ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Marine algae for agricultural sector for high yield

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ABSTRACT

Seaweeds have been consumed in Asia since ancient times. Marine algae have been utilized in Japan as raw materials in the manufacture of many seaweed food products, such as jam, cheese, wine, tea, soup and noodles and in the western countries, mainly as a source of polysaccharides for food and pharmaceutical applications. From the wide literature, it is observed that little work has been carried out on marine algae as microbial inoculant for agricultural applications. This paper discusses briefly about biofertilisers and various material methods adopted by different researchers mentioning the use of algae as biofertiliser.

Key words: Marine algae, biofertiliser, agricultural

1. INTRODUCTION

The growth, development and yield of many crop plants depend upon several factors like climate, soil and mineral elements etc. The plants need number of macro-elements and microelements for growth and yield. The soil fertility is dependent upon amount of nitrogen, phosphorous, potassium and other elements present in the soil. The farmers add different forms of natural or synthetic fertilizers to restore soil fertility. The synthetic fertilizers give better and immediate response in the form of increased yield but their continuous use develops soil salinization problem. The farmers have switched over from modern intensive agriculture to ecologically protective beneficial agriculture with the use of biofertilizers. The term biofertilizers refers to preparations of primarily active strains of different micro-organisms i.e. biologically originated forms. These organisms can bring about soil nutrient enrichment. Biofertilizers as nutrient inputs of biological origin useful for plant growth. Biofertilizers are known as 'microbial inoculants', because they synthesize complex compounds and further release them into outer medium. Jalapathi *et al* reported the positive effect of cyanobacterialization on reduction of sterility of rice grain. The stimulative and profoundly significant impact of cyanobacterialization through use of cyanobacteria was found to be evident on yield of grain of both the varieties of rice over the control irrespective of the seasons. The algalization technology has been reported to be successful to a great extent in India. Literature review shows that very limited works have been done in this area in world.

A bio-fertilizer provides the following benefits:

1. Since a bio-fertilizer is technically living, it can symbiotically associate with plant roots. Involved microorganisms could readily and safely convert complex organic material in simple compounds, so that plants are easily taken up.

2. Microorganism function is in long duration, causing improvement of the soil fertility. It maintains the natural habitat of the soil. It increases crop yield by 20-30%, replaces chemical nitrogen and phosphorus by 25%, and stimulates plant growth. It can also provide protection against drought and some soil-borne diseases.

3. Bio-fertilizers are cost-effective relative to chemical fertilizers. They have lower manufacturing costs, especially regarding nitrogen and phosphorus use.

Some important groups of Bio-fertilizers:

1. **Azolla-Anabena symbiosis:** Azolla is a small, eukaryotic, aquatic fern having global distribution. Prokaryotic blue green algae Anabenaazolla resides in its leaves as a symbiont. Azolla is an alternative nitrogen source. This association has gained wide interest because of its potential use as an alternative to chemical fertilizers.

2**. Rhizobium:** Symbiotic nitrogen fixation by Rhizobium with legumes contribute substantially to total nitrogen fixation. Rhizobium inoculation is a well-known agronomic practice to ensure adequate nitrogen.

Application of high input technologies has resulted insignificant increase in agricultural productivity. There is, however, a growing concern about the adverse effects of indiscriminate use of chemical fertilizers on soil productivity and environmental quality. Cyanobacteria offer an economically attractive and ecologically sound alternative to chemical fertilizers for realizing the ultimate goal of increased productivity, especially in rice cultivation. In awetl and rice ecosystem, nitrogen fixation by free living cyanobacteria also significantly supplements soil nitrogen.

Due to this important characteristic of nitrogen fixation, the utility of cyanobacteria in agriculture to enhance production is beyond doubt. Many studies have been reported on the use of dried cyanobacteria to inoculate soils as a means of aiding fertility, and the effect of adding cyanobacteria to soil on rice yield was first studied in the 1950s in Japan. The term 'algalization' is now applied to the use of a defined mixture of cyanobacterial species to inoculate soil, and research onalgalization is going on in all major rice producing countries.

The average of the results from all these studies have shown an increase in grain yield of 15-20% in field experiments. It has been suggested that the cyanobacteria of algalization can establish themselves permanently if inoculation is done consecutively for 3-4 cropping seasons.

