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Spirulina - A Complete Protein Food

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SUMMARY

In India a significant portion of algae production appears to have great potential as a high protein feed supplement for livestock, particularly for poultry, and also will make an excellent bio fertilizer for rice. The production of protein rich spirulina is important where scarcity of nutritional food is occurring. It is excellent method to fulfill the need of nutritious food for large (increasing) population, on small land. Spirulina appears to have considerable potential for development, especially as a small-scale crop for nutritional enhancement, livelihood development and environmental mitigation. In particular, the production and use of spirulina has the various advantages.

INTRODUCTION

Spirulina is a multicellular, filamentous, cyanobacterium which can colonize environments that are unsuitable for many other organisms, forming populations in freshwater and brackish lakes and some marine environments, mainly alkaline saline lakes (Vonshak, 1997). Spirulina contains a high content of protein (up to 70%), along with high amounts of essential fatty acids, essential amino acids, minerals, vitamins (especially B_{12}), antioxidant pigments (phyco- biliproteins and carotenoids) and polysaccharides (Belay et al., 1993; Vonshak, 1997). Cyanobacteria have a cell wall similar to that of Gram-negative bacteria: They contain peptide glucan, a lysozyme-sensitive heteropolymer that confers shape and osmotic protection to the cell, in addition to other material not sensitive to lysozyme. Spirulina contains unusually high amounts of protein, between 55 and 70 percent by dry weight, depending upon the source (Phang *et al*., 2000). It is a complete protein, containing all essential amino acids, though with reduced amounts of methionine, cystine, and lysine, as compared to standard proteins such as that from meat, eggs, or milk; it is, however, superior to all standard plant protein, such as that from legumes. A special value of spirulina is that it is readily digested due to the absence of cellulose in its cell walls, after 18 hours more than 85 percent of its protein is digested and assimilated (Sasson, 1997).

Consequently, the commercial production of spirulina has gained worldwide attention for use in human food supplements, animal feed and pharmaceuticals. In aquaculture, spirulina is used as a feed additive to improve growth, feed efficiency, carcass quality, and physiological response to disease in several species of fish (Mustafa et al., 1994). Furthermore, it is the richest algal source of Gamma-linolenic acid (GLA), a precursor for the biologically-active compound (prostaglandins,PGE1) (Habib et al., 2008) which is necessary for the enhancement of the immune system in shrimp larvae (Belay et al.,1996; Yuan-Kun et al., 2003). In addition to its good nutritional value, the evidence for its potential therapeutic application is overwhelming for the human being,(Belay et al., 1993; Belay, 2002). The body surface of spirulina is smooth and without covering, so it is easily digestible by simple enzymatic systems.

The growth of spirulina and the composition of the biomass produced depend on many factors, the most important of which are nutrient availability, temperature and light (photo-period 12/12,4 luxes) (Cornet et al.,1992). In addition, spirulina requires relatively high pH values between 9.5 and 9.8 (Belkin and Boussiba, 1971), which effectively inhibits contamination by most algae in the culture. Production of spirulina with reduced costs is necessary when considering large-scale cultivation for industrial purposes. The cost of nutrients is considered the second major factors influence the cost of spirulina biomass production (Vonshak,1997). Zarrouk's medium has successfully served as the standard medium (SM) for spirulina culture for many years (Zarrouk,1966).

Consequently, many media have been developed using seawater (Faucher et al., 1979), sewage water (Saxena et al.,1982) and industrial effluents (Tanticharoen et al., 1993). *S. platensis* also called as Arthrospira is a microscopic and filamentous cyanobacterium (Blue green algae) that has a long history of usage as food. Its name is derived from the spiral or helical nature of its filaments (Becker,1993). *S. platensis* has been used as food for centuries by different populations and only rediscovered in recent years. 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 *S.platensis* is cultivated in the forms of cakes, tablets, powder. It is also used as a food supplement in the aquaculture, aquarium and poultry industries (Vonshok, 2001 and Geitler, 1982). Therefore, the present study was undertaken to evaluate the growth of *Spirulina platensis* in a medium based on commercial grade. This will allow the derivation of a new medium to assist in decreasing the cost of spirulina production.

