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COMPOSITION OF SOUTHERN OYSTERS

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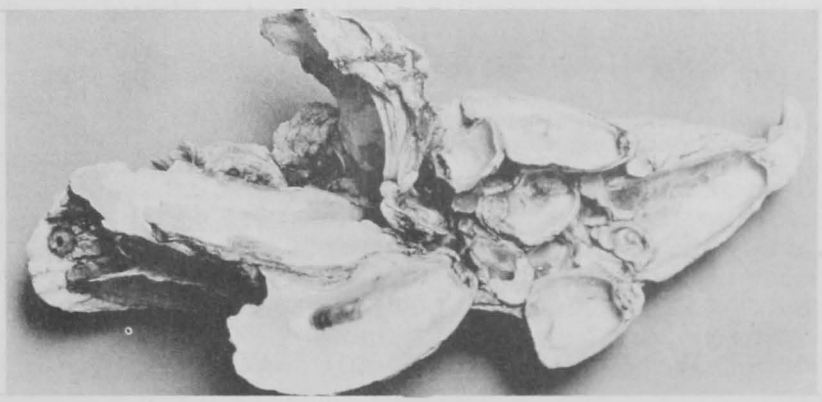
ABSTRACT

Southern oysters collected from plants along the South Atlantic and Gulf Coasts have been analyzed for dry matter, protein, fat, mineral matter, and salt. The carbohydrate content was calculated by difference. During the period from October 1954 to October 1955 inclusive, 58 sample pairs were collected, each consisting of a sample of oysters taken at the plant directly from the shell oysters, and a sample of the regularly shucked and washed commercial product from the same lot of oysters. It was found that the dry matter, fat, and carbohydrate content of the "shell" samples all changed in a similar manner during the season. Minimum values for monthly averages were observed for September and October and maximum values for April or May. This had been expected because of the relationship of these constituents to the spawning cycle; however, no explanation is apparent for a very similar fluctuation in the mineral matter and salt content of these oysters. Comparisons of all data have been made on a dry-weight basis. When the data for "plant" and "shell" samples were averaged by states, the values for constituents of the "plant" were slightly greater than for the "shell" samples. Comparatively little difference between oysters from different states is evident from these averages. The large variability resulting from seasonal fluctuation masks the relatively minor effects of factors such as differences in plant practices and location. This study of composition of the Southern oyster is being continued for a second year.

BACKGROUND

Technological investigation and research on the Southern oyster was started in October 1954 with funds provided by Public Law 466 (Saltonstall-Kennedy Act of 1954). It was thought desirable to conduct most of the research through contracts with qualified and interested groups in the area, because of the geographical remoteness of the Fish and Wildlife Service's nearest technological laboratory from the Gulf Coast and because of the highly perishable nature of the product. Staff members of the Service's Fishery Technological Laboratory at College Park, Md., were assigned to do the proximate analyses of oysters and keep close liaison with the contractors. Contracts were negotiated with three Southern universities during February 1955. Staff workers of the College Park Laboratory maintained liaison among the several groups, sponsored joint project conferences, and assisted in any way possible to facilitate research.



A cluster of South Atlantic oysters.

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FACTORS AFFECTING STORAGF OF RAW SHUCKED OYSTERS

Dr. E. A. Fieger and staff at Louisiana State University in Baton Rouge, La., contracted to investigate factors affecting frozen storage of raw shucked oysters. The first year in storage has been completed for the first lot of oysters; these were packed in May 1955. The results of this storage test will be reported shortly.

Since January 1956, when Southern oysters in good condition were available again, four new packs of oysters for frozen storage have been prepared: two from Louisiana, one from Bon Secour, Ala., and one from Mississippi. Storage tests should demonstrate whether factors related to the season of catch, location of beds, and methods of handling in the plant affect the quality of the frozen pack.

Dr. Fieger and his staff have also studied changes during iced storage of two lots of fresh oysters as commercially shucked and washed. The data from these tests should show, to some extent, the effect on quality and storage life, when iced, of oysters produced by the different methods of shucking and washing used by the various plants in this area.

DEVELOPMENT OF NEW COOKED SOUTHERN OYSTER PRODUCTS

A second contract was allotted to Florida State University in Tallahassee, Fla. Dr. Betty M. Watts and her staff of the School of Home Economics are primarily concerned with the development of new cooked Southern oyster products for frozen storage, such as stews, soups, scalloped oysters, and other casserole-type dishes in which the juices contribute flavor and nutritional value. Frozen products of this type involve a great deal of developmental research, and the problem has been complicated by the short season (January to April) during which good commercial oysters are available locally. However, encouraging progress has been made and it is expected that this program will be expanded considerably during the coming season.

