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Production of export quality agar

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The seaweeds are the renewable and economically valuable wealth of the sea. The phytochemicals agar and algin are produced from the seaweeds. The red algae ***Gelidiella acerosa*** and ***Gracilaria edulis*** are the source of raw materials for agar industries and ***Sargassum*** and ***Turbinaria*** for algin industries. Annually 50 tons of agar and 500 tons of alginates are manufactured in India.

Two grades of agar are produced in India namely food grade and IP Grade. (Bacteriological grade). Gel strength is the main criteria for differentiating these two types of agar. ***Gracilaria edulis*** is used for food grade agar and ***Gelidiella acerosa*** for IP grade agar. The specifications for the food grade and IP grade agars are given below.

1. Food Grade Agar (Indian Bureau of Standards IS : 5707 - 1970)

Characteristics	Requirements
1. Water absorption	to pass the test
2. Moisture, % by weight on drying at 105° C for 5h, max.	20.0
3. Total ash, % by weight, max.	6.5
4. Acid insoluble ash, % by weight max.	1.0
5. Gelatin	to pass the test
6. Insoluable matter, % by weight max.	1.0
7. Starch and dextrin	to pass the test
8. Arsenic (as As), mg/kg max.	3.0
9. Lead (as Pb), mg/kg, max.	10.0

2. Bacteriological Grade Agar (Indian Bureau of Standards IS : 6850 - 1973)

Characteristics	Requirements
1. Moisture, % by mass on drying at 105°C for 5h, max.	to pass the test
2. Total ash, % by mass, max.	20.0
3. Acid insoluble ash, % by mass max.	1.0
4. Gelatin	to pass the test
5. Insoluble matter, % by mass, max.	1.0
6. Arsenic (as As) mg/kg	3.0
7. Lead (as Pb), mg/kg	10.0

In India most of the agar industries are following preacid treatment method for extraction of agar i.e., the sun dried seaweeds washed with water to remove the sand and other impurities. The seaweeds are then treated with hydrochloric acid. The acid treated seaweeds

are washed with water to neutralise. Then the seaweed is boiled in the agar extraction vessel (agar digester) under steam pressure for 1-2 hours. The gel is collected in trays and kept in the freezing unit for 24 hours at low temperature. After thawing, the agar sheets are bleached, sun dried and marketed. The agar produced by preacid treatment usually have low gel strength. In foreign countries like Japan, Thailand and China several methods of alkali treatments have been developed to improve the gelling ability of agarophytes and particularly ***Gracilaria*** species. It was found ***Gracilaria*** agar gels are superior in gel strength than ***Gelidium*** agar due to alkali treatment.

As gel strength is the most important physical property for commercial agar, reducing the sulphate content is beneficial to increase gel strength. The most effective methods of desulfation is alkali treatment. The bacteriological agar grade should be neutral and contain the least possible amount of sulphate. The demand for agar as culture media is so high that prices increased considerably. The agar gel is more suitable as culture medium for diagnostic test and tissue culture.

Naturally the plant ***Gelidiella acerosa*** contain very good quality of agar with low sulphate content. However the pretreatment of ***Gelidiella acerosa*** with low concentration of sodium carbonate for 30 minutes gives high gel strength upto 700gm/cm^2 whereas the gel strength of agar by acid pretreatment was only 250 gm/cm^2. The sulphate and ash content in alkali treated seaweeds are found in low quantity. In general the agar extracted by acid treatment process shows the gel strength ranging from 100-150 gm/cm^2 in ***Gracilaria*** spp and 200-250 gm/cm^2 in ***Gelidiella*** spp. So care should be taken at various stages in agar production particularly at the stage of pretreatment before boiling the seaweed to improve the gel strength of agar.

The cost of raw material of ***Gracilaria edulis*** is cheaper than the ***Gelidiella acerosa*** and hence most of the industries are utilising the ***Gracilaria*** spp and produce low quality (food grade) agar. As far as ***Gracilaria*** is concerned, the seaweed treatment prior to the extraction is very important as it will influence the sulphate content of the agar. There are three types of processing methods with alkali treatment.

In the first treatment, ***Gracilaria*** seaweed is submerged in moderate concentration of NaOH solution for 5 days or more at room temperature. The volume of NaOH is about 15 to 20 times that of the raw material (dried). By this method the yield and the gel strength of agar are high. The demerits of this method is that it is long time processing method and require large quantities of NaOH and also seaweed immersing tanks. This method is suitable for delicate ***Gracilaria*** plants.

In the second type, the concentration of NaOH is still low but the seaweeds are treated at 60-85^0 C for 16-20 hrs. This is suitable to almost all the species of ***Gracilaria.*** This method also improves the yield and gel strength of agar to a maximum level.

The last method is usually with a very low concentration of NaOH at a higher temperature (90^0-95^{0}C) for 1-3 hrs. The concentration of NaOH and the temperature are dependant on the quantity and texture of ***Gracilaria*** spp. The higher temperature and lower concentration of NaOH are used to treat the seaweeds with hard texture and large quantity. A lower temperature and a higher concentration of NaOH are much more suitable to those seaweeds with delicate texture and poor quality.

In general the following points have to be taken into account to get maximum yield of agar and gel strength for exporting them to earn a very good foreign exchange to our country.

(a) Selection of good grade raw material

(b) **Acid Treatment:** The acid concentration and treating time should be considered.

(c) **Alkali pretreatment:** The alkali concentration, temperature and time of treatment should be considered for better yield and high gel strength of agar.

(d) Neutralization after alkali treatment.

(e) Extraction temperature and time.

(f) **Bleaching:** The concentration of bleaching agent and bleaching time should be strictly controlled. The agar sheets should be thoroughly washed after treating with bleaching agents.

(g) Drying should be kept at lower 60°C to prevent depolymerization of the products.