pressure readings of Ponca wheat of high viability have been mentioned. Many of the commercial wheat samples used in this study were either of unknown variety or mixtures of several varieties. A number of other possibilities, such as the effect of protein content on enzyme activity, are being studied. It appears also that if the nonviable kernels of a wheat sample were badly damaged, the pressure increase produced could be unusually low, particularly with commercial mixtures of wheat.

Germination percentage has been used in this study as a primary standard for the deterioration of wheat in storage. It is recognized, however, that germination percentage is apparently not a sufficient index as far as the suitability of wheat for bread making is concerned. Work is in progress to prepare standards for different varieties of wheat, and to correlate the glutamic acid decarboxylase activity of a given wheat sample with its actual baking quality.

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FISH COMPOSITION

Proximate Composition of Nine Species of Sole and Flounder

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In order that adequate data could be provided for the commercially important and palatably desirable group of West Coast marine fishes known as sole and flounder, the composition of nine of the more common species was determined. This investigation included the analysis of more than 200 specimens of varying size collected over a period of 3 years in different seasons and preserved in different ways. Large variations were found among the nine species and among the fish within a given species. The group as a whole was low in oil and ash, about average in protein, and high in sodium. Variations for all specimens grouped according to size of fish, season of capture, and manner of preservation were not large. Both the nonedible parts and the whole fish for the various species were sufficiently high in oil, protein, and minerals to be commercially important as an animal food, or as a supplement in poultry feed when converted to meal.

More than a dozen species of sole and flounder inhabit the waters along the Pacific Coast of the United States (*1, 4*). Mature specimens of these fishes range in length from 25 to 70 cm. but the average is about 40 cm. They are taken by commercial fishermen at all seasons of the year. In 1957, the combined catch from California, Oregon, and Washington amounted to 48 million pounds (*3*). The catches of other important species taken during the same year, also in millions of pounds, were Pacific salmon 61, rockfish 28, halibut 22, and Pacific cod 12.

Sole and flounder usually are marketed as fresh or as frozen fillets, and their processing is an important part of the West Coast fishing industry. The edible portion of sole and flounder represents approximately 28% of the total weight of the fish, and the remainder is frozen and sold primarily for use as feed for fur-bearing animals.

Because sole and flounder are used as food for humans and as sources of feed for animals, it is important to know the nutritive value of the whole fish, of the edible flesh, and of the nonedible parts of the fish. Very few data are available in the literature regarding the proximate composition of these fishes. The reports that have been published deal with abnormal conditions (*2, 6*) or compare the composition of the right and left sides of the fish (*5*). The object of the present investigation therefore was to establish the proximate composition of several species of sole and flounder from the west coast of the United States.

Experimental

In order that data could be provided for this purpose, chemists from the Seattle Technological Laboratory of the Bureau of Commercial Fisheries analyzed more

Table I. Source Data for Sole and Flounder

No. Fish	Series No.	Common Name	Date Caught	Method of Storage
17	1	Dover sole[a]	3–58	Frozen
11	2	Dover sole	10–58	Frozen
14	3	Dover sole	4–59	Frozen
12	4	Dover sole	10–59	Iced
10	5	English sole[b]	12–57	Iced
7	6	English sole	3–58	Iced
14	7	English sole	4–59	Frozen
14	8	English sole	11–59	Iced
5	9	Petrale sole[c]	3–58	Iced
14	10	Petrale sole	4–58	Frozen
14	11	Petrale sole	4–59	Frozen
15	12	Petrale sole	11–59	Iced
11	13	Rex sole[d]	4–58	Frozen
17	14	Rex sole	10–58	Frozen
14	15	Rex sole	4–59	Frozen
12	16	Rock sole[e]	6–59	Iced
6	17	Flathead sole[f]	4–58	Frozen
9	18	Sand sole[g]	12–57	Iced
12	19	Starry flounder[h]	6–59	Iced
12	20	Arrowtooth flounder[i]	10–58	Frozen

[a] *Microstomus pacificus.* [b] *Parophrys vetulus.* [c] *Eopsetta jordani.* [d] *Glyptocephalus zachirus.* [e] *Lepidopsetta bilineata.* [f] *Hippoglossoides elassodon.* [g] *Psettichthys melanostictus.* [h] *Platichthys stellatus.* [i] *Atheresthes stomias.*