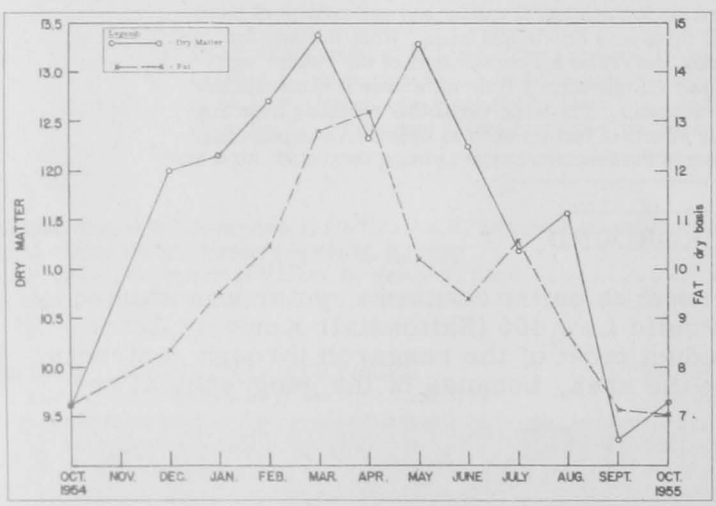

Fig. 1 - Average dry matter and fat content, dry-weight basis, of "shell" oysters according to month samples were collected.

Four separate reports on results of the work during the first contract year will be published by the group at Florida State University. The first on changes during storage of cooked oysters has been been submitted to Food Technology, and the second, on the relation of pH to quality of shucked oysters will be published in Commercial Fisheries Review. Reports are also in preparation on seasonal changes in total solids, niacin, and riboflavin content of the local oysters, and on the results of irradiation of oysters with Cobalt 60.

BODY-FLUID BALANCE AND DISCOLORATION IN SOUTHERN OYSTERS

Dr. Milton Fingerman at Tulane University in New Orleans has the third contract for some basic physiological research concerned with the body-fluid balance in live Southern oysters.

The results of Dr. Fingerman's initial research have been published in Tulane Studies in Zoology, vol. 3, no. 9, April 12, 1956. This research is continuing,

and will include during the second year a more extensive study of the internal sources of these fluids and the body mechanism that regulates their composition. Also under investigation are the causes of the brown or blackish discoloration that is observed in oysters from certain production areas. This discoloration has been the subject, in the past, of much speculation as to origin but little investigation, and the present work has mainly proven that most of the previously advanced explanations have little basis in fact. A preliminary report of this phase of their research will appear in Commercial Fisheries Review.

SEASONAL VARIABILITY IN COMPOSITION OF OYSTERS

Providing data on seasonal variability in compostion of the oysters from the numerous producing areas in the South is a second function of the Service's College Park Fishery Technological Laboratory. Contractors have, for the most part, used local oysters for their storage tests and other phases of their research. Knowledge of the effect of seasonal and geographical factors on the composition of the Southern oyster is needed to extend the applicability of the results of these research projects, since virtually no information on this subject is available in the literature. Samples collected throughout the area have been analyzed for dry matter, crude protein, fat, mineral matter, and salt. The carbohydrate content has been calculated by difference. All of these constituents vary markedly and the data serve adequately to demonstrate seasonal differences and variations due to location.

COLLECTION OF SAMPLES: The method of sampling raw shucked oysters is of importance because of the very rapid loss in body fluids and the resulting change in composition that occurs within minutes after shucking (Fingerman 1956). For the desired comparisons of season and area, plant samples were of little value since there were also large salt and fluid losses in the shucking bucket and in washing the shucked meats. Thus, for these comparisons, it was necessary to obtain samples shucked directly from the shell into a sample can at the plant by one of the regular oyster shuckers. These samples were difficult to obtain because shucking operations are irregular everywhere on the South Atlantic and Gulf Coasts except in New Orleans, being limited to 3- or 4-hour periods once or twice each week during much of the season.

