) [4].

Spirulina can play an important role in human and animal nutrition, environmental protection through wastewater recycling and energy conservation. Spirulina is rich in proteins (60 - 70%) vitamins and minerals used as protein supplement in diets of undernourished poor children in developing countries. One gram of Spirulina protein is equivalent to one kilogram of assorted vegetables. The amino acid composition of Spirulina protein ranks among the best in the plant world, more than that of soya bean (Tanseem, 1990) [5].

Vitamins and minerals, Gamma-linolenic acid contained in this alga have been reported to stimulate prostaglandin synthesis and induction of the regulation of blood pressure, cholesterol synthesis, inflammation and cell proliferation (Venkataraman, 1993; Borowitzka, 2010) [6, 7].

Spirulina provides all essential nutrients without excess calories and fats. It is recommended to control obesity and premenstrual stress. Athletes take Spirulina for instant energy. The beta carotene and other carotenoids are having a suggested role in the control of cancer in human and enhancement of pigmentation of eggs, meats and coloration of ornamental fish (G. Usharani, 2012) [8].

Spirulina is rich in protein, vitamins, minerals and carotenoids, antioxidants that can help to protect cells from damage. It contains nutrients including B-complex vitamins, beta carotene, vitamin-E, manganese, zinc, copper, iron, selenium and gamma linolenic acid an essential fatty acid (Vessey, 2003) [11].

Its impressive protein content and its rapid growth in entirely mineral environments have attracted the attention of both researchers and industrialists alike.

Spirulina has reported to prevent oxidative damage and hence can indirectly reduce cancer formation in human body. In this respect, the increased consumption of foods characterized by free radical scavenging activity, leads up to

a doubling of protection against many common types of cancer formation (Cooke *et al*., 2002; Romay *et al*., 2003; Anbarasan *et al*., 2011) [13, 14].

There are several species of spirulina. The ones most commonly used in nutritional supplements are spirulina platensis and spirulina maxima. Spirulina is cultivated worldwide used as a dietary supplement as well as flake, tablets and powder form. It is also used as a feed supplements in the aquaculture aquarium and poultry in industries.

It has been stated by NASA that the nutritional value of 1000 kg of fruits and vegetables equals one kg of spirulina. Therefore, in long-term space missions NASA (CELSS) and European space agency (MELISSA) proposed that spirulina serves as a major source of food and nutrition (G. Mahasin, 1988, Cornet, 1990) [9, 10].

Spirulina or Arthrospira is a blue-green alga that became famous after it was successfully used by NASA as a dietary supplement for astronauts on space missions. It has the ability to modulate immune functions and exhibits anti-inflammatory properties by inhibiting the release of histamine by mast cells (P. D. Karkos, 2010) [11].

Spirulina has become popularly known as a superfood due to the great diversity and concentration of nutrients it contains. It is the most nutritious, concentrated whole food source found in nature.

2. Methodology

Nutritional Analysis In the present study, the product was analysed for proximate composition. In this phase it involves nutritional analysis in different parameters.

- Determination of total energy
- Determination of moisture percentage
- Determination of ash percentage
- Determination of fat percentage
- Determination of protein content
- Determination of carbohydrate percentage

Source: the following tests were determined at the RFRAC centre (regional food analysis centre) Lucknow.

3. Result and Discussions

3.1 Determination of nutrient composition

Determination of nutritional analysis of processed spirulina by-product were tested by 6 parameters such as-

- Fat
- Protein
- Carbohydrate
- Energy
- Moisture
- Ash contains

3.2 Determination of Nutrient composition of spirulina soup sticks

Nutritive value of experimental sample (100g). The result shown in the form of table below.

3.3 Fat, Protein and Carbohydrate

Table 1: Nutrient contents in Spirulina soup sticks.

Parameters	Experimental
Fat(g)	6.46
Protein(g)	13.73
Carbohydrate(g)	67.0

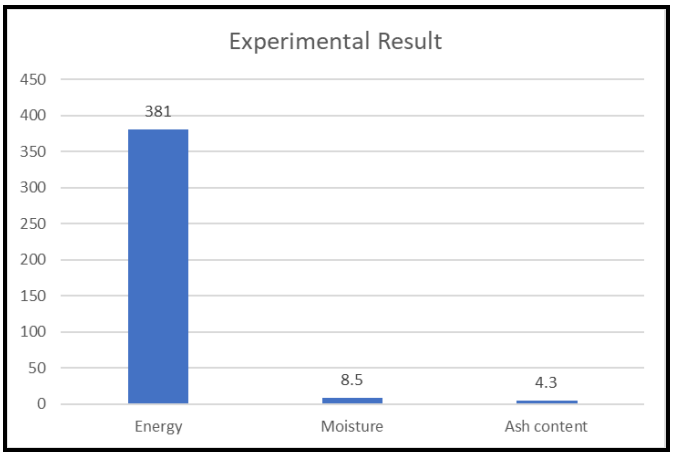

Fig 1: Graphical representation of Fat, Protein, Carbohydrate in Spirulina soup sticks.

The above drawn graph shows the higher percentage of Carbohydrate than protein and fat in experimental product.

3.3.1 Energy, Moisture and Ash Content

Table 2: Energy, moisture and ash content in Spirulina soup sticks.

Parameters	Experimental
Energy (Kcal)	381
Moisture	8.5
Ash Content	4.3

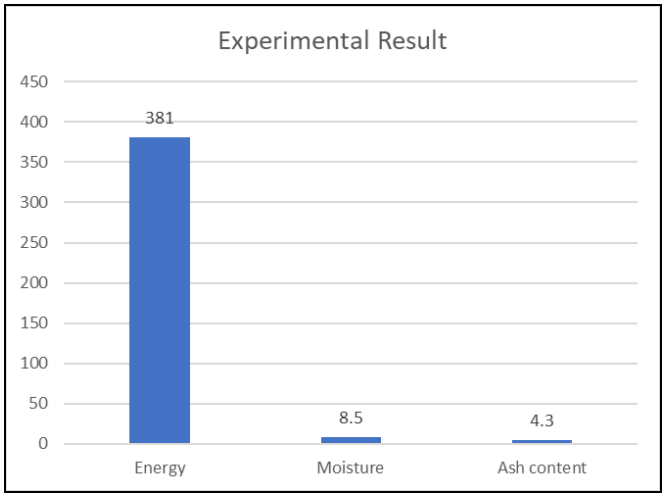

Fig 2: Graphical representation of Energy, Moisture, and Ash content in Spirulina soup sticks.

The above drawn graph shows the higher percentage of Energy than Moisture and Ash content in experimental product.

4. Summary and Conclusion

Spirulina by-product such as spirulina power contain a high amount of enhancing substances such as (protein, carbohydrate, essential lipids, vitamins and minerals). The utilization of spirulina by-product has become an important aspect in nutrition and supplements management to contribute to more production in food industries as well as pharmaceutical, nutraceutical and supplement industries. For the insurance product quality, nutritionally analysis is good to determine the quality and freshness of product. Nutritionally analysis of the spirulina by-product was done

by testing as six parameters. The scoring for each of the product was done according to various parameters i.e. fat, protein, carbohydrate, energy, moisture, and ash contain fat.

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