Seaweed Res. Utiln., 23 (1&2) : 55 - 58, 2001

Commercial scale production of agar from the red alga *Gracilaria edulis* (Gmelin) Silva

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ABSTRACT

Agar is produced on commercial scale from August, 1999 onwards in the Agar Plant at Regional Centre of Central Marine Fisheries Research Institute, Mandapam Camp using the red seaweed *Gracilaria edulis* (Kanji Pasi) as raw material. Agar is manufactured in sheet form by washing the dried seaweed in the agitator tank, treating with Hcl, cooking in the digester by passing steam, collecting the agar gel in aluminium trays, freezing the gel in freezing unit, thawing, bleaching and sun-drying of agar sheets. The yield of agar is found to be 6 to 8%. The gel strength, gelling and melting temperature of 1.5% agar ranged from 74 to 122 g/cm^2, 44 to 46°C and 95 to 97°C respectively. The bleached agar sheets are marketed by packing them in polythene bags. The methods for improving the yield and quality of agar are suggested.

Introduction

In India, seaweeds exploited from natural seaweed beds are used as raw materials for the production of agar, alginates and seaweed liquid fertilizer. There are about 25 agar industries and 10 algin industries situated at different places in the maritime states of Tamilnadu, Kerala, Karnataka, Andhra Pradesh and Gujarat. Now the red algae such as *Gelidiella acerosa, Gracilaria edulis, G.crassa, G.foliifera* and *G.verrucosa* are used for agar manufacture and brown algae *Sargassum* spp, *Turbinaria* spp and *Cystoseira trinodis* for alginates and liquid seaweed fertilizer. Among these agarophytes, *G.acerosa* yields bacteriological grade agar and species of *Gracilaria* yield food grade agar. The agar yielding seaweeds are harvested since 1966 from the natural seaweed beds of Gulf of Mannar islands, along the coastline from Rameswaram to Tuticorin in Gulf of Mannar area and at Sethubava chatram area in Palk Bay of Tamil Nadu. Data collected by the Central Marine Fisheries Research Institute on seaweed landings in Tamil Nadu from 1978 to 2000 reveal that the quantity (dry wt) exploited in a year during this period varied from 102 to 541 tonnes for *Gelidiella acerosa*, 108 to 982 tonnes for *Gracilaria edulis,* 2 to 96 tonnes for *G.crassa,* 3 to 110 tonnes for *G.foliifera* and 129 to 830 tonnes for *G.verrucosa.* (Silas and Kalimuthu, 1987; Kaliaperumal and Kalimuthu, 1997; Kalimuthu and Kaliaperumal, 1991 and 1996; Kaladharan and Kaliaperumal, 1999; Ramalingam *et. al.,* 2000).

The cottage industry method for extraction of agar from *Gracilaria* species was evolved by Thivy (1960) and commercial scale

method for manufature of agar by Visweswara Rao *et. al.* (1965). In the method given by Visweswara Rao *et. al.* (1965),the quantity of raw material used is less i.e. 8.5 kg only. In the present investigation food grade agar was produced on commercial scale using more quantity (200 kg) of *Gracilaria edulis* (Kanji pasi) raw material. The processing details, yield, gel strength, gelling and melting temperature of agar are presented in this paper. The methods for improving the yield and quality of agar are also given.

Materials and Methods

The plants of *Gracilaria edulis* growing in the Gulf of Mannar islands and Rameswaram area are collected by the fishermen and they are beach dried by the seaweed suppliers after procuring the materials from the fishermen. The dried *G.edulis* (raw material) is purchased from the seaweed suppliers at the rate of Rs.4,100/- to 4,800/- per ton and they are utilized as raw material for the production of food grade agar in sheet form. The method of processing the seaweed for agar is given in the flow sheet. The gel strength of 1.5% agar was determined using a gelometer described by Funaki and Kajima (1951). The gelling and melting temperatures were determined with a thermometer following the movement of lead shots in the setting and melting gels. Replicates from random agar samples were used to estimate the yield and determine the physical properties of agar.

