Bull. Fish. Res. Stn., Ceylon. Vol. 16, No. 1, pp. 49-52, June, 1963

Small Scale Manufacture of Crude Agar from *Gracilaria* Seaweeds

C. GUNASEKERA,
Fisheries Research Station, Colombo 3, Ceylon

Introduction

A Survey of Ceylon's agar-producing seaweeds (*a*) indicated that considerable amounts of *Gracilaria* were present off Kalpitiya and Mannar on the west coast and off Trincomalee on the east coast. The east coast beds were composed largely of a single species, *Gracilaria confervoides*, and occurred in sufficient quantities for commercial harvesting. Chemical analysis of this species showed it to be a rich source of good quality agar (*b*) and an export market was found for the seaweed in Japan (*c*). In recent years a regular industry has been established on the east coast for the collection and preparation of *Gracilaria* for export (*c*).

Instead of exporting seaweeds it was thought advisable to convert the weed into agar which could then be exported at lower shipping costs for a higher price or marketed locally for domestic use in sweetmeats or for the confectionery industry. In fact, over a ton of prepared agar is imported annually for various purposes which have been listed by Durairatnam (1961).

Methods

Many processes for extracting agar have been described (*d*). All these methods involve the use of chemicals for extraction and purification. A typical process for *Gracilaria confervoides* as practised in Japan (*e*) involves—

(i) washing and sun-drying (bleaching) the weed ;

(ii) alkali treatment to obtain free agar in the weed accompanied sometimes by chemical bleaching ;

(iii) acid extraction of the agar ;

(iv) decolourization with activated charcoal and clarification by pressure filtration with a filter aid ;

(v) separation of water and dissolved salts by slow freezing or by use of a special hydraulic press ;

(vi) drying moist agar in the sun or in a drier.

(*a*) Durairatnam and Medcof, 1954 ; 1955.
(*b*) Durairatnam and Medcof, 1954.
(*c*) Durairatnam, 1961,
(*d*) Marshall, Newton and Orr, 1949 ; Wood, 1946 ; 1947.
(*e*) Gunasekera, 1961.

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An attempt was made to simplify this process stage by stage to make it as easy as possible for local adoption for the production of crude agar.

Laboratory tests for purity of agar extracted were based on methods described in the literature (*d*).

Experimental Work

(i) *Cleaning :* To avoid many stages of purification during or after extraction of agar attention was paid to methods of cleaning the weed before extraction. Prolonged washing left too little time for drying within the day with consequent decomposition of the wet weeds at night. An alkali or acid wash prior to sun-drying reduced the agar content in the weed very markedly. The best procedure was the usual practice of a quick, freshwater rinse followed by several hours of intense sun-drying. After the first rinse to remove mud and similar impurities, the weed was dried and sorted manually to obtain it free from entangled debris, shells and other weeds. The rinsing and drying process was then repeated daily for about a week to obtain a clean, bleached weed. By this careful cleaning process the weight of the dried weed was reduced to 45% of its original dried weight. Laboratory analysis of a batch of dried cleaned weeds showed it to contain 32.4% agar.

(ii) *Pre-treatment :* Omitted.

(iii) *Extraction :* Instead of acid or alkali extraction, the clean weed was boiled with fresh water. A 4% (4 lbs. per 10 gallons) mixture of weeds in water had to be extracted twice to recover all the agar showing that a more dilute mixture would be better. When boiled as a 2% (2 lbs. per 10 gallons) mixture in water for 4 hours, complete extraction was effected as shown by analysis of the residual weeds which contained only about 0.5% agar. If the weed was insufficiently cleaned, less agar was extracted by the boiling process. When extracted in the proportion of 2 lbs. per 10 gallons the liquid set easily to a firm jelly, a form required to effect satisfactory purification.

(iv) *Decolourization and clarification :* Omitted.

(v) *Separation of water and salts :* This is the removal of water (and dissolved salts) from the agar extract after it has set to a firm jelly. A fish meal press was available at the Govt. Fisheries Factory, Mutwal, but proved unsatisfactory in pressing out water from the agar jelly. The freezing facilities available at this factory were a blast freezer (at –40°C) for quick freezing ; an ice-making machine for slow freezing, and cold storage rooms (at –10°C). Agar jelly (98% moisture) when kept in the cold rooms over a 3-day period separated out as frozen agar and ice. When subsequently dried for one day the moisture content reduced to 36% which proved that the separation of water by this method was satisfactory. However, large amounts of jelly at ordinary temperatures cannot be placed in the cold rooms without altering the temperature of the rooms. The ice-making machine had therefore to be used. At normal setting, the ice-making machine froze the jelly overnight in a homogeneous block, i.e., without separating out water and agar. Slowing down the machine so that freezing took one day also failed to effect separation. Two-day freezing also proved unsatisfactory. It was necessary to slow the machine down so as to freeze a 56-lb. block of jelly over a period of 3 days before it was possible to separate ice and agar within the block of jelly.

(*d*) Marshall, Newton and Orr, 1949; Wood, 1946 ; 1947.

(vi) *Drying :* The frozen blocks of jelly with their double layers of ice and agar were left in the sun on cloth to thaw and dry. In one day the moisture dropped to about 36% but it took 3 days to obtain dried agar with a moisture content of 16%. The agar was crude and highly coloured and represented 36.5% of the cleaned weed. As the weed contained 32.4% agar, the crude agar contains at most 90% agar. The actual yield when purified was 75% agar. The pure agar recovered represents over 80% of the agar originally present in the weed, hence the efficiency of the simplified extraction process must be placed at a little above 80%.

(vii) *Tests :* The crude agar had a high ash content of 7–10%. Its gel strength classified it as Grade II agar on the Japanese scale. Purified agar had an ash content of 4% and a gel strength which classified it as Grade I agar on the Japanese scale.

(viii) *Labour :* Cleaning seaweed requires considerable manual labour varying with the state of the weed and the skill of the sorter. In experimental work, about 50 lbs. of weed were cleaned per man-hour. The morning rinse and placing out to dry should be done within $\frac{1}{2}$ hour to completely dry the weed during the day and avoid rotting of damp weed at night. One man can handle about 50 lbs. of weed within this $\frac{1}{2}$ hour. The boiling process is done in dilute solution and so is slow. For example it took 12 man-hours to extract 12 lbs. of seaweed using 60 gallons of water. However if several vats of large size are used together, the rate of processing can be much increased with the same labour force. Similarly the ice-making machine has to be continuously attended by at least one man whatever its size and whether it is filled to capacity or not. Placing the agar to dry each day takes only a few minutes per lb. of agar.

Discussion

The preparation of crude agar is a comparatively simple process which can be done without the use of any chemicals. It requires simple vats for boiling the seaweed in water and some type of freezing apparatus for freezing out water from agar jelly. An ice-making machine provides a very convenient method of freezing using standard equipment. When seaweeds are in short supply the machine can work at ice production or ice may become the main product and agar the subsidiary product.

Crude agar can be exported or sold locally. A further suggestion for marketing seaweeds locally is to sell clean packeted seaweed directly to housewives who can prepare the jelly from the weed in their kitchens by boiling the weed with water and straining off the solid residue.

Summary

A simplified process was worked out to prepare crude agar from red seaweeds (*Gracilaria* sp.). The process required careful preliminary cleaning and bleaching (sun-drying) of the weed. The agar was extracted by boiling with water in a mixture (2%) strong enough to set as a jelly. Freezing the jelly over a 3–day period in an ice-making machine, adjusted to work slowly, separated out ice and agar. The blocks were thawed out and the agar dried in the sun. The efficiency of extraction was over 80%.

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