STUDIES ON THE BLEACHING AND UTILIZATION OF THE SEAWEED "GULAMAN-DAGAT" (*GRACILARIA CONFERVOIDES*)[1]

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The annual occurence of "gulaman-dagat" seaweed (*Gracilaria confervoides*) in Philippine marine waters, especially along the shallow shores of Manila Bay, was first reported by Seale in 1911. The heavy season of this particular seaweed begins from January to the latter part of June every year. The report of Collado (1926)[2] on the nutritive properties of seaweeds, mentioned gulaman-dagat as a possible source of commercial agar and food as well. The amount of gulaman-dagat, found annually along the shallow shores of Manila Bay is enough to supply a home industry for bleaching and drying the seaweed for commercial purposes.

During the Japanese occupation in World War II, gulaman-dagat was used extensively as food in the form of salad and dessert, a kind of preparation similar to various recipes made out of imported commercial agar. Likewise, De Leon, *et al.* (1947), reported that gulaman-dagat is definitely an ideal source of commercial agar. Also in 1951, Kojiman claimed that the quality of agar prepared from *Gracilaria confervoides* is superior to others, and even exceeds the standard specified by the United States Pharmacopeia. A year later, Sulit, *et al.* (1952), mentioned gulaman-dagat, among other seaweeds, as a potential source of commercial agar. However, in spite of the aforementioned properties of this particular marine plant product, there is no move whatsoever in utilizing it in the manufacture of agar in the Philippines. The main reason, perhaps, is the high cost of producing this important commodity in this country as compared with other nations that can utilize the natural cold winter in freezing the solidified agar extract. One of the methods used in the manufacture of dried agar requires freezing temperature to freeze the

[1] Presented at the Indo Pacific Fish Council Meeting, 1961.
[2] Numbers in parentheses refer to references cited.

agar extract, so that drying is easily accomplished outdo in a comparatively short period.

Under Philippine conditions, the authors advocate the dire utilization of the bleached dried gulaman-dagat in the prepar tion of various food products, purposely to create a hor industry project in regions where this seaweed is plentif Bleaching and drying of the seaweeds may create a comm nity home industry in many fishing villages throughout t Philippines. In this manner, importation of commercial ag may be reduced.

The usual practice of bleaching and drying gulaman-dag seaweed under direct sunlight takes at least three days.

The present study was undertaken to find out the best a quickest means of bleaching gulaman-dagat by chemical me ods and the utility of the product.

Gathering the seaweed.—Gathering the seaweed along t shallow shores of Manila Bay usually starts in the early mor ing when the tide is low. It is estimated that at the pe of the season, no less than 1,000 tiklis [3] of seaweed is harvest daily. Each tiklis has an average net weight of thirty-f kilograms of seaweed, and is being sold at prices rangi from ten to twenty-five centavos per tiklis, the price dependi on the distance or place of destination.

Manual raking of the seaweed is a slow process and operate only at a depth under one fathom. To increase t amount of harvest per man hour, an improvised rake is of attached to an outboard motor. This also enable harvest to cover deeper areas even beyond one fathom. A collec with a bamboo basket goes around to each harvester collects the seaweed, which is in turn deposited in a wait "banca' or dugout. As soon as the banca is fully loaded, it towed to transport the seaweed to prospective buyers, m of whom are fishpond operators who use it as supplement feed for the "bangos', Chanos chanos (Forskal).

Bleaching the seaweed.—Several experiments were un taken on bleaching the seaweed. Kojima (1951) used hy chlorides of calcium and sodium successfully in expedi bleaching. Potassium permanganate and hydrogen pero were also tried by him; but it took a longer time to accomp the desired effect with these than with the hypochlorides

Treatment with saturated calcium oxide solution (calcium ydroxide.—In this study, a saturated solution of local ma- erial calcium oxide was used as a preliminary treatment in he sunbleaching of the seaweed. The seaweed was soaked n saturated solution of calcium oxide for several minutes ntil the final color of the seaweed was olive green. It was hen spread on bamboo mattings and moistened occasionally o facilitate the bleaching. As soon as the seaweed was horoughly bleached it was washed with fresh water and then ried in the sun. On drying, the product turned light brown. he whole process of bleaching and drying took 1½ days, epending upon the weather condition. Although calcium xide aids in shortening the time of bleaching, the property f this chemical to harden plant tissues, toughens the seaweed, hereby making it hard to extract the agar from it completely.

Treatment with sodium hypochlorite.—The sodium hypo- hlorite used in this study was prepared in the laboratory by assing chlorine gas to a 5 per cent solution of sodium ydroxide. The solution thus prepared was too strong for leaching the seaweed. Hence, it was diluted by using 1:10 p to 1:50 parts of water. The color of the seaweed was hanged from dark green to olive or pea green. The treated eaweed was spread on bamboo mattings and occassionally noistened with water. As soon as bleached, the seaweed was washed with fresh water and then dried in the sun. With :10 and 1:50 dilutions, the length of time consumed was 0 minutes and 50 minutes, respectively. Although the length f time was shortened in converting the color of the seaweed o light green with the strong and 1:10 dilution of sodium ypochlorite, the gel strength of the agar extract prepared rom the treated dried seaweed was found to be very low Table 2). The 1:50 dilution of sodium hypochlorite proved o be the best as shown by the gel strength of the agar extract repared from it. Table 2 shows that the gel strength is lightly higher in the experiment conducted without the addition f sulphuric acid.