Table II. Physical Data for Sole and Flounder

No. Fish	Species	Length, Cm. Av.	Length, Cm. Range	Weight, G. Av.	Weight, G. Range	Fillet Yield, % Av.	Fillet Yield, % Range
54	Dover	43	31–58	834	285–2166	26.6	18.3–39.6
45	English	35	25–47	437	138–1014	32.6	21.6–40.1
48	Petrale	38	24–49	689	164–1496	33.6	22.4–43.0
42	Rex	38	26–45	347	140–786	28.1	22.8–34.2
12	Rock	41	32–50	959	410–2016	26.4	23.3–29.3
6	Flathead	32	28–39	348	236–504	27.4	18.3–34.1
9	Sand	33	27–44	492	292–910	33.0	21.1–42.9
12	Starry flounder	51	39–59	1859	798–2648	18.7	14.8–25.7
12	Arrowtooth flounder	43	35–59	915	440–2510	27.8	22.3–35.9
240	All	40	24–59	764	138–2648	28.2	18.3–43.0

than 200 fish representing nine species of sole and flounder. These nine species include a wide variety of specimens with regard to size of fish, season of capture, and method of preservation. Data were collected both on the fillet flesh and on the nonedible parts of the fish.

Collection of Specimens. The fish from which the data reported in this paper were obtained represent the right-eyed flounder (*Pleuronectidae*) family. They were collected from 1957 through 1959 and represent all four seasons of the year, but most of them were obtained during the spring and fall. The specimens were either frozen at once or held in ice in the round on board the fishing vessel (Table I). At the laboratory, the fish were either processed at once or were held in storage at −18° C. until samples could be prepared.

Preparation of Samples. In order to minimize moisture loss (drip), the frozen fish were partially thawed in lukewarm water for about 1 hour, washed, and processed while still in a semifrozen state. Similarly, iced fish after a thorough washing were processed while still cold. The length and weight were recorded for each fish, and the fillets were removed, skinned, weighed, ground, hermetically sealed in 0.5-pound cans, and stored at −18° C. until used for analysis. Composite samples were prepared from the nonedible parts of most of the series of fish. In the preparation of a sample for analysis, the contents of the can were thawed by immersing the can in water at room temperature for about 20 minutes. The sample was then removed from the can, placed in a beaker, and reground with a high-speed cutting blade in order to render it more nearly homogeneous.

Methods of Analysis. Each sample was analyzed in duplicate for moisture, oil, protein, ash, sodium, and potassium by standard methods previously described (7).

Results and Discussion

Size, Weight, and Yield of Specimens. The nine species of sole and flounder analyzed included a wide variety of sizes. The average length was 40 cm., with a range of 24 to 59 cm. (Table II). Starry flounder was the largest of the specimens studied. Arranged in decreasing order of length, the three most important commercial species were dover, petrale, and English sole. The average weight of the more than 200 fish examined was 764 grams, and the range was 138 to 2648 grams. The variation of weight with length was not uniform, apparently depending on the general health of the individual fish. The fillet yield averaged 28.2%, with a range of 18.3 to 43.0%. In the majority of the 20 series reported, the fillet yield varied inversely with size of the fish.

Variations in the Composition of Fillets. The average composition of the fillets of the nine species of sole and flounder was: moisture 81.4%, oil 1.10%, protein 17.1%, ash 1.13%, sodium 83 mg.%, and potassium 354 mg.% (Table III). The values deviated to a considerable extent from one species to another as well as from one individual to another within a given species. The unusually high moisture, low protein, and high sodium content

Table III. Variations in Composition of Fillets According to Species

No. Fish	Species	Moisture, % Av.	Moisture, % Range	Oil, % Av.	Oil, % Range	Protein, % Av.	Protein, % Range	Ash, % Av.	Ash, % Range	Sodium, Mg. % Av.	Sodium, Mg. % Range	Potassium, Mg. % Av.	Potassium, Mg. % Range
54	Dover	83.6	81.0–90.3	0.78	0.19–2.73	15.2	8.4–17.6	1.09	1.01–1.18	106	69–195	315	210–353
45	English	81.1	76.7–84.2	1.55	0.49–5.41	17.0	14.1–19.1	1.17	0.99–1.34	79	49–115	397	274–441
48	Petrale	79.8	76.4–83.0	1.50	0.52–3.82	18.2	15.9–19.9	1.20	1.02–1.31	72	53–105	393	298–444
42	Rex	82.4	80.8–84.7	0.70	0.35–3.09	16.6	14.6–17.8	1.13	1.05–1.25	119	95–156	315	272–345
12	Rock	80.6	78.8–83.3	0.69	0.48–1.05	18.3	17.1–19.7	1.14	1.08–1.18	80	69–96	380	371–402
6	Flathead	81.1	79.8–83.9	0.92	0.80–1.50	17.6	14.9–18.3	1.05	0.96–1.16	73	57–87	299	265–336
9	Sand	82.1	80.1–84.3	0.53	0.38–0.88	17.2	15.1–19.1	1.11	1.05–1.18	56	45–73	344	306–375
12	Starry flounder	82.5	79.8–83.8	0.83	0.54–1.47	16.1	13.4–18.2	1.13	1.09–1.19	99	84–118	350	315–377
12	Arrowtooth flounder	79.7	76.6–81.7	2.39	0.78–6.10	17.9	17.3–18.4	1.15	1.06–1.20	59	52–75	394	380–413
240	All	81.4	76.4–90.3	1.10	0.19–6.10	17.1	8.4–19.9	1.13	0.91–1.34	83	45–195	354	210–444

found in the dover-sole group was due chiefly to one series in which the "jellied" condition (*6*) was prominent. Compared with other salt-water fish, sole and flounder and especially the English and petrale species usually were low in oil and ash content and about average in protein and sodium content. The sodium content of dover and rex sole was usually above 100 mg. %, whereas values for the other species were uniformly lower than 100 mg. %.