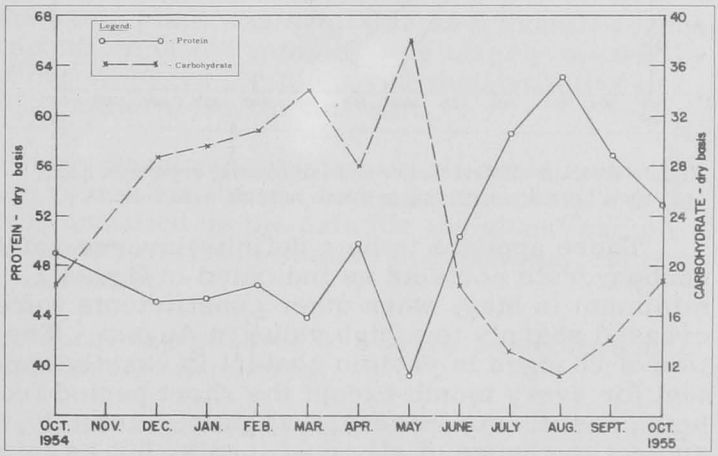

Fig. 2 - Average protein and carbohydrate content, dry-weight basis, of "shell" oysters according to month samples were collected.

Whenever a "shell" sample could be obtained, a comparable "plant" sample was also collected from the same lot of oysters that had been shucked in the usual manner, and drained and washed on the skimmer according to the usual plant practice. This permitted a comparison of the commercial product from various plants and, more specifically, a comparison of the effect of the different handling methods on the composition of the washed product. Because of the large differences in dry-matter content of these samples, the data have been converted to a dry basis for better comparison.

ANALYSIS OF DATA: The data for all constituents of the "shell" samples have been averaged by months to determine the extent of seasonal effect on composition (figs. 1, 2, and 3), and the same data for both "shell" and "plant" samples have been averaged for each state (table 1) to determine whether differences exist between oysters from the several states.

The data for the "shell" samples according to month of collection are summarized in figures 1, 2, and 3. Because of the difficulty in obtaining the "shell" samples, none of the monthly averages includes data for all six states that would be desirable for maximum significance. This results in a considerable range in the number of values for each month; from 11 for October 1954 to only 2 for the months from May through August 1955, when shucking has stopped in most areas. The summer samples were all collected from New Orleans plants by the staff of Louisiana State University.

The first samples were obtained in October 1954, and the figures include the period through October 1955 with data for all months except for November 1954. The change in composition, usually associated with the advancing season (the "R" months), is an improvement in the condition of the oyster after the summer spawning period. In the South the spawning period is much longer than in colder climates, and oysters are thin and in poor condition for a somewhat longer period, extending well into the fall months. The data in figures 1 and 2 show the very definite increase in dry matter, fat, and carbohydrates that occurred from October to March. Oysters were in good condition from March through May when judged on the basis of dry matter and carbohydrates, although the fat content had already decreased markedly by May. All three constituents were found in decreasing quantities during the summer, with the lowest values for each in September. Dry matter and fat had not changed in October but the carbohydrate content had increased slightly.

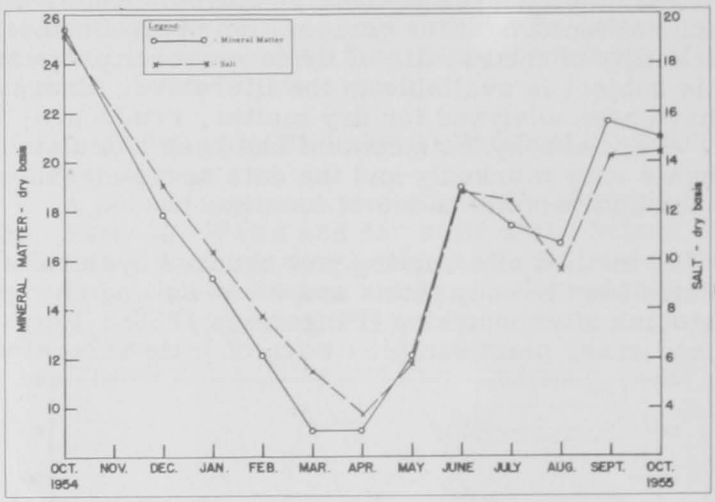

Fig. 3 - Average mineral matter and salt content, dry-weight basis, of "shell" oysters according to month samples were collected.

There appears to be a definite inverse relationship between the protein and the carbohydrate contents as indicated in figure 2. The protein content decreased to a minimum in May, when other constitutents were at the seasonal maximum, then increased sharply to a high value in August. The data in figure 2 show that the direction of changes in protein content is exactly opposite to that of the carbohydrate content for every month except the short period from December to February, when both constituents increased slightly. Actually, the protein content is probably least subject to change of all constituents, but as fat and carbohydrate contents decrease, the protein makes up a greater proportion of the remaining body tissue percentagewise.

