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Knowledge Resonance

Biotechnological Potentials of Spirulina (Arthrospira platensis) of Lonar Origin

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ABSTRACT:
In present day era the human society is facing the burden of over population, resulting in many of the critical problems such as scarcity of food & it's quality. To overcome this problem, farmers are being forced to use the chemical fertilizer and pesticides. The hazardous impacts of the excessive use of these chemicals are well known and their bioaccumulation in the livestock and long durability is the cause of concern. African nations are being suffered from the malnutrition and in Indian perspective though our economy is growing still the area of concern is population explosion and poverty. Worldwide the efforts are being taken for the production cheaper and high quality food, Spirulina provides the opportunity to exploit it as an ideal nutritional supplement. The biotechnological applications of the Spirulina are vivid and used in various industries for the production of valuable products. These characteristics make this microorganism economically important.

KEY WORDS:
Spirulina, Biotechnological applications, Economic importance.

Introduction:
Spirulina, now known as Arthrospira, is a microscopic and filamentous cyanobacterium (blue green alga), which has been used as food from many centuries. Reports say that it was used as food in Mexico during Aztec civilization some 400 years ago. Presently its been used as food by Kanebu tribe in the lake Chad in the Republic of Chad where it is sold in the form of dried bread called as "dihe"[1]. Spirulina is produced on commercial scale for its nutritional value and various industrial uses[2-4]. That's why the potentials of Spirulina in biotechnology are vivid. Earlier Spirulina captured the interest due to its high nutritional value; protein, vitamins, minerals, essential amino acids, minerals and essential fatty acids. Spirulina is made up of 60-70% of protein and acts as rich source of vitamins precisely vitamin B12, β carotene and in minerals it is rich source of iron. It also contains dietary linolenic acid. Presently potential applications of spirulina in various following industries and some possibilities of cost effective commercial exploitation in Indian scenario revealed greater horizons for future spirulina research.

1. **Pharmaceuticals**: - Some species of Spirulina are rich source of phycocyanin, which acts as a natural colourant and also has therapeutic uses. Liu et. al has carried out the work on inhibitory effect of phycocyanin from S. platensis on the growth of human leukemia k562 cells[5]. In 1993 review on potential health benefits of Spirulina, Belay et.al published limited information on this cyanobacterium and attracted the attention of researchers in the area of immunity enhancement and cancer[6]. Hayashi et.al were the pioneer in determining the immunomodulatory effects of spirulina in mice[7]. Mao et. al published the information regarding the stimulation of interleukin and interferon production in human mononuclear cells[8]. Saeki et.al. firstly showed increased IFN-γ secretion activity in human volunteers[9].
   Spirulina also exhibits the anticancer activity. Spirulina is able to reduce rate of hair loss, activate hair growth, as spirulina consists of necessary fatty acids (sometimes called vitamin F), including linoleic acid and arachidonic acid which are the important fatty acids for nourishing hair, skin and nail. Meanwhile, they are helpful for the hair root that leads to good growth and strong hair.
2. **Foods:** -The rich content of proteins, vitamins and minerals in Spirulina, made it a good source of food. The WHO officially accepted it as food and granted the marketing

of spirulina as nutritional supplement. Spirulina contain high level of proteins, chlorophyll, vitamin B12 and folic acid; therefore, it is able to increase the quantity and efficiency of red blood cells, which will result in more exchange of oxygen for better circulation within 30 days. Spirulina also gives an excellent nutritive value to the patients who lacks nutrients for longer period of time and improves health by providing sufficient vitamin E, B12 and folic acid. Recently the experiments were designed by NASA to testify the use of Spirulina as a resourceful food for astronauts[10]. The nutritional composition of spirulina differs accordingly with respect to species and the cultivation conditions. Various products of spirulina such as biscuits, powder, dietary pills etc are available in the markets.[11]The nutritional composition of Spirulina is shown in the table below;

