

FEEDING STUDIES WITH THE GUM OF GRACILLARIA CONFEROIDES AND CARBOXYMETHYLCELLULOSE

By Hugo W. Nilson* and Maurice Bender*

ABSTRACT

GRACILLARIA GUM AND CARBOXYMETHYLCELLULOSE ARE WHOLESOME PRODUCTS WHEN FED TO RATS AND MICE IN COMPARATIVELY LARGE QUANTITIES FOR PERIODS FROM WEANING TO DEATH.

INTRODUCTION

Investigation of the possibility of replacement of imported agar with seaweed gums of domestic origin, particularly for use as bacteriological media, was a wartime project of the Service's Fishery Technological Laboratory at College Park, Maryland. The gum of Gracillaria confervoides (North Carolina) met the specifications of the Pharmacopoeia of the United States XIII (1947) for agar. But, it was shown by Lee and Stoloff (1946) that this gum could not replace agar as a media for micro-organisms, at least for forensic purposes, since it exhibits a comparatively high degree of syneresis. The liquid of syneresis permitted spreading of plate cultures so no accurate counts could be made. The great majority of samples which were extracted also had such high viscosity at temperatures above 45° C. that they were unsuitable for bacteriological media involving mixing the inoculum with the medium.

However, the gum from Gracillaria could replace agar from Gelidium in certain industrial uses to good advantage. The difficulty in harvesting the seaweed has made the cost of material so high that postwar production, at least on any sizable scale, has not been continued. The data on feeding studies are reported herewith since domestic production may again be undertaken if more efficient harvesting and manufacturing processes can be devised.

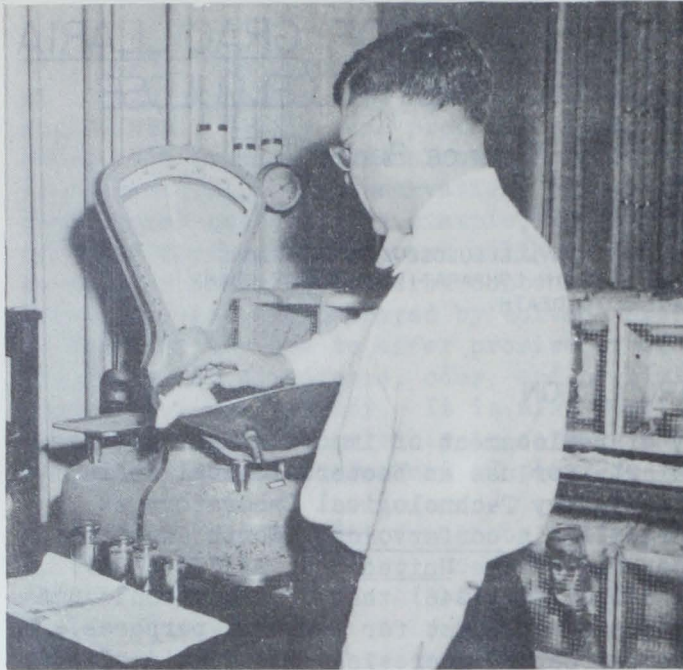
Carboxymethylcellulose is made from non-fishery sources. The gum in solution, however, showed some initial promise of being used as a glaze on frozen fishery products. Unpublished data from this laboratory indicate that the carboxymethylcellulose film dries out and becomes brittle when fishery products, mostly whole fish which have been glazed with the solution, are stored in the freezer. This permits dehydration of the products. The experiments did not show sufficient promise to recommend this gum as a coating medium. The feeding studies are reported herewith since the gum is used in considerable quantities in the food industry.

ANIMAL FEEDING TESTS

Rats and mice were allotted to the experiment at about weaning age. They were housed individually in wire screen cages fitted with screen floors. Food and water were allowed ad libitum. Live weight and food consumption data were taken at weekly intervals. Only male rats were used in the tests with Gracillaria gum, but both sexes were used in the tests with carboxymethylcellulose.

Groups were fed the control diet and diets containing 5 and 10 percent Gracillaria gum and 5 percent carboxymethylcellulose. The control diet consisted of casein, 15; lactalbumin, 5; lard, 15; brewer's yeast, 5; wheat germ, 2; salt mixture, U.S.P. XII, No. 2 for vitamin A and D assay, 4; cod liver oil, 2; and

*PHARMACOLOGIST, FISHERY TECHNOLOGICAL LABORATORY, BRANCH OF COMMERCIAL FISHERIES, U. S. FISH AND WILDLIFE SERVICE, COLLEGE PARK, MARYLAND.



WEIGHING A TEST ANIMAL AT THE COLLEGE PARK FISHERY TECHNOLOGICAL LABORATORY.

carried out for a 10-week period. Comparable data are given for the single level of carboxymethylcellulose which was fed. The data in Table 1 are comparable to those for algin reported by Nilson and Lemon (1942), and for agar and Irish moss reported by Nilson and Schaller (1941). The only statistically significant differences from the controls were greater mean food and water requirements per unit gain in weight for the group fed the 10 percent level of Gracillaria gum.