Extraction of agar.—The extraction of agar from the bleach- d, dried seaweed presents another problem. The use of in- rganic acid was advocated by Tressler and Lemon (1951). Kojima reported that at a pH of 6.0 brought about by the ddition of sulphuric acid, greater yield of high quality agar s produced. In the present study, various amounts of one-

tenth normal sulphuric acid (1/10 NH_2SO_4) were used in t extraction of the agar.

For every 5-gram sample of the bleached, dried seaweed, 5 ml. of water, 5 ml. 10 ml. and 15 ml. of 1/10 NH_2SO_4 a were added and the resulting pH determined (Table 1). the experimental batches were boiled down to the same weight before filtering into 100 ml. beakers set aside for in the gel strength determination.

TABLE 1.—*Comparative hydrogen-ion concentration o, the dried, bleach gulaman-dagat (Gracilaria confervoides) soaked in water contain various amounts of 1/10 NH_2SO_4.*

Treatment of seaweeds	Hydrogen-ion concentrati according to amounts of acid			
	0 ml. acid	5 ml. acid	10 ml. acid	15 a
	pH	pH	pH	p
1. No treatment (control)	7.49	6.58	6.23	3.
2. Saturated calcium hydroxide solution	7.42	6.66	5.82	3.
3. Strong sodium hypochloride	7.46	6.58	5.75	3.
4. Sodium hypochloride (1:10)	7.56	6.44	5.52	3.
5. Sodium hypochloride (1:50)	7.20	6.41	5.60	3.

Gel strength of solidified agar extracts.—In order to det mine the quality of the extracted agar, the solidified ag extracts contained in 100 ml. beakers were tested for th gel strength in an improvised apparatus. The gel streng was measured in terms of milliliters of water registered a 100 ml. burette attached to a balance. The cracking po made by the burette on the gel contained in the beaker c stitutes the gel strength of the agar extracts (Table 2). T gel strength was seen to be poor, ranging from 2.40 to 8.

TABLE 2.—*Gel strength in milliliters of water of agar extracted from dried bleached gulaman-dagat with various amounts of 1/10 NH_2SO_4.*

Treatment of seaweeds	Gel strength of extracted agar			
	0 ml. acid	5 ml. acid	10 ml. acid	15 ml. aci
1. No treatment (control)	17.1	13.8	14.32	
2. Saturated calcium hydroxide solution	2.40	5.75	8.10	
3. Strong sodium hypochlorite solution	10.20	7.10	3.30	
4. Sodium hypochlorite (1:10)	15.80	8.50	5.30	
5. Sodium hypochlorite (1:50)	27.70	25.20	26.40	2

Preparation of nutrient agar.—The imported bacto-agar is n expensive item in the preparation of nutrient agar solution. acto-agar was prepared by using the bleached, dried gulaman-agat seaweed. To 14.25 grams of the bleached dried seaweed, 00 ml. of water was added, boiled for ten minutes and then ltered through cheesecloth. To every 200 ml. of the filtrate ere added the following:

Peptone	1.25 grams
Bacto-beef extract	0.75 grams
Sodium chloride	2.00 grams

The mixture was heated to dissolve all the ingredients, the H adjusted to 7.3, transferred to test tubes for purposes of lating and slants and then autoclaved for 15 minutes at 21°C. (15 lb. pressure). The nutrient agar thus prepared as satisfactory for plate count of bacteria in the micro-iological laboratory.

Preparation of dried agar similar to imported commercial gar.—To 25 grams of bleached, dried gulaman-dagat, 875 ml. of water was added, and then it was acidified by adding 20 ml. of 1/10 NH_2SO_4 acid. The mixture was boiled for 30 minutes and then strained through cheesecloth. The residue was treated with 250 ml. of water; acidified with 10 ml. of sulphuric acid; heated to boiling; and then strained. After combining the first and second extracts, the mixture was allowed to solidify in moulds. The agar was then cut into strips of one half inch, and then set aside to freeze in the refrigerator. The next day the frozen agar was thawed and dried outdoors.

The prepared, dried agar was analyzed chemically and it compared well with the chemical analysis of the imported agar (Table 3).

TABLE 3.—*Comparative chemical analysis of various brands of agar.*

Proximate chemical composition	Gulaman-dagat agar	Korean agar	Japanese agar	American agar
1. Moisture	8.57	15.25	19.60	18.41
2. Ash	3.92	1.17	2.90	3.20
3. Protein (Nx 6.25)	5.28	6.25	4.23	1.12
4. Nitrogen free extract	0.17	0.20	1.08	0.19

Gulaman-dagat recipes.—A few preparations were ma using directly the bleached, dried gulaman-dagat. The ba materials and the proportions of each are as follows: 25 gra of the seaweed; 4 cups of water; 3/4 cup of sugar and cup of milk (coconut or cow's milk). Fruits and other gredients were added to improve the flavor of the desserts. panel of tasters favorably endorsed the wholesomeness of the preparations.

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