The data in figure 3 show a surprisingly consistent decrease in mineral matter and in salt from October to April. Thereafter there was a fairly regular increase in these constituents until September, with values for September and October being only slightly lower than the high values found in October 1954. The explanation for the fluctuation in salt and the positively-correlated changes in mineral matter content is not known. This might reasonably be assumed to be related to the salinity of the water from which the oysters were taken. Information on this variable is not available but salinity would hardly be expected to show as uniform a cycle of change as is indicated by the data in figure 3, especially since a considerable and variable number of different and widely-scattered areas are represented in the monthly averages.

The data in table 1 show that the ranges for maximum and minimum values for the six constituents are quite large in many instances. This is almost entirely due to the seasonal variation already demonstrated. Although the oyster samples were not always obtained from the same plant each month, and oysters were often from

Table 1 - Data on the Composition of the Shell and the Plant Samples of Southern Oysters from October 1954 to October 1955 Inclusive

State	Number of Pairs of Samples1/	Dry Matter		On Dry Basis									
				Protein		Fat		Mineral Matter		Salt2/		Carbohydrates	
		"Plant"	"Shell"	"Plant"	"Shell"	"Plant"	"Shell"	"Plant"	"Shell"	"Plant"	"Shell"	"Plant"	"Shell"
		(Percent)											
Louisiana:	29												
Maximum		18.1	17.1	74.8	63.5	14.7	16.7	17.1	35.9	10.4	28.9	42.2	41.3
Minimum		5.9	6.9	40.9	36.8	6.8	5.6	4.6	6.4	1.1	2.8	7.1	8.1
Mean		11.2	11.5	56.0	51.3	11.0	10.1	9.8	16.5	4.6	10.8	23.1	22.3
Mississippi:	5												
Maximum		17.0	14.5	60.8	58.7	12.7	11.3	14.1	24.1	5.5	16.2	41.7	35.7
Minimum		10.9	7.5	40.6	37.3	8.8	8.0	5.1	13.9	1.3	9.7	18.9	15.6
Mean		13.5	11.2	49.1	45.1	11.3	10.0	8.9	17.9	3.2	12.4	30.7	27.1
Alabama:	11												
Maximum		15.2	13.6	60.1	56.8	16.5	14.6	12.4	24.6	6.7	18.2	37.2	34.8
Minimum		7.0	10.2	43.8	42.1	8.7	6.5	4.7	5.5	0.7	2.2	16.5	13.0
Mean		12.6	11.8	50.7	50.0	12.5	11.0	7.5	12.1	3.1	7.2	29.3	27.9
Florida:	6												
Maximum		17.5	12.3	61.4	52.8	13.5	10.5	18.3	30.3	10.1	22.4	35.4	34.8
Minimum		9.9	8.3	45.0	40.8	7.6	5.5	8.6	12.3	4.7	8.6	13.3	12.3
Mean		13.5	10.8	51.5	46.6	10.1	7.4	13.6	22.9	7.9	17.2	24.9	23.0
Georgia:	2												
Maximum		14.2	11.1	54.2	48.0	9.2	6.9	17.6	25.6	11.6	21.2	27.6	22.9
Minimum		13.9	10.3	51.2	45.9	7.6	5.7	12.0	24.3	6.8	18.3	20.6	20.8
Mean		14.1	10.7	52.7	47.0	8.4	6.3	14.8	25.0	9.2	19.8	24.1	21.9
South Carolina:	3												
Maximum		17.9	15.3	52.7	46.0	9.8	8.3	12.6	22.4	8.4	17.9	37.0	30.1
Minimum		16.3	12.1	46.1	44.7	5.8	6.8	9.2	15.9	5.5	11.5	25.5	25.3
Mean		17.3	13.5	49.7	45.4	8.3	7.7	11.3	19.2	6.5	14.7	30.1	27.7

1/ Pairs consist of one sample of oysters shucked directly from the shell and the other taken from regular plant production.
2/ Sodium chloride calculated from chloride content.

different growing areas even when the same plant was available as a sample source, the effect of these factors on the composition of the samples was largely masked by seasonal influences. Comparison of the averages for plant and shell samples in general show large differences only for mineral matter and salt.

CONCLUSIONS: Because of the large seasonal variation in all constituents, comparison between states of average values for the various constituents is hardly warranted. However, these averages, qualified by the data for individual sample pairs not shown in the table, seem to justify certain tentative conclusions, subject to confirmation from data for a second season:

(1) Oysters in all areas studied conform in a general way to the same seasonal cycle of variability for each of the constituents measured.