Table 1 -- Feeding data with Gracillaria gum and carboxymethylcellulose during the ten-week test with groups of 10 rats each

Diet designation	Mean daily gain	Coefficient of variation	Per-gram gain in weight			
			Mean food	Coefficient of variation	Mean water	Coefficient of variation
	grams	percent	grams	percent	milliliters	percent
Control	3.48	11	2.92	6	5.76	19
<u>Gracillaria</u> :						
5 percent	3.41	7	3.08	5	5.42	12
10 percent	3.35	12	3.21*	6	6.31	15
Carboxymethylcellulose:						
5 percent	3.26	18	3.16	13	no data	no data

*A significant difference from control according to the Fisher t test.

OBSERVATIONS ON ANIMAL FEEDING TESTS

The coefficient of variation of mean weekly food intake for the group of rats fed carboxymethylcellulose is nearly twice that of the groups fed Gracillaria gum. The greater variation apparently was due to what seemed to be diarrhea. The smeary feces were very characteristic but did not seem to be a symptom of an injurious process. It was most probably due to the low absorption quality of the purified diet. One litter of five rats was allotted to a group fed a mixture of 5 percent carboxymethylcellulose and 95 percent ground Purina Dog Chow by weight. These rats were fed the diet for a month. They did not grow as well as the rats fed the same gum in the purified diet, but the feces were firm in texture and well formed.

Gross necropsy studies of the rats fed the 10 percent level of Gracillaria gum at the close of the 10-week test did not reveal any pathology. The remain-

an equal mixture of sucrose and and corn starch dextrin, 52 parts by weight. The different gums were incorporated into this diet at the expense of an equal amount of the sucrose-dextrin mixture.

The Gracillaria gum was purchased on the open market (1944) and the two lots which were used analyzed, respectively, 13.33 and 14.73 percent moisture; 1.48 and 0.86 percent protein (N x 6.25); 7.95 and 5.32 percent ash; and 77.24 and 79.09 percent carbohydrates (by difference). This gum was produced commercially by various companies operating at Beaufort, North Carolina. The carboxymethylcellulose, low viscosity type, was supplied by the Hercules Powder Company of Wilmington, Delaware.

The initial test with two levels of Gracillaria gum was

ing animals were fed the diets for a year (the rats fed the 5 percent level of carboxymethylcellulose), or until they died. The comparative data calculated for the 10-week period indicate that both gums were wholesome.

Diet designation	Length of life in weeks*
Rats:	
Control	22, 51, 68, 70, 70, 82, 82, 105, 128
<i>Gracillaria</i> : 5 percent	11, 17, 58, 60, 78, 84, 86, 88, 93, 94
Carboxymethylcellulose: 5 percent	sacrificed after 51 to 57 weeks
Mice:	
Control	25, 35, 50, 51, 75
Carboxymethylcellulose: 5 percent	1, 20, 24, 27, 39, 39, 54, 55, 66, 77

*Only male rats were used in tests with *Gracillaria* gum. Both male and female animals were used in tests with carboxymethylcellulose.

The data in Table 2 show that the various animals receiving the 5 percent levels of *Gracillaria* gum or carboxymethylcellulose lived as long as the respective control animals. Those which died and upon which a post-mortem examination could be made did not show any gross symptoms characteristic of any toxic condition. The data in Table 3 indicate no statistically significant differences between groups in mean maximum weight, mean weekly intake of food, or mean weekly intake of water where comparisons are possible.

Diet designation	Number of animals	Mean maximum weight	Standard error of maximum weight	Mean weekly intake of gum	Mean weekly intake of basal diet	Standard error of total food consumption	Mean weekly water intake	Standard error of water intake
		grams	grams	grams	grams	grams	milliliters	milliliters
Rats:								
From weaning to death:								
Control	10	452	32	0.0	71.4	3.28	143.5	6.96
<i>Gracillaria</i> ; 5 percent	10	418	30	3.5	67.4	2.73	145.4	4.15
For one year:								
Carboxymethylcellulose, 5 percent	10	404	19	3.9	73.6	3.20	-	-
Mice:								
From about weaning to death:								
Control	5	31	3	0.0	18.9	2.55	-	-
Carboxymethylcellulose, 5 percent	10	32	3	1.1	21.5	1.69	-	-

The rats fed the 5-percent level of carboxymethylcellulose were sacrificed after one year and the principal organs were examined microscopically. The pathologist found no evidence that the carboxymethylcellulose produced any specific uniform change in the heart, liver, kidney, spleen, or gastrointestinal tract. There was no evidence of gross pathology when the rats were sacrificed.

CONCLUSION

In summary, the data indicate that both the *Gracillaria* gum and carboxymethylcellulose are wholesome products when fed to rats and mice in comparatively large quantities for periods from weaning to death.

LITERATURE CITED

- LEE, CHARLES F. AND STOLOFF, LEONARD S.
1946. STUDIES OF GUM EXTRACTS FROM *GRACILLARIA CONFERYOIDES* (NORTH CAROLINA). U. S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE, SPECIAL SCIENTIFIC REPORT NO. 37, PP. 1-12.
- NILSON, HUGO W. AND SCHALLER, JOSEPH W.
1941. NUTRITIVE VALUE OF AGAR AND IRISH MOSS. FOOD RESEARCH 6 (NO. 5): PP. 461-69.
- NILSON, HUGO W. AND LEMON, JAMES M.
1942. METABOLISM STUDIES WITH ALGIN AND GELATIN. U. S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE, RESEARCH REPORT NO. 4: PP. 1-9.
- PHARMACOPOEIA OF THE UNITED STATES
1947. THIRTEENTH REVISION. MACK PUBLISHING COMPANY, EASTON, PA., P. 721.