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Yield and quality of agars in selected members of *Gelidiales* and *Gracilariales*

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Abstract

The red algae *Gelidium micropterum, Gelidiella acerosa, Gracilaria fergusonii* and *Gracilaria millardetii* were collected from south east coast of Tamil Nadu, India, during summer and winter. Phycocolloids were extracted and their yield and physico-chemical properties were determined. The gel strength of agar was dependent on high 3,6 anhydro galactose content and inversely related to the sulphate. Seasonal variations were compared.

Keywords : 3,6 anhydrogalactose, gel strength, phycocolloids, sulphate, viscosity, yield

INTRODUCTION

Agar is a major gelling polysaccharide obtained from a number of Rhodophyceae, especially from two main families Gelidiaceae and Gracilariaceae. It is a polysaccharide composed mainly of two sugar residues, D-galactose and 3, 6 anhydro-L-galactose with smaller proportions of other monosaccharides and substituent groups. Agar is of great importance in the food and drug industries and also in non food applications such as in the preparation of cosmetics, leather and textile industries. It is also used as emulsifier in dairy products. Agar- Agar is of great value in the preparation of jellies and is particularly used in slimming diet. It is also used as a base for culture media in bacteriology, plant tissue culture, biochemistry and molecular biology.

Carter and Anderson (1986) reported seasonal growth and agar contents in *Gelidium pristoides* from South Africa. The physicochemical properties of *Gelidium* sp. was studied by Zanlungo (1980). The quality of agar varies with environmental conditions of the locality of *Gelidiella acerosa* (Laserna *et al.*, 1981; Mathew *et al.*, 1993; Roleda *et al.*, 1997 and Villaneuva *et al.*, 1999). Several workers have analysed the phycocolloids obtained from *Gracilaria* spp.and it is interesting to note the variations in the yield among different species. Seasonal variations of agar in *Gracilaria corticata* was reported by Oza (1978), *G. edulis* by Chennubhotla *et al.*, (1986) and Kaliaperumal and Uthirasivan (2001). However, information is available only with reference to few Indian species. So in the present work, an attempt has been made to study the yield, gel strength and other physico- chemical characters of phycocolloids in selected members belonging to Gelidiales and Gracilariales.

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MATERIALS AND METHODS

The red algae *Gelidium micropterum* Kuetz., *Gelidiella acerosa*(Forsskal) Feldmann & Hamel, *Gracilaria fergusonii* J. Ag., and *Gracilaria millardetii* (Mont.) J.Ag., were collected on the south east coast of Tamil Nadu, India, in June 2001 and January 2002 (Table 1). Specimens were collected up to the depth of 0.5 - 1.0 meter in inter tidal regions during low tide. They were cleaned and freed from epiphytes and thoroughly washed before drying in the shade. Mostly vegetative thalli in bulk were dried in shade, stored in polythene bags and used for extraction of cell wall polysaccharides. Generally the cell wall polysaccharides are soluble in water (Visweswara Rao *et al.*, 1965). Therefore hot water extraction method was adopted. The polysaccharides of summer and winter collections from these algae were dried in dessicator. The dried polysaccharides were powdered and transferred to air tight glass bottles and stored for quality analysis.

Physico- chemical characteristics of Polysaccharides

Gelling temperature, melting temperature and Gel Strength were determined for 1.5% phycocolloid as per the methods described by Hellebust and Craigie (1978). Viscosity of 0.1 % phycocolloid sample at 30°C was determined using Ostwald's Viscometer. The values were expressed as centipoise (cps). Here 0.1% phycocolloid was used because 1% phycocolloid gels at room temperature. The percentage yield of the dried polysaccharide was calculated from the dry weight of the original sample (raw material). For the estimation of chemical composition of polysaccharide, extraction was done by the method of Hellebust and Craigie (1978). Total Galactose was estimated by the phenol sulphuric acid method (Dubois *et al.*, 1956; Hellebust and Craigie, 1978). 3, 6 anhydrogalactose (3, 6 AG) was estimated following the acetal - resorcinol method of Yaphe and Arsenault (1965). Sulphate content was estimated by following the method of Verma (1977).

Table 1. Species of algae used in the present study and place of collection

S.No.	Algal species	Order	Place of collection	Latitude	Longitude
1	*Gelidium micropterum*	Gelidiales	Kanyakumari	8°4[illegible] N	[illegible]° 34
2	*Gelidiella acerosa*	Gelidiales	Pudumadam	[illegible]	[illegible]°32
3	*Gracilaria fergusonii*	Gracilariales	Kanyakumari	[illegible]N	[illegible]° 34
4	*Gracilaria millardetii*	Gracilariales	Rameswaram	9.28°N	79°E