Proteins	71%	**Vitamins**	**mg/kg**
Essential Amino Acids		Thiamine B_1	55.0
Isoleucine	4.13%	Riboflavin B_2	40.0
Leucine	5.50%	Niacin B_3	140
Lysine	4.0%	Pyridoxine B_6	3.0
Methionine	2.17 %	Cyanocobalamine B_{12}	2.0
Phenylalanine	3.95%	Tocopherol E	190.0
Threonine	4.17%	Vitamin K-1	22
Tryptophan	1.13%	Inositol	350
Valine	6.0%	Folic acid	0.5
Non Essential Amino Acid		Pantothenic acid	11.0
Alanine	5.82%	Biotin (H)	0.4
Arginine	5.98%	**Minerals**	**mg/kg**
Aspartic acid	6.32%	Calcium	1,315
Cystine	0.67%	Magnesium	1,915
Glutamic acid	8.94%	Potassium	15,400
Glycine	3.46%	Phosphorus	8,000
Histidine	1.08%	Sodium	412
Proline	2.97%	Manganese	25
Tyrosine	4.60%	Zinc	39
Serine	4.0%	Copper	12
RNA	3.5%	Chromium	2.8
DNA	1.0%	Iron	580
Essential Fatty Acids	**mg/kg**	**Pigments**	**mg/kg**
Palmitic acid	21,141	β Carotene	1,700
γ-Linolenic acid	11, 970	Carotenoids	4,000
Palmitoleic acid	2,035	Chlorophyll	7,600
Oleic acid	3,009		
Stearic acid	353		

3. **Neutraceuticals:** - According to the Miranda et.al. the main phenolic compounds found in spirulina are salicylic, trans-cinnamic, synaptic, chlorogenic, quimic and caffeic acids[12]. However, the metabolic pathways for the formation of these compounds in cyanobacteria and their importance are still unknown. A study has demonstrated the effect of temperature on the productivity of neutraceutical compounds in spirulina. It also contains rare and vital linolenic acid, which need more investigation. Spirulina also been exploited as an excellent source for the single cell protein[13].

4. **Colourants:** - Cyanobactaria and algae possess a wide range of colored components including carotenoids, chlorophyll and phycocyanin[14]. Spirulina being the blue green algae exhibit the characteristic ability to produce the fluorescent blue pigment known as phycocyanin. The applications of cyanobacterial phycocyanin are vivid, it is used as natural colorant as it is nontoxic and non carcinogenic. It is used as colourant in cosmetic industry, food industry[15]. Depending upon the purity ratio of the phycocyanin, it's use in the food industry and pharmaceutical industry is decided. Pharma industries require more pure phycocyanin. It is also used in chewing gums, dairy products, ice creams, and jellies[16]. Glazer has demonstrated the biomedical research applications of this novel pigment in1994[17]. It is used as a potential therapeutic agent in oxidative stress induced disease. Along with phycocyanin spirulina also acts as source for phycoerythrine, which is red in colour and possesses variant applications. A recent elaborate study shows that oral administration of cphycocyanin in rats prevents kainic- acid- prevailed behavioral reactivity in the rat hippocampus demonstrating its protectiveness over neurons. The study revealed, phycocyanin reduced experimental status epilepticus, indicating possible therapeutic application in the treatment of some cases of epilepsy. According to the authors, kainic acid (KA) triggered excitotoxicities resulted in the production of reactive oxygen species. It is therefore postulated that the protective effect of phycocyanin in neuronal damage may be due to its free-radical scavenging and antioxidant properties. An interesting aspect of this research is the finding that oral administration of phycocyanin exerts its effect in the hippocampus, crossing the hematoencephalic barrier. According to the investigators, such findings and the virtual lack of toxicity of phycocyanin suggest that this phytochemical could be applied the treatment of neurodegenerative diseases such as Alzheimer's and Parkinson's, diseases brought on by oxidative stress-induced neuronal injury[18].
5. **Biosorption**: -The efforts are being taken by the researchers to use the spirulina for accumulation of the hazardous metals such as mercury, antimony, chromium and manganese from the lakes and other water bodies. So spirulina will act as environmental friendly control of metal aggregation in the water bodies and can be useful to control the water pollution. Recently the accumulation of cobalt, copper and zinc in spirulina platensis by the researchers, this study discusses the interesting results of accumulation of metals in free and immobilized cyanobacterial biomass by polyacrelamide gel. The immobilization of the biomass increased its reuse by seven times for the same purpose. The study of investigators reveals the use of spirulina in wastewater treatment for removal of nitrogen and phosphorus effectively[19]. The studies on biosorption of Antimony and Chromium by Spirulina platensis[20], the interesting aspect of this study reveals the application of Spirulina in bioextraction the Sb & Cr from natural and industrial water resources. This ability of spirulina of biosorption can be exploited for wastewater management and minimization of metal concentration from the water bodies. A lot of work yet to be done on this particular perspective of spirulina. The chelation of iron by cyanobacteria is well known. Spirulina plays a vital role in the chelation of Fe, which can be exploited for the environmental friendly remediation on industrial effluents containing metals. The detailed investigation have been carried out by the researchers to study capability of Spirulina platensis for the chelation of free inorganic Fe and humic Fe[21].

