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STUDIES ON *SPIRULINAS* FROM NORTH EAST RAJASTHAN

RANDHIR SINGH GAJRAJ and **PUSHPA SRIVASTAVA**

Department of Botany, University of Rajasthan, Jaipur-302 004 India.

Cyanobacterium *Spirulina* - the commercial enterprise has been surveyed in different parts of Rajasthan. Among 9 species reported in the present communication, 3 species viz. *S.subtillissima*, *S. meneghiniana* and *S.subsalsa* (Turpin) have been reported for the first time.

Keywords : Cyanobacterium; Species; *S. subtillissima; S. meneghiniana; S. subsalsa.*

Introduction

Microalgae became an attractive candidate for the 'food for the future' due to their higher protein contents and potentials for other nutritional accumulations[1,2]. Their additional benefits in therepeutic and chemopreventive applications add to their significance[3].

There has been a long dispute between *Arthrospira* and *Spirulina* placing as separate taxa or under one genus. Algologists after staining[4-9] noted only one genus *Spirulina* has been recognised, but they split it into two subsections i.e., *Arthrospira* (stizenb) Geitler and *Euspirulina fortii.* It has been suggested that the septate forms should be delimited to *Arthrospira* . But the status of various *Spirulina* species and their separation or amalgamation, still remained a dubious question.

A survey of blue greens was carried out in different parts of north-east Rajasthan, describing *Spirulinas.* The arid and semi arid zones provided extreme climatic conditions, suitable for blue greens and *Spirulinas* in particular. Tracing out a superstrain among the prevailing germplasms of *Spirulinas* in the north east part of Rajasthan could serve the purpose of the production of high quality protein and other nutritionally and therapeutically important products in the desert terrains.

Materials and methods

A survey was carried out in and around Jaipur, Alwar and Sambhar districts. *Spirulinas* were found concomitant with other algal varieties in and around road side puddles in Jaipur, on moist soil in Alwar (Jaisamand and Seliserh) and in Sambhar lake as planktonic forms. *Spirulinas* were isolated following micropipetting and dilution methods. Out of nine species, five viz. *Spirulina subsalsa* Oerst ex Gomont (marine), *Spirulina subsalsa* Oerst ex Gomont (fresh water), *S. meneghiniana* Zanard ex Gomont (fresh water), *Spirulina labryrinthiformis* (mengh) Gomont and *Arthrospira platensis* (Rich) were raised successfully into their desired culture media and optimum culture conditions (Fig.1). Rest of them were fixed in 4% formalin. Identification and taxonomic positions were determined by lines proposed by Desikachary[10].

Results and discussion

Spirulina subsalsa, Oerst ex Gomont (Fig. 1-A) formed water blooms on the surface of brine in salt Kyars of Sambhar lake associated