RESULTS AND DISCUSSION

The seasonal variations in the physico-chemical properties of the agars are shown in Table 2. In the present study, the yield and physico-chemical properties of agars exhibited seasonal variations. The agar yield varied from 15 to 39 %. The maximum yield was obtained in G*elidium micropterum* and minimum in the summer collection obtained from *Gelidiella acerosa.* High agar yields were found in plants harvested during winter in all the species. This is comparable with earlier observations (Oza, 1978; Chennubhotla *et al.*, 1986; Bird and Ryther 1990; Villanueva *et al*., 1999). However, Carter and Anderson (1986) and Mouradi-Givernaud *et al.*, (1992) have recorded increased yield of agar in summer. The agar yield was positively correlated with temperature and salinity. The high yield of agar in winter in the present study might be attributable to the less stressful conditions of temperature and salinity during this season which is characteristic of the tropical climate. The lower agar yield obtained during dry months could be attributed to desiccation stress due to the periodic exposure of plants to air which probably led to the inhibition of agar production. It seems that in response to high summer temperature and decay after the development of reproductive structures, there is no active agar synthesis during summer.

The gel strength of agars in these algae ranged from 84 to 562 g /cm^2 .The highest value of gel strength was observed in *Gelidium micropterum* in both seasons. The agar extracted from *Gracilaria fergusonii* showed minimum gel strength. In general, the samples collected during summer recorded higher gel strength than those collected in winter. The peak of gel strength was observed during summer, similar to the observations of Whyte *et al.* (1981), Chennubhotla *et al.* (1986), Bird and Ryther (1990), Mouradi-Givernaud *et al*. (1992), Villanueva *et al.* (1999) and Kaliaperumal and Uthirasivan (2001). The gel strength and the yield of agar were reported to be positively correlated with temperature by Sasikumar *et. al*. (1999). The same correlation was observed in the present study. Low gel strength might be due to high sulphation in the polysaccharides (Table 2) as sulphated residues strongly reduce the gel strength (Whyte *et al.,* 1981; Mouradi-Givernaud *et al.*, 1992). The gel strength of agar was dependent on high 3,6 anhydro galactose content and inversely related to the sulphate(Asare,1980; Craigie and Wen,1984). In the present study, the phycocolloids showed high gel strength, when 3, 6 anhydrogalactose was high and that of sulphate was low.

Gelling temperature of 1.5% agars ranged from 34-43°C and melting temperature from 72-88°C. In the present study, melting temperature showed a significant positive correlation with gelling temperature and with gel strength. Gelling temperature of *Geldium micropterum* and *Gelidiella acerosa* ranged from 36 to 43°C and are comparable with earlier reports for *G. acerosa* (Thomas *et al.*, 1975 and Villanueva *et al.,* 1999). The gel strength showed positive significant correlation with melting temperature and yield whereas an inverse significant correlation is exhibited with sulphate. Similar observation was reported by Sasikumar *et al.* (1999). Seasonal variations were observed in gelling and melting temperature of agar in these algae with maximum values in summer. There is strong variability in gelling mechanism. Gelling ability of agar depends on the molecular weight and the level of 3, 6 anhydrogalactose (Whyte *et al.,* 1981).

The viscosity of agar solutions was found to be positively correlated with gel strength by Roleda *et al.* (1997). But no significant correlation was noticed by Villanueva *et al.* (1999). In the present study, viscosity of 0.1% agar, recorded from 0.5 to 0.8 cps, was higher in summer. However, no significant correlation was found in the present study between melting temperature and viscosity values which usually provide a comparison of polymer size as already pointed out by Whyte *et al.* (1981).

CONCLUSION

On the basis of the present observations, one may be led to assume that commercial harvesting should be concentrated during the summer season, when the yield is optimum and the gel strength is maximum.

Table 2. Physico-chemical properties of agar obtained from selected members of *Gelidiales* and *Gracilariales*

Parameter	*Gelidium miocropterum*		*Gelidiella acerosa*		*Gracilaria fergusonii*		*Gracilaria millardetii*	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Yield (%)	25	39	15	18	19	21	16	18
Viscosity (cps)	0.6	0.5	0.6	0.5	0.8	0.6	0.7	0.6
Gelling temperature (°C)	48	39	42	36	40	34	41	36
Melting temperature (°C)	88	82	83	79	76	72	80	74
Gel strength (g/cm^2)	562	539	342	239	126	84	148	96
Galactose (%)	48	50	40	48	40	42	42	46
3,6 anhydro galactose (%)	39	37	40	32	43	40	39	35
Sulphate (%)	0.4	0.9	1.0	1.8	3.0	3.2	1.7	1.8

However, biomass production in summer is less and therefore not favourable for such a practice. Since most of the plants analysed were vegetative, the changes in the amount of anhydrogalactose and sulphate may be important in determining the time of the year to obtain desirable quality gel. According to the American society of Microbiology (Meer, 1980), the gelling and melting temperature specifications for bacteriological agar are 33-38 ºC and 80 ± 5ºC, respectively, giving a temperature hysteresis of 42-52 ºC. Of the South Indian species studied here, only the agar obtained from *Gelidium miocropterum* and *Gelidiella acerosa* can be recommended for use in microbiology as these conform to the above specification.

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