Seaweed species are rich in beneficial nutrients, in countries such as China, Japan and Korea, they have been commonly utilized in human alimentation. Seaweeds have been consumed in Asia since ancient times. Further, marine algae have been utilized in Japan as raw materials in the manufacture of many seaweed food products, such as jam, cheese, wine, tea, soup and noodles and in the western countries, mainly as a source of polysaccharides for food and pharmaceutical uses.From the literature, it is observed that the edible seaweeds contain a significant amount of the protein, vitamins and minerals essential for the human nutrition. The nutrient composition of seaweed varies and is affected by the species, geographic areas, and seasons of the year and temperature of the water. Seaweeds have recently received significant attention for their potential as natural antioxidants. Most of the compounds of marine algae show anti-bacterial activities. Many metabolites isolated from marine algae have been shown to possess bioactive efforts.

Little study has been carried out on *kappaphycusspps*as biofertiliser which in turn will yield high nutritional seeds/products. The macro algae, red algae (*kappaphycussps)* grow in abundance as dominant communities in the shores of Kanyakumari and Ramanthapuram Districts of Tamil Nadu State, India. Further, the information is lacking on the seasonal and geographic variations in the specific bioactive metabolites of marine algae of antimicrobial potential, especially for the marine algae of South India. It is important to study in depth the biochemical composition, nutraceuticals, biofertiliser and antibacterial activity of red algae at different locations/places and seasons along of coastal regions of Tamil Nadu. This paper explores the possibility of use of marine red algae as biofertiliser in view of agricultural applications.

MATERIALS AND METHODS

A biofertilizer (also *bio-fertilizer*) is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of bio-fertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil. Since they play several roles, a preferred scientific term for such beneficial bacteria is "plant-growth promoting rhizobacteria" (PGPR). Therefore, they are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients through microorganism and their byproducts. Hence, bio-fertilizers do not contain any chemicals which are harmful to the living soil. Bio-fertilizers ecofriendly organic agro-input and more cost-effective than chemical fertilizers. Bio-fertilizers such as Rhizobium, Azotobacter, Azospirillum and blue green algae (BGA) have been in use a long time. Rhizobiuminoculant is used for leguminous crops. Azotobacter can be used with crops like wheat, maize, mustard, cotton, potato and other vegetable crops. Azospirillum inoculations are recommended mainly for sorghum, millets, maize, sugarcane and wheat. Blue green algae belonging to a general cyanobacteriagenus, *Nostoc* or *Anabaena* or *Tolypothrix* or *Aulosira*, fix atmospheric nitrogen and are used as inoculations for paddy crop grown both under upland and low-land conditions. *Anabaena* in association with water fern Azolla contributes nitrogen up to 60 kg/ha/season and also enriches soils with organic matter.

Alla et al. (1994) examined the effect of commercial inoculant of cyanobacteria on wheat cv. Sakha 69 grown in pot experiments using sterilized or non-sterilized clay and/or sand soils introduced as a resultTreatments were control (water), live cyanobacteria, killed cyanobacteria, live cyanobacteria plus K, P and S, killed cyanobacteria plus K, P and S and K, P and S only. Live inoculant and live inoculant plus K, P and S significantly increased dry weight, total nitrogen, and pigment contents of wheat plants over control and other treatments. The increase in growth parameters could be attributed to the substantial increases of N2-fixation due to nitrogenase activity of the cyanobacteria. The promotive effect of cyanobacterial inoculant, especially on growth, hold promise for use of such inoculants to enhance the nitrogen status of irrigated plantation crops.

Field experiments were conducted by Tripathi et al. (2008) to analyze the growth performance, elemental composition (Fe, Si, Zn, Mn, Cu, Ni, Cd and As) and yield of the rice plants (Oryza sativa L. cv. Saryu-52) grown under different doses of fly-ash (FA; applied @ 10 and 100 t ha^{-1} denoted as FA_{10} and FA_{100}, respectively) mixed with garden soil (GS) in combination with nitrogen fertilizer (NF; applied @ 90 and 120 kg ha^{-1} denoted as NF_{90} and NF_{120}, respectively) and blue green algae biofertilizer (BGA; applied @ 12.5 kg ha^{-1} denoted as $BGA_{12.5}$). Significant enhancement of growth was observed in the plants growing on amended soils as compared to GS and best response was obtained in amendment of FA_{10}+NF_{90} + $BGA_{12.5}$. Accumulation of Si, Fe, Zn and Mn was higher than Cu, Cd, Ni and As. Arsenic accumulation was detected only in FA_{100} and its amendments. Inoculation of $BGA_{12.5}$ caused slight reduction in Cd, Ni and as content of plants as compared to NF_{120} amendment. The high levels of stress inducible non-protein thiols (NP-SH) and cysteine in FA_{100} were decreased by application of NF and BGA indicating stress amelioration. Study suggests integrated use of FA, BGA and NF for improved growth, yield and mineral composition of the rice plants besides reducing the high demand of nitrogen fertilizers.