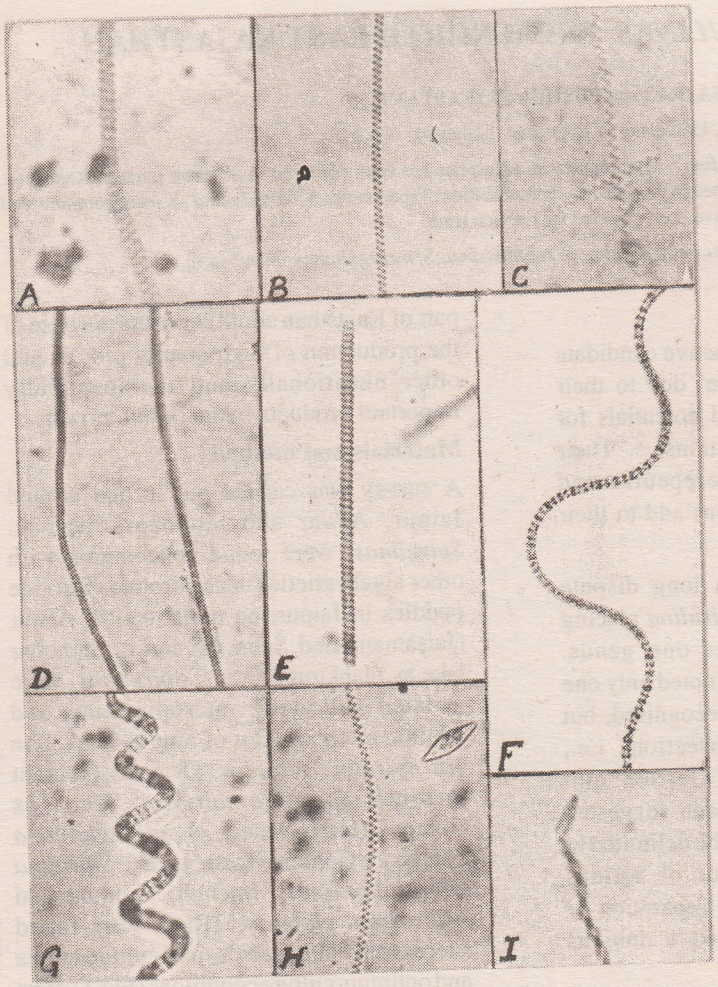

Fig. 1. Showing different *Spirulinoid* forms
A. *Spirulina subsalsa* Oerst ex Gomont.(X 2400).
B. *Spirulina meneghiniana* Zanard ex. Gomont.(X 2400).
C. *Spirulina subtillissima* Kutz ex Gomont.(X 2400).
D. *Spirulina labyrinthyformis* (menegh) Gom. (X 2400)
E. *Spirulina subsalsa* Oerst ex Gomont.(X 2400)
F. *Arthrospira platensis* Rich (X 2400).
G. *Arthrospira platensis* (Nordst) ex Gomont. (X 2400).
H. *Spirulina meneghiniana* Zanard ex Gomont. (X 2400).
I. *Spirulina subsalsa* Turpin (X 2400).

Table 1. Showig site and environmental requisites of Different algal isolate.

S.No.	PLACE	ALGAL ISOLATES	SITE	MONTH	TEMPERATURE	pH
1.	JAIPUR					
	a/Vaishalinagar	*S.labyrinthiformis* (menegh) Gom.		June-July	28-42^{0}C	8.5
	b/ Jyotinagar	*S. subsalsa* oerst ex. Gomont. *S.menighiniana* Zanard ex Gomont *A.platensis* Rich.	Road side Puddles	Oct-Nov.	22-34^{0}C	8.8
2.	ALWAR					
	a/ Jaisamand b/ Seliserh	*S.substillissima* Kutz ex Gomont.	Moist soil	Nov.	20-32^{0}C	8.5
3.	SAMBHAR	*A. platensis* Nordst ex Gomont.				
	a/ Salt Lake	*S.subsalsa* Oerstex Gomont *S. subsalsa* Turpin *S. meneghiniana* Zanard ex Gomont.	Planktonic	Round the year	12-36^{0}C	11-12

Table 2. Showing habitat and Dimensions of different algal isolates.

S.No.	ALGAL ISOLATES	TRICHOME BREADTH (µm)	SPIRAL BREADTH (µm)	PITCH (µm)	HABITAT
1.	*Spirulina subsalsa* Oerst ex Gomont.	5.0 -6.25	2.5 - 3.25	2.5 - 3.25	Saline
2.	*Spirulina subsalsa* Oerst ex Gomont	4.5 -5.0	2.0 - 2.5	2.0 - 2.5	Fresh water
3.	*Spirulina subsalsa* Turpin	2.5 -3.0	2.5 - 3.25	2.5 - 3.0	Saline
4.	*Spirulina meneghiniana* Zanard ex Gomont	3.0 - 3.5	3.25 - 4.5	2.5 - 3.25	Fresh water
5.	*Spirulina meneghiniana* Zanard ex Gomont	2.75 -3.25	3.0 - 4.0	2.25 - 2.50	Saline
6.	*Spirulina subtillissima* Kutz ex Gomont	2.5 - 3.25	3.25 - 3.25	3.25 - 4.0	Fresh water
7.	*Spirulina labyrinthyformis* (menegh) Gom.	2.75 -3.0	2.0 -2.5	1.25 -2.5	Fresh water
8.	*Arthrospira platensis* Rich.	6.0 -7.5	50 -75	75 -125	Fresh water
9.	*Arthrospira platensis* (Nordst) ex Gomont.	6.25 -7.5	25 -40	30 -50	Saline.

with species of Oscillatoria, Anabaenopsis and several diatoms. It had dark blue green colour and grew luxuriantely well in high pH of Sambhar lake (Table-1). Thick and slimy muscilage was an adaptive feature of the genus with two filaments coiled helically around each other with 5-6.5 mm breadth. Irregularly dense spiral coiling of the filaments but some times loose coilings were also noted. It seems to be the characteristic feature of the species as has been mentioned in earlier reports[10].