Composition data for the fillets of fish arranged according to size of fish, for three of the species, did not show much variation among the various constituents (Table IV). The data, however, are too limited to permit definite conclusions to be drawn regarding the influence of size on composition. A comparison of data for specimens taken in the spring and fall seasons of 1958 and 1959 reveals definite fluctuations, but these fluctuations were not large nor were they uniform (Table IV). Oil, protein, and ash values were higher in the spring group for 1958, whereas the reverse was true for the 1959 specimens. Sodium also showed a reverse relationship, being higher in the fall of 1958 and in the spring of 1959.

Table IV shows a comparison of the composition of fish that had been frozen in the round with fish that had been iced in the round on board the fishing vessel for the three most important species—namely, dover, English, and petrale sole. Again the variations were neither large nor uniform except for the sodium and oil contents. The lower sodium values of the specimens that had been in iced storage can be attributed to a leaching effect while in contact with the ice. This effect has been noted in previous reports (*7, 8*). The large difference in oil content between the iced and frozen petrale sole (Table IV) is due more to the influence of size of specimens and the season of their capture than to the method of preservation.

Table IV. Variation in Composition of Fillets According to Size, Season, and Preservation

Factor of Variation	No. Fish	Moisture, %	Oil, %	Protein, %	Ash, %	Sodium, Mg. %	Potassium, Mg. %
Size of fish[a]							
Dover							
Small	7	82.9	0.77	16.0	1.14	115	323
Medium	34	83.5	0.84	15.3	1.08	105	321
Large	13	83.7	1.08	14.9	1.07	104	313
English							
Small	35	81.1	1.53	17.2	1.18	82	378
Medium	9	81.3	1.58	16.8	1.12	74	365
Petrale							
Small	13	79.6	1.40	18.6	1.19	74	380
Medium	26	80.2	1.58	17.9	1.18	71	393
Large	8	80.8	1.28	18.3	1.20	65	405
Season of capture							
Spring 1958	50	81.3	1.30	16.9	1.17	86	346
Fall 1958	28	82.8	0.96	16.0	1.07	105	317
Spring 1959	56	82.8	0.76	16.1	1.17	109	363
Fall 1959	39	80.5	1.56	17.7	1.12	70	365
Spring 58, 59	106	82.1	1.09	16.5	1.17	98	355
Fall 58, 59	67	81.5	1.29	17.0	1.10	85	345
Method of preservation							
Frozen							
Dover	11	83.5	1.13	15.1	1.05	100	324
English	14	81.3	1.41	17.0	1.23	95	407
Petrale	28	81.0	0.92	17.7	1.19	76	389
Iced							
Dover	12	82.6	0.63	16.6	1.08	80	330
English	7	81.8	1.21	16.5	1.26	79	395
Petrale	20	78.4	2.30	18.8	1.18	65	394

[a] Small, under 500 grams; large, over 1000 grams.

Table V. Composition of Nonedible Parts

Species	No. Fish	Av. Weight, G.	Moisture, %	Oil, %	Protein, %	Ash, %	Sodium, Mg. %	Potassium, Mg. %
Dover	54	836	81.2	4.44	11.7	3.46	175	189
English	45	437	75.7	6.99	13.9	4.72	165	229
Petrale	38	690	74.8	6.71	14.8	3.79	163	253
Rex	42	313	81.1	3.53	12.4	3.07	180	203
Others	35	789	74.1	6.72	15.2	4.16	135	245
All	214	613	77.4	5.68	13.6	3.84	164	224

Table VI. Composition of Whole Fish

Species	No. Fish	Av. Weight, G.	Moisture, %	Oil, %	Protein, %	Ash, %	Sodium, Mg. %	Potassium, Mg. %
Dover	54	836	81.9	3.48	12.7	2.66	135	225
English	45	437	76.9	5.32	14.8	3.66	139	272
Petrale	38	690	76.5	4.91	15.9	2.89	132	300
Rex	42	313	81.4	2.72	13.6	2.51	162	234
Others	35	789	76.1	5.18	16.0	3.25	117	284
All	214	613	78.6	4.32	14.6	2.99	137	263

Variations in the Composition of the Nonedible Parts. Composite samples were prepared from the nonedible parts of all of the fish in 16 of the 20 series analyzed. The composition data arranged according to species are shown in Table V. The average composition for all series was moisture 77.4%, oil 5.68%, protein 13.6%, ash 3.84%, sodium 164 mg. %, and potassium 224 mg. %. The variations were not large, being about ±1% for all constituents except moisture, which varied by ±3%. Although the nonedible parts of sole and flounder had lower values for protein and ash than did those of other salt-water species, they still were high enough to provide a by-product that can be marketed to advantage for use as feed for fur-bearing animals or can be converted to meal for use in poultry feed.