Results

Agar is manufactured in sheet form by washing the dried material of *Gracilaria edulis* in the agitator tank, treating with Hcl, cooking in the digester by passing steam, collecting the agar gel in aluminium trays, freezing the agar gel in freezing unit, thawing, bleaching and sun-drying of agar sheets. The details of these various steps in the processing of seaweed for agar is given in the flow sheet. Some precautions are taken

Production of agar on commercial scale

Dried *Gracilaria edulis* (200 kg)
↓
Leaching in freshwater for 12-18 hours
↓
Washing two times with freshwater in agitator tank (3 washes-10 min.duration each)
↓
Softening of seaweed with Hcl for ½ hr (pH 2 - 4)
↓
Washing with fresh water (7 pH)
↓
Cooking seaweed in digester for 2-3 hrs by passing steam at 50 lb pressure
↓
Settling agar gel for ½ hr
↓
Filtering agar gel through filter cloth
↓
Collection of agar gel in aluminium trays
↓
Cooling agar gel at room temperature for 1 - 2 hours
↓
Shredding agar gel with gel chopper
↓
Freezing agar for 24 hours (till temp.comes down to –20 °C)
↓
Thawing agar after removal from freezing room
↓
Drying agar in sun on velon screen frames
↓
Bleaching agar in 10% chlorine water for 5-10 minutes
↓
Washing agar with fresh water for 2-3 times
↓
Drying agar in sun on velon screen frames
↓
Dried agar (15 kg)
↓
Packing dried agar sheets in polythene bags (1 kg packets)
↓
Sale

while processing. For instance, the quantity of Hcl used for softening the seaweed after washing with freshwater in the agitator tank depends on the growth stage of alga and quality of the raw material. Similarly just before completion of cooking, if necessary, required quantity of soda ash is added to neutralise the gel, for easy flow and filteration of agar gel.The yield of agar varied from 6 to 8% depending on the stature, moisture content and purity of plants. The gel strength, gelling and melting temperature of 1.5% agar varied from 74 to 122g/ m^2, 44 to 46°C and 95 to 97°C respectively.

Discussion

During and after the second world war, attempts were made to extract agar from Indian seaweeds (Bose *et. al.*,1943; Chakraborty, 1945; Joseph and Mahadevan, 1948; Karunakar *et. al.*, 1948). These workers used different techniques for purification of agar gel. In the method given by Bose *et.al.* (1943), the seaweed was leached for 18 hours before extraction and the gel was maintained at 60°C to remove the suspended impurities. Starch present in the gel was removed by treating with 0.2% acetic acid for 1 hour and then washing the gel in water. Similarly in the present method also the seaweed is leached for 12-18 hours before agar extraction and the starch present in the gel is removed by bleaching with 10% chlorine water for 5-10 minutes and then thoroughly washing with fresh water for 2 to 3 times. Karunakar *et. al.* (1948) employed bacteriological method for purification of gel. Chakraborty (1945) used freezing technique to remove the suspended impurities. In the present method also freezing technique is followed to remove the suspended material from the agar gel. Mohanty (1955) found that heating under pressure at 230°F was necessary for the removal of impurities in the gel of *Gracilaria verrucosa.*

Pillai (1955) observed 60-90% minerals and a good amount of sulphur, nitrogenous matters and carbonates occurring in water soluble form and these compounds which come as impurities while extracting agar could be removed by pulverising, soaking and washing the weed. Based on this important observation, a cottage industry method was developed in the Central Marine Fisheries Research Institute for the manufacture of pure agar from *Gracilaria edulis* (Pillai, 1955; Thivy, 1960). In this method the impurities are removed from the seaweed before extraction and not from the gel. The leaching process will minimise the cost of production since large-scale equipments are not involved for freezing the gel. The yield from the pulverised weed is also higher than that obtained in the other methods.

Several methods were described subsequently for large-scale agar extraction with minor modification given in the process by Thivy (1960). Kappanna and Visweswara Rao (1963) suggested that the quality of agar could be improved by freezing and thawing which is adopted in the present processing. In the pilot plant trials conducted later, Visweswara Rao *et. al.* (1965) soaked the pulverised weed overnight in fresh water before wet-grinding and extraction of agar. In the present attempt on agar production, pulverising and wet-grinding of seaweed are not done as it is not practically possible in large scale extraction The method suggested by Srinivasan and Santhanaraja (1967) is more or less similar to the method described by Kappanna and Visweswara Rao (1963) except pulverising of seaweed into fine powder before extraction. Desai (1967) suggested 90% industrial alcohol for the flocculation of agar from filtrate to eliminate the cost of freezing.