Upasana Mishra and Sunil Pabbi (2004) mentioned that the basic method of mass production involves a mixture of nitrogen fixing cyanobacteria in shallow trays or polythene lined pitsfilled with water kept in open air, using clean, sieved farm soil as a carrier material. To each pit 10 kg soil and 250 g single super phosphate is added and water is filled upto a height of 12-15 cm. Starter culture, a mixture of *Anabaena*, *Nostoc*,*Aulosira*and *Tolypothrix,* is inoculated in each multiplication unit. Malathion (5-10 ml per tank) or carbofuran (3% granules, 20 g per tank) is also added to prevent insect breeding. In hot summer months, the cyanobacteria form a thick mat over the surface after 10-12 days of growth in open sun. The contents are allowed to dry and the dried flakes are collected, packed and used to inoculate rice fields. The basic advantage of this technology is that farmers after getting the soil based starter culture can produce the biofertilizer on their own with minimum additional inputs. An inoculum of 10-12 kg is considered sufficient to inoculate one hectare of paddy field 3-4 days after transplantation.

Experiments were conducted by Begum et al. (2011) in the field 4 km south-east of Bangladesh Rice Research Institute, Gazipur during T-Aus and Boro seasons using two High Yielding Varieties (HYV) of rice namely BR-28 and BR-29 as the test crop to evaluate their response to applied cyanobacterial inoculum and urea-N at different combinations. Thirty days old rice seedlings of uniform health and size were transplanted in experimental plots of 5 m2 at the rate of 3 seedlings/hill and the hill to hill distance maintained was 6 inches. The treatments used (kg ha-1) were N0P0K0S0 inoculum0 (control), N97P18K52S18 inoculum0 (RFD), N78P18K52S18 inoculum1 (minus 20% urea N), N58P18K52S18 inoculum1 (minus 40% urea-N) and N19P35K52S18 inoculum0 (minus 80% urea- N). Treatments were arranged following a randomized block design with four replications. Agronomic practices were done whenever required up to maturity of the crop. Fertilizers were applied as urea-N, TSP-P, MP-K and gypsum-S. One-third of N together with PKS were applied at final land preparation. The rest two-third of N was incorporated in three equal instalments at 30 and 60 days of transplantation. However, the extra amount of P was added in three equal splits at 10, 20, and 30 days transplantation. Species of *Nostocspongiaeformae*Dh 164, *Nostoc commune* Dh 169, *Calothrixmarchica*Dh 167 and *Stigonema*Dh 168 were grown in plastic bowls separately keeping on window sill along with foam blocks of 1 cm2 surface area. All the strains were mixed on the day of inoculation with fresh foam (about 0.1 m2 foam-based inocula were mixed with 0.3 m^2 fresh-foam blocks) and spread on designed plots at the rate 1 kg dry inocula $ha^{-1.}$ Agronomic parameters were recorded following collection of four hills from each plot. Grain yield was, however, recorded at harvest. Riceter L. PB-2106 kett standard moisture meter was used to estimate the moisture content of the grains and corrected to 14% in calculating the yield. The weight of oven dried (80ºC for 24 hours) straw was also measured.

SUMMARY

Little study has been carried out on *kappaphycussps*as biofertiliser which in turn will yield high nutritional seeds/products. The macro algae, red algae (*kappaphycussps)* grow in abundance as dominant communities in the shores of Kanyakumari and Ramanthapuram Districts of Tamilnadu State, India. Further, the information is lacking on the seasonal and geographic variations in the specific bioactive metabolites of marine algae of antimicrobial potential, especially for the marine algae of South India. From the review, it is observed that it is essential to study in depth the biochemical composition, nutraceuticals, biofertiliser and antibacterial activity of red algae at different locations/places and seasons along of coastal regions of Tamilnadu.

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