Spirulina and its use by humans:

- Immune system enhancement
- Nutritional supplement
- Food source

Spirulina and agriculture:

- Use as fertilizer
- Use as a protein supplement in poultry and livestock feeds

Spirulina and aquaculture:

Spirulina as a nutritional supplement. Fishmeal, groundnut meal and soybean meal can be partially replaced by spirulina in the preparation of diets of fish, poultry, cattle and domestic animals (Venkataraman, Somasekaran and Becker, 1994; El-Sayed, 1994; Britz, 1996).

Method of production of spirulina:

Microorganism:

The cyanobacterium *S. platensis*, strain K-2, used in the present study was obtained from farmer fields from Nanded in Marathwada region. The strain was maintained in 500 mL sterilized flasks containing 100 mL Zarrouk's medium (Zarrouk, 1966) at 30±2 ^{o}C, pH 9.5. The culture was subcultured on field in pond after 15 days.

Fig1. Growth of spirulina on Zarrouk's medium

Fig 2. Growth of spirulina (Field) after 15 days

Fig 3. Powder of spirulina

Culture media

All constituents of Zarrouk's medium were used as the standard control medium (SM).

Table: 4. Chemical composition of Zarrouk's medium

Chemical component	Concentration g/l
Sodium bicarbonate	8
Sea salt	5
Potassium Nitrate	2
Magnesium Sulphate	0.16
Ammonium phosphate	0.08
Urea	0.2
Ferrous Sulphate	0.05
Distilled water	1L

Process

Culture of spirulina of Zarrouk's medium, was transferred in field for large scale production of spirulina. The size of pond is 15m in length and 5m in width. The water level of the pond should be minimum of 20 cm from bottom. The tarpolene sheet was used for making pond. Water could be added when needed, but that could not change chemical composition or pH (9.5-9.8) of the culture medium. Agitation of the water in pond was necessary to homogenize and ensure a good distribution of lighting among all the filaments of spirulina. Agitation was with clean brush, 4 times per day, for 2 minutes. The pond has to be exposed to sunlight as the spirulina takes 3 to 4 days to mature. The mature spirulina (when the pale medium turns into dark green) can be harvested after 15 days by skimming the surface of the basin and initially filtration of spirulina was performed through a mosquito net or a simple cloth. Wash the spirulina in fresh water (to remove the adhering chemicals), ground it after drying and stored in plastic pouch. It can be directly mixed with chapatti dough, chutneys, noodles, pulses, vegetables etc. Spirulina can also be preserved by drying. To store spirulina for a much longer time, it is vacuum dried and packed airtight so that it sustains its nutritional qualities for five years.

Importance of spirulina production:

- It provides an easily digestible high (60 percent) protein product with high levels of β-carotene, vitamin B_{12}, iron, few other minerals and the rare essential fatty acid γ-linolenic acid (GLA).
- Its production occupies only a small environmental footprint, with considerable efficiencies in terms of water use, land occupation and energy consumption when compared to traditional terrestrial crops.
- Its production is especially suitable to saline and alkaline conditions that are often unfavourable to traditional crops and are frequently occupied by disadvantaged people suffering from, or vulnerable to, natural disasters.
- Its production can be conducted at a number of different scales, from household "pot culture" to intensive commercial development over large areas.
- It has the potential for integration with rural organic waste treatment processes to improve both environmental conditions and improve energy transfer efficiencies.

CONCLUSION

Spirulina production is an advanced tool about nutrient enrichment in crop plants. The cyanobacterium (Blue-green algae), *Spirulina platensis* has been commercialized in several countries for its use as a health food and for therapeutic purposes due to its valuable constituents, particularly proteins and vitamins. Present project title is primarily focused over an production of protein rich spirulina (algae). Providing nutritional supplements for widespread use in rural and urban communities where the staple diet is poor or inadequate. It can be directly mixed with chapatti dough, chutneys, noodles, pulses, vegetables etc.

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