In general, the yield and quality of agar can be improved by the following methods i.e. using pure raw material with minimum moisture content (< 20%) and without sand, unwanted algae and other foreign matters;

pretreating the seaweed with acid (Hcl); pretreating the seaweed with alkali (Na OH); neutralising after acid/alkali treatment; changing the period of cooking, cooking pressure and temperature according to the statue/quality of seaweed; using of best bleaching agent and changing the duration of bleaching; washing of agar sheets thoroughly with fresh water after treating with bleaching agents and proper drying of agar sheets.

Acknowledgement

The auhors express their thanks to Dr. M. Devaraj and Dr. V. Narayana Pillai, Foremer Directors, CMFRI, Cochin and Dr. Mohan Joseph Modayil, Director, CMFRI, Cochin for encouragement and facilities provided. They are grateful to ICAR, New Delhi for providing financial assistance from Revolving Fund to this project work. They are also thankful to Shri. S. Kalimuthu, Technical Officer, Regional Centre of CMFRI, Mandapam Camp for going through the Manuscript.

Literature cited

Bose, J., L. Karimullah and S. Siddique 1943. Manufacture of agar in India. *J. Sci. Indust. Res. (India),* 1: 98.

Chakraborty,D. 1945. Agar-agar manufacture from *Gracilaria confervoides. Jour. Proc. Inst. Chem. (India),* 17 : 188.

Desai, B. N. 1967. Seaweed resources and extraction of alginate and agar. *Proc. Sem. Sea. Salt* and *Plants,* CSMCRI, Bhavnagar. pp. 343-351.

Funaki, K. and Y. Kojima 1951. Studies on the properties of agar-agar from *Gracilaria confervoides.* Part-3. *Bull. Jap. Soc. Sci. Fish.,* 16:401-404.

Joseph, I and S.Mahadevan 1948. *Production of agar-agar.* Dept. Res. Univ. Travancore. Rep. for Septen., pp.55-60.

Kaladharan, P. and N. Kaliaperumal 1999. Seaweed Industry in India. *NAGA (ICLARM),* 22(1) : 11-14.

Kaliaperumal, N and S. Kalimuthu 1997. Seaweed potential and its exploitation in India. *Seaweed.Res.Utiln.,*19(1&2):33-40.

Kalimuthu, S. and N. Kaliaperumal 1991. Unusual landings of agar yielding seaweed *Gracilaria edulis* in Kottaipattinam-Chinnamanai area. *Mar. Fish. Infor. Serv. T&E Ser.,* 108: 10-11.

Kalimuthu, S. and N. Kaliaperumal 1996. Commercial exploitation of seaweeds in India and need for their large scale cultivation. *Proc. Natl. Symp. Aquaculture* for 2000 AD. Palani Paramount Publications, Palani. pp.215-219.

Kappanna,A.N. and A.Visweswara Rao 1963. Preparation and properties of agar-agar from Indian seaweeds. *Indian Jour. Tech.,* 1: 224.

Karunakar,P.D. M.S.Raju and S.Varadarajan 1948. Manufacture of agar-agar from seaweed *Gracilaria lichenoides. Indian Vet. J.,* 24:274.

Mahonty, C. B. 1956. Fishery byproducts industry in India – Seaweeds. *In : Progress of Fisheries Development in India,* Cuttack.

Pillai, V.K.1955. Water soluble constituents of *Gracilaria lichenoides. Jour. Sci. Indust. Res.(India),* 14 B:473-477.

Ramalingam, J. R., N. Kaliaperumal and S. Kalimuthu 2000. Seaweed exploitation in India. *Seaweed Res. Utiln.,* 22 (1&2): 75-80.

Silas,E.G. and S.Kalimuthu 1987.Commercial exploitation of seaweeds in India. *CMFRI Bulletin,* 41: 55-59.

Srinivasan, R. and T. Santhanaraja 1967. Studies on the extraction and properties of agar-agar from the seaweed *Gracilaria* species in Madras State. *Madras Jour. Fish.,* 3 : 146-151.

Thivy, F. 1960. Seaweed utilisation in India. *Proc. Symp. Algology,* ICAR, New Delhi. pp.345-365.

Visweswara Rao, A., K.N.Patel and H.N.Shah 1965. Manufacture of agar-agar from red seaweeds. *Res. Ind.,* 10: 131-133.