Spirulina subsalsa Turpin (Fig.1-I) a yet another planctonic variety of light blue green colour was found mixed with species of *Rhizoclonium, Oscillatoria* and several diatoms in Sambhar lake. It differed from the other species (Fig.1-A) in its reduced trichome breadth 2.5-3.0 mm (Table-2). It also had irregular loose coiling of filaments.

Spirulina subsalsa oerst ex Gomont (Fig. 1-E) was one of the most agile species reported along the road side puddle in Jaipur city (Table-1) and showed close resemblance to the halotolerant species in its morphology (Fig.1-A). Species of *Phormidium, Oscillatoria* and *Plectonema* were found associated with it. Absence of thick mucilagenous sheath was a significant character of this speices of *Spirulina*.

Spirulina meneghiniana Zanard ex Gomont (Fig. 1-B), a rare species recorded for the first time from the state of Rajasthan alongwith the species of *Oscillatoria, Phormidium* and diatoms.The flexible and irregular spiral coiling of the fresh water form showed close resemblance to its counterpart *S. meneghiniana* Zanard ex Gomont (Fig. 1-H), but differed in having reduced trichome breadth of 2.75-3.25 mm and a thin muscilagenous sheath around. This bright blue green coloured form had spirals of 3.0-4.0μm and a pitch of 2.25-2.5 μm.

Spirulina labyrinthiformis (menegh) Gomont (Fig. 1-D) was floating over the surface of a puddle in Jaipur with a number of species of *Oscillatoria* and diatoms. It was a thermotolerant speices (Table-1).Long trichomes with slightly loose spirals were specific features of the species. Its spiral and pitch breadth varied from 2.0-2.5 and 1.25-2.5 mm respectively, while trichome breadth was 2.75-3.0 μm (Table - 2).

Cultures collected from the moist and alkaline soils of Jaisamand and Seliserh (Alwar) revealed an entirely new species - *Spirulina subtillisima* Kutz ex Gomont (Fig. 1-C). Light blue green form with regular spirals was thrivig well along the species of *Lyngbya, Synechocystis, Phormidium* and *Pseudoanabeana.* Trichomes were 2.5-3.25 μm broad, spirals being 3.25 μm brood with a intermittant distance of 3.5-4.0 μm.

Arthrospira platensis Rich (Fig.1-F) a fresh water form was found in a puddle on Jaipur along with the species of *Oscillatoria, Phormidium,. Synechocystis* and several diatoms. Septate lush blue green trichomes with broad and regular spirals differed from its counterpart from saline habitat *Arthrospira platensis* (Nordstex Gom.) (Fig.1-H) in the size of pitch and spiral breadth (Table-2).

Of the nine species described three species of *Spirulina* are fresh on record from Rajasthan. *S. subsalsa* Turp. from fresh water habitat is being reported for the

first time. *S.subtillissima* has earlier been reported from Calcutta, Mudurai, Bombay and Pamban and *S.meneghiniana* from Calcutta, as has been quoted by Desikachary[10].

Spirulina suffered many vesititudes. In his monographic work Desikachary[10] described free floating trichomes, unbranched and non-heterotrichous, but differentiated into cells as *Arthrospira* and those without it as *Spirulina*. This system was primarily followed by Desikachary and Bai[11] who also treated *Spirulina* and *Arthrospira* as separate genera. Recently Bourrelly[12] while discussing the status of *Spirulina* have proposed *Arthrospira* and *Spirulina* to be distinct genera. However, Holmgren *et al*[13] has gone a step ahead in his fresh water treatise to merge *Arthrospira* in *Oscillatoria.* But, Bourrelly[12] felt that spiral *Oscillatorias* may be the stages in the life history of certain *Arthrospira* species. They, further suggested that straight forms may be referred to *Oscillatoria* and wavy and serpentine forms under *Arthrospira.* Further studies of Gupta and Changwal[14] found cross walls in *Spirulina major* and suggested the transfer of *Spirulina* to *Arthrospira,* while Tomaselli and Tredici[15] emphasised that *Arthrospira* has wrongly been used as *Spirulina.* They have described that the presence of two filaments in a single unit and absence of cellular septation under light microscope as main characters of *Spirulina* single filament, straight or variously coiled with visible septa should be called *Arthrospira.*

Based on the toxicological and nutritional studies it was emphasised that the genera *Spirulina* and *Arthrospira* are quite different and are probably not closely related phylogenetically. In view of these suggestions, *Spirulina* and *Arthrospira* have been treated as separate entities in the present communication.

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