Conclusion: -

Due to the restricted availability of farming land, the Spirulina production has attracted many nations worldwide. And nations like India, which are highly populated and where land crisis occurring along with floods and draughts, the spirulina production will act as boon for the farmers and will be the good subordinate business. The efforts have been made by CFTRI regarding various applications and production of industrially important products of Spirulina. In India spirulina has been produced by Ballarpur industries limited on commercial scale, their total pond area is nearly 54,000 m2 and the productivity is 25 tones per year. These numbers are not satisfying if compared with the other worldwide firms, they seems to be negligible. Being the tropical nation we should exploit the abundance of solar energy for spirulina production. There is need to provide the detail information to the farmers regarding the spirulina cultivation and its economic importance, for better exploitation of such a novel microorganism.

References:

1. Abdulqader G, Barsanti L, Tredici M. Harvest of Arthrospira platensis from Lake Kossorom (Chad) and its household usage among the Kanembu. J Appl Phycol. 2000;12:493-498.
2. Belay A, Ota Y, Miyakawa K, Shimamatsu H. Production of high quality Spirulina at Earthrise Farms. In: Phang et al., eds. Algal Biotechnology in the Asia-Pacific Region. University of Malaya; 1994:92-102.
3. Belay A, Kato T, Ota Y. Spirulina (Arthrospira): potential application as an animal feed supplement. J Appl Phycol. 1996;8:303-311.
4. Belay A. Mass culture of Spirulina outdoors: the Earthrise Farms experience. In: Vonshak A, ed. Spirulina platensis (Arthrospira) Physiology, Cell Biology and Biotechnology. London: Taylor & Francis; 1997;131-158.
5. Liu L, Guo B, Ruan J, Dai X, Chen L, Wu B. Study on effect and mechanism of polysaccharides on Spirulina platensis on body immune functions improvement. Marine Sci. 1991.6:44-49.
6. Belay A. Current knowledge on potential health benefits of Spirulina. J Appl Phycol. 1993;5:235-241.
7. Hayashi O, Katoh T, Okuwaki Y. Enhancement of antibody production in mice by dietary Spirulina platensis. J Nutr Sci Vitaminol. 1994;40:431-441.
8. Hayashi O, Katoh T, Okuwaki Y. Enhancement of antibody production in mice by dietary Spirulina platensis. J Nutr Sci Vitaminol. 1994;40:431-441.
9. Saeki Y, Matsumoto M, Hayashi A, Azuma I, Toyoshima K, Seya T. The effect of Spirulina hot water extract to the basic immune activation. Summary of paper presented at the 30th Annual Meeting of the Japanese Society for Immunology. November 14-16, 2000.
10. Tadros M.G and MacElroy R.D, Characterization of Spirulina Biomass for CELLS diet potential, NASA, Contractor NCC 2-501, October 1988.
11. DBT Annual Report 2005-06, Chapter Seven.
12. Miranda MS, Cintra RG, Barros SB, Mancini Filho J. Antioxidant activity of the microalga Spirulina maxima. Braz J Med Biol Res 1998;31:1075-9
13. Anupama, P.R., 2000. Value-added food: single cell protein. Biotechnology Advances 18, 459–479.
14. Gantt, E. (1981). Phycobilisomes. Ann Rev Plant Physiology 32:327-47.
15. Romay, C.; Ledon, N.; Gonzalez, R. (2000). Effects of phycocyanin extract on prostaglandin E2 levels in mouse ear inflammation test. Arzneimittelforschung 50: 1106-1109.
16. Yoshinda, A.; Takagaki, Y.; Nishimune, I. (1996). Enzyme immunoassay for phycocyanin as the main component of Spirulina colour in food biotechnology. Biochem 60: 57-60.
17. Glazer, A.N. (1994). Phycobiliproteins a family of valuable widely used fluorophores. J. Appl. Phycol 6:105-112.
18. Rimbau V, Camins A, Romay C, Gonzalez R, Pallas M. Protective effect of C-phycocyanin against kainic acid induced neuronal damage in rat

hippocampus. Neuroscience Letters. 1999;276:75-78.
19. Kosaric, N., H. T. Nguyen, and M. A. Bergognou. 1974.Growth of Spirulina maxima algae in effluents from secondary waste-water treatment plants. Biotechnol. Bioeng. 16:881-896.
20. Yolanda Madrid, Ma. Esther Barrio-Cordoba and Carmen Cámara* Analyst, July 1998, Vol. 123 (1593–1598).
21. Konstantin Benderliev, BULG. J. PLANT PHYSIOL., 1999, 25(1–2), 65–75.
22. Mohite Y.S. & Wakte P. S. Effect of variaous growth elements on the morphological variations of Spirulina platensis isolated from halo-alkaline habitat. Proceedings BIOCAM 2008, 361-363.