(2) The dry matter of most of the plant-washed samples is greater than for the comparable "shell" samples. This is a result of the usual practice of only washing the oysters on the skimmer with a spray nozzle, which gives a much shorter exposure to fresh water than occurs during blowing.

(3) There is a loss of salt amounting to from 55 to 60 percent for the "plant" samples as compared with the "shell" samples. Most of this loss is probably in the liquor drained off on the skimmer.

(4) The decrease in salt and in the mineral matter combined with the usual increase in dry matter results in an even larger apparent increase in protein and usually in carbohydrate for the "plant" samples as compared with similar values for the "shell" samples. These constituents are insoluble and thus constitute a greater proportion of the remaining solids.

(5) There is a marked decrease in the saltiness of the oysters in all areas from October to March. By May the salt content is increasing toward a September maximum. The reasons for this unexpectedly large and apparently cyclic fluctuation

in salt are not known. No data on salinities of the water in producing areas are available to determine the effect of this factor upon the salt content of the oyster.

The factors affecting the composition of the oyster are so numerous that interpretation of data, even with the 116 samples included in this series, is unsatisfactory in many instances, due to the small number of values for any single constituent. Samples for analysis for the second season, that is, the period from October 1955 to April 1956, have already been collected. No solution has been found for the various problems involved in obtaining more complete sample series from certain problem areas. Efforts were made to obtain the desired samples at various selected locations through the cooperation of (1) a plant owner, (2) an employee in a Fish and Wildlife Service Wildlife Refuge located very near two oyster plants, (3) a U. S. Public Health Service official who regularly visited one producing area to obtain samples for his own work, and (4) one of the university groups with an oyster research contract. The results ranged from fair to failure; none supplied a satisfactory series of samples. Particular credit should, however, be given to Dr. Arthur Novak at Louisiana State University. Through his efforts, complete series are available for two plants in New Orleans and quite satisfactory coverage for several plants in Mississippi and Alabama. The plant owners contacted everywhere have been uniformly cooperative in supplying the type of samples desired if visited when shucking was in progress and this cooperation is deeply appreciated.

Sample collections will be continued through October 1956 to provide data for a second complete year. Because of the virtual impossibility of obtaining satisfactory coverage of the South Atlantic Coast, it is not expected at this time to try to sample the whole area for a third season, unless unexpected and inexplicable differences are found between the data of the first two years.

SUMMARY: Data for average proximate composition of 16 samples of oysters collected from producing areas from South Carolina to Louisiana are presented tabularly by States, and by the type of sample, either "shell" as shucked; or "plant," that is commercially drained and washed on the skimmer. The values for certain constituents of the "shell" samples have been averaged by months when collected. These data are included in figures 1, 2, and 3, and indicate the type of seasonal fluctuation found. Comparisons are made entirely on dry basis. In general, dry matter, fat carbohydrate, mineral matter, and salt were at seasonal maxima in April and May, while minimum values were found in September and October. An inverse relationship was found for the protein content, that is, a May minimum and an August maximum. The study of composition of Southern oysters is being continued for a second season.

BIBLIIOGRAPHY

1. Osmotic Behavior and Bleeding of the Oyster, Crassostrea virginica, by Milton Fingerman and Laurence D. Fairbanks. Tulane Studies in Zoology, vol. 3, no. 9, April 1956, pp. 152-168.

2. Some Factors Affecting Fluid Loss in Southern Oysters, by Milton Fingerman and Laurence D. Fairbanks. Commercial Fisheries Review, vol. 18, no. 1, January 1956, pp. 10-11 (also Sep. No. 426).

3. Investigation of the Deterioration of Cooked Oysters, by Elizabeth Ann Gardner and Betty M. Watts. Submitted to Food Technology.

4. Correlation of pH and Quality of Shucked Southern Oysters, by Elizabeth Ann Gardner and Betty M. Watts. Submitted for publication in Commercial Fisheries Review.

5. "Brown-Spotting" in the Southern Oyster, by Milton Fingerman. Scheduled for publication in Commercial Fisheries Review, vol. 18, no. 8, August 1956.

6. Rapid Procedures for Approximation of Bacterial Count in Shrimp and Oysters, by A. F. Novak, E. A. Fieger, and M. E. Bailey. Food Technology, vol. 10, no. 2, February 1956, pp. 66-67.

7. Composition of Southern Oysters, by Betty M. Watts to be published in Commercial Fisheries Review.