Variations in Composition of Whole Fish. Composition data for whole fish have been calculated from the composition of edible and nonedible parts and from the percentage of fillet obtained. The averages as shown in Table VI were moisture 78.6 ± 3%, oil 4.32 ± 1.5%, protein 14.6 ± 2%, ash 2.99 ± 0.5%, sodium 137 ± 15 mg. %, and potassium 263 ± 15 mg. %. Variations in composition of whole fish were slightly greater than were those for the nonedible parts, but smaller than those found in composition of edible flesh. These data reveal that the whole fish could be utilized to good advantage for industrial purposes.

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NUTRIENTS IN FROZEN FOODS

Variations in Nutritive Value of Frozen Green Baby Lima Beans as a Result of Methods of Processing and Cooking

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As methods of food processing are changed continually to enable the commercial processor to increase production volume and minimize production costs, it is desirable to reassess the values of processed foods to determine if the changes unnecessarily destroy nutritive quality. The effect of different blanching methods and cooking on five B vitamins and ascorbic acid was determined on baby Lima beans. Beans blanched experimentally in hot water and treated with 12 or 28% (by weight) salt solution—concentrations commonly used in commercial freezing plants for quality grading of beans and peas—had greater loss of all vitamins than steam- or hot water–blanched beans. Vitamin losses were less in beans cooked by the steam-boil method in 1/6 cup of water per 10-ounce package than in those cooked in 1 cup of water according to package directions.

FROZEN FOODS are becoming increasingly important in the diets of our population. To maintain a high standard of health, it is important to determine and practice methods of processing, storage, and preparation—both commercially and in the home—by which the food will retain a maximum amount of its original nutritive value.

Frozen green baby Lima beans are a good source of most of the B-complex vitamins, and a fair source of protein and minerals. They rank as good as or better than the cereal grains in several minerals and vitamins.

Published values for nutrients in green Lima beans vary considerably. The variations become important to the consumer when they represent losses of nutrients which could have been prevented in processing and handling. The nutritive quality of the final product is affected by variety, degree of maturity or grade, holding temperature during transit, time in transit from field to packing plant (or laboratory), methods of cleaning, grading, and blanching in preparation for freezing, and cooking methods. These factors could be controlled, to a certain degree, more often than they are, with a resulting gain in retention of original nutrients.

Of the many studies published on the effect of various types of blanching and freezing of green Lima beans, none has determined the effect of all the commercial processing stages preceding freezing on all of the food nutrients in the same sample of beans, and none has attempted to reproduce such methods in order to determine why certain nutrients are considerably lower in the frozen beans than in beans of the same lot freshly harvested. Methods of processing are changed continually to enable commercial processors to increase the volume of production and to keep production costs at a minimum. Therefore, it is desirable to reassess the value of processed foods from time to time to determine if changing processing methods are unnecessarily destroying nutritive quality. Consumers need to learn how to handle these products in institutions and in the home, so that maximum food values are retained.

Experimental Procedures

Preparation of Samples. Commercially frozen Clark's Bush variety of baby Lima beans of the 1956 and 1957 crops were obtained from a frozen foods plant in Stanislaus County, California, and Clark's Bush baby Lima beans of the Thorogreen variety, 1957 and 1958 crops, were obtained from a freezing plant in Santa Clara County.

The beans used as controls for the experiments were obtained as a truck load of the vined and podded beans from the growing field was dumped onto the platform of the freezing plant ready to be put into the flume which carried them through the various processes in preparation for freezing. Frozen packaged beans from the same load of beans were set aside for the experiments after freezing.

The methods for cleaning, for separation into grades, and for blanching used in the two frozen foods plants were essentially the same as those described by Tressler and Evers (*11*). Briefly, the beans were prepared for freezing in the following stages: pumped from the unloading platform through a flume, with water for partial cleaning; passed through salt brine solution for partial grading into mature and immature beans, and for removal of shriveled beans, pieces of pods and vines, and other extraneous materials; blanched for about 3 minutes in water at temperatures ranging from 98° to 100° C.; cooled in cold water for about 2 minutes; passed