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Spirulina the super food; regulation of foul-fishy smell

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Spirulina (*Arthrospira platensis*) is a concentrated source of nutrients, which can be used as an additional food supplement for immediate and long-term health. It provides complete nutrition to the body. The “fishy” or “seaweed” smell of *Spirulina* is one of its organoleptic characteristics which are a concern for taste. The odour of *Spirulina* is due to the presence of a phyto-nutrient, Polyamines. These are the molecules that give *Spirulina* its characteristic smell. The smell can be masked by using a special treatment, but by doing so, the essential nutrients are being removed. It is against the Food & Drugs act and also against the organic standards.

We want to provide quality product to our customers that meets all the organic and health standards. Currently there is no way to alter the foul-fishy smell of *Spirulina* during growth. *Spirulina* tablet can be coated to mask the order hence this is the widely accepted formulation all over the word. Manufacturers attempted to modify the smell, either through masking, encapsulation, or modifying the production process. But that also means more production cost, and possible modification of the organic form of *Spirulina*.

Just like fermented food, smell & taste can be acquired. Anjana Kaveri B. (2015) used the

coating of Spirulina with chitosan by spray drying for masking the odour (<http://ir.cftri.com/11920/>). Super Crop Safe, as our name suggest, prefers to explore natural ways of minimising possible unpleasantness in consuming Spirulina.

State of the Art

Biogenic amines, including tyramine, histamine, putrescine, cadaverine, spermine, and spermidine, can be produced and degraded by the normal metabolic activities of animals, plants, and microorganisms. These amines are mainly produced by microbial decarboxylation of amino acids in foods (Choi J et al 2013, Brink B et al 1990). Putrescine, spermidine, and spermine are three well-known polyamines that are present in the cells of all organisms. Polyamines play an important role in regulating cell growth and proliferation, stabilization of the negative charges of DNA, RNA transcription, protein synthesis, apoptosis, and regulation of the immune response (Larqué E et al 2007). Polyamines can be expected to have cell regeneration and antioxidant effects (Larqué E et al 2007); however, there are few studies of the polyamine contents of specific strains of microbes that are used as foods.

Arginine decarboxylase (ADC) is the first and rate-limiting step in the polyamine (PA) biosynthetic pathway originating from ARG (arginine). This enzyme has been partially purified from barley (Smith T A 1963) and purified to homogeneity from *L. sativus* (Ramkrishna S and Adiga P R 1975), oat seedlings (Smith T A 1979), rice embryos (Choudhuri MM and Ghosh B 1982), K-deficient leaves (Flores H E 1984) and cucumber seedlings (GL Prasad and PR Adiga 1985). The levels of this enzyme in *Lathyrus sativus* have been shown to increase progressively with the age of the plant embryo in whole seedlings, cotyledons and in embryo axes, indicating that the production of putrescine (PUT) and hence PAs are linked to growth. Putrescine are precursor for the synthesis of Spermidine, Homospermidine, Spermine, Thermospermine etc.

The activity of ADC can be altered / modulated under various stress condition. As early as 1952, Richards and Coleman demonstrated that K⁺ deficiency causes accumulation of PUT. Latter it was firmly established that K⁺ deficiency results in marked elevation of ADC in Barley (Smith T A 1963). Flores et al 1984 have shown that K⁺ deficiency results 30 fold enhancement of ADC accompanied by marked accumulation of PUT in Oat seedlings. Several monovalent cations could partially replace K⁺ in this system, both in terms of restoring growth and ADC activity. Cereal leaves under osmotic stress also exhibit elevated ADC (2-3 fold) and putrescine (30 fold) reported by Flores H E and Galston A W 1982. No such studies are reported in Spirulina.

Super Crop Safe is focusing on to find a nutritional factor /element regulating the growth

and hence the polyamine biosynthesis to a great extent without affecting the biomass and nutrient value of Spirulina. Nutrients acting as key components to maintain the logarithmic growth and increase the longevity/duration of stationary phase of growth were evaluated in the current study. Organoleptic characteristics were studied to see the effect on foul odour of produced spirulina biomass along with the other nutrient characteristics.

Methodology

We are producing Spirulina in raceway ponds in open conditions. The media standardized for growth of Spirulina at our conditions is a CFTRI medium (Venkataraman et al., 1995). For experimental purpose the cultivation was carried out in a 25 ml culture tube containing 10 ml media. Axenic culture of *Spirulina platensis* was collected and maintained in CFTRI medium tubes. Six elements in three concentrations were studied in CFTRI medium to see its role in Spirulina growth over control. Different elements (Mn, Zn, Cu, KCl, K₂SO₄, K₂HPO₄) in three concentrations (10, 50 and 100 ppm) were added to the CFTRI medium. The pH was adjusted at 8.5 and medium was sterilized by autoclaving at 121 deg C for 20 minutes. A known number of mother cultures (spirals) were inoculated. The inoculated culture tubes were kept on a Shaker at 100 rpm, 28 ± 2°C temperature and 3000 lux light intensity for 12 hour light-dark cycles. The growth was monitored at regular interval. To determine the growth microscopic observations were made and the total count of spiral was enumerated by Lackey's drop count method under 100 and 400 x magnifications. Amount of drop was fixed (A modification of Lackey's method) to express the count and calculate increase / decrease in growth.

Result and Discussion

Six elements in three concentrations were studied in CFTRI medium to see its role in Spirulina growth over control. The response of these elements was remarkable on the growth and development of spirulina. We expect it must have some role in modulation of enzyme expression of ADC a key molecule for polyamine biosynthesis (Smith T A 1963, Flores H E 1984) responsible for fishy smell of spirulina. By increasing the concentrations of different salts of potash (potassium chloride, potassium sulphate and di potassium hydrogen phosphate) and enzyme co-factors (Manganese, Zinc and Copper); our objective was to select the key elements indicating their regulatory role on growth and hence indirectly on ADC for controlled polyamine biosynthesis in spirulina. Based on our observations 10 ppm of Zn, Mn & KCl and 50 ppm of K₂SO₄ was screened for further study on regulation of growth and development in Spirulina. Mn and KCl 10 ppm was found ideal over control in terms of biomass production as well as organoleptic characteristics of Spirulina.

There are no reported studies on regulation of polyamine biosynthesis in Spirulina and its effect on organoleptic characteristics however based on reported studies in higher plants (Smith T A 1963, 1979, Ramkrishna S and Adiga P R 1975, Flores H E 1984, GL Prasad and PR Adiga 1985) we have strategised to implement it and the initial results were quite encouraging. We hope that it will pave the way to get rid of bad odour of spirulina, a major concern for taste. By following it we can manage the quality without compromising the essential nutrients of Spirulina. It will also not be against the Food & Drugs act and the organic standards.

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