Total gossypol also seems to have some effect on growth, an effect which may be independent of free ε-amino lysine, as shown in Figure 3*C*. The DS sample, for example, has a higher total gossypol content than the NC sample, but it has similar free ε-amino lysine value; nevertheless, weight gain was much lower with the DS sample than with the NC sample. This observation, however, deserves further study.

Work along these lines is being continued to determine differences in effect between free and total gossypol, available lysine, and other nutritional defects in cottonseed meal and flour.

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FISH COMPOSITION

Proximate Composition of Silver Salmon

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Proximate composition of silver salmon was determined to obtain information about variations in composition from year to year, within the season, from fish to fish, and from different sections of individual fish. Average composition of edible flesh was: moisture, 72.7%; protein, 21.5%; oil, 5.73%; and ash, 1.2%. Silver salmon varied from very lean to oily—the amount of oil ranged from 1.6 to 12.5%. Fatty deposits were shown to exist in the belly flap, the dark meat along the side, and the dorsal layer along the back of the fish. These tissues had high concentrations of oil even when the entire edible flesh had a low amount of oil.

Silver salmon (*Oncorhynchus kisutch*) are found along the Pacific Coast from Monterey Bay, Calif., north to Kotzebue Sound in the Bering Straits, and in Asiatic waters as far south as Japan. The largest concentrations are found in Oregon, Washington, British Columbia, and southeastern Alaska. The salmon are marketed primarily as fresh, frozen, or canned fish. A fraction of the catch is smoked or kippered. Although silver salmon are important to sports and commercial fishermen, little has been reported on their composition or on variations in composition. Two extensive investigations have been made on the composition of canned silver salmon. Shostrom *et al.* (*3*) analyzed nine samples each from 11 localities in Alaska and Washington.

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Table I. Catch Information and Physical Data for Nine Lots, Each with 10 Troll-Caught Silver Salmon

Lot	Date Caught		Weight, Pounds		Length, Inches	
	Month	Year	Av.	Range	Av.	Range
1	7	59	3.8	3.6–6.3	22.4	20.1–24.8
2	8	59	4.8	3.6–5.8	23.6	21.7–24.8
3	10	59	4.8	3.6–7.8	24.0	19.7–29.1
4	7	60	4.7	4.1–6.6	22.4	20.9–24.8
5	8	60	6.6	5.9–8.2	25.6	23.6–26.4
6	10	60	8.2	4.5–11.0	27.0	23.2–29.5
7	6	61	4.5	3.6–7.1	22.4	20.9–25.6
8	8	61	6.1	5.2–7.2	24.4	22.8–25.2
9	10	61	7.4	5.4–8.8	26.5	22.4–30.7

The fish had been specially canned so that all samples were from the same section of the fish. Composition of fish from the different localities varied little except for the oil content, which ranged from 4.7 to 11.5%. Riddell (*2*) analyzed random samples of canned fish caught from May through September from one point off the British Columbia coast. Composition varied from month to month. The amounts of oil and protein were at a maximum in July. The present article

reports on a series of samples from one locality. The samples were analyzed to obtain information about variations in composition from year to year, within the season, from fish to fish, and from different sections of the individual fish.

Samples

Description of Samples. The silver salmon used in these studies were obtained during three summers, 1959–61. This species is caught commercially for 3 to 4 months each year from late June to early October. Lots of 10 fish each were obtained from commercial catches at the beginning, middle, and end of each fishing season. All salmon were caught by trolling off the northwest coast of Washington, and were gutted. They were landed at Neah Bay and were trucked to Seattle. When they were received at the laboratory, they were 2 to 3 days old and in excellent condition. The gutted fish ranged in weight from 3.6 to 11 pounds (Table I). The fish caught at the beginning of the season were smaller, on the average, than those caught later.

Preparation of Samples. The fish were washed, measured, and weighed immediately upon arrival at the laboratory. They were dipped individually in boiling water for a few minutes to loosen the skin for peeling. Three 1-inch steaks were removed from the nape, center, and tail sections. These steaks were representative of the entire cross-section of edible flesh, including both light and dark meat. In one series each year, additional sections were separated as follows: belly flaps, dark meat along the lateral sections of both sides, and dorsal fatty layer along the back. Each sample was weighed, ground in a Hobart grinder, vacuum packed in a 0.5-pound can, and stored at −18° C. until analyzed.

Methods of Analysis. Standard methods of analysis of the Association of Agricultural Chemists (*7*) were used to determine the percentage of moisture, protein, oil, and ash in each sample.

Results and Discussion

Composition of Edible Flesh. Composition of the edible flesh is reported in Table II. Protein and ash values showed only slight variation among the 90 samples analyzed. The amount of oil shows that silver salmon range from very lean to oily. The variation could not be correlated with size of the fish, period of the season, or year the fish were caught.

Composition of Steaks from Nape, Center, and Tail Sections. It is valuable in determining nutritive values to know which areas are fat depots and what variations occur within individual fish. Steaks were analyzed from cross-

Table II. Proximate Composition of Edible Flesh of 90 Silver Salmon

	Moisture, %		Protein, %		Oil, %		Ash, %	
Lot	Av.	Range	Av.	Range	Av.	Range	Av.	Range
1	73.9	71.8–75.6	21.3	20.7–22.3	4.64	3.03–6.73	1.17	1.10–1.26
2	72.0	69.7–74.2	21.8	21.1–22.8	6.04	4.12–8.89	1.23	1.16–1.29
3	75.3	72.8–77.2	21.4	20.3–22.4	3.10	1.63–6.36	1.26	1.22–1.30
4	70.7	67.9–76.0	21.0	20.2–21.9	8.20	2.49–11.86	1.18	1.11–1.26
5	73.8	72.1–75.6	21.9	21.1–22.5	4.05	2.79–6.48	1.25	1.21–1.29
6	72.2	69.5–74.5	21.4	20.0–21.8	6.38	3.81–8.80	1.13	1.07–1.17
7	74.0	71.3–76.3	21.7	21.3–22.2	4.30	2.00–6.35	1.23	1.18–1.26
8	71.7	68.7–74.9	21.9	20.8–22.6	6.55	3.30–10.56	1.21	1.16–1.29
9	70.3	66.9–72.8	21.4	20.6–22.1	8.30	5.17–12.51	1.16	1.07–1.26
Av.	72.7	66.9–77.2	21.5	20.0–22.8	5.73	1.63–12.51	1.20	1.07–1.30

Table III. Proximate Composition of Steaks from Nape, Center, and Tail Sections of 90 Silver Salmon

Lot	Steak	Moisture, %	Protein, %	Oil, %	Ash, %
1	Nape	72.7	20.4	6.58	1.16
	Center	73.5	21.7	4.63	1.20
	Tail	75.4	21.8	2.73	1.17
2	Nape	70.4	20.9	8.37	1.21
	Center	71.5	22.2	6.28	1.25
	Tail	74.1	22.3	3.47	1.22
3	Nape	74.6	21.1	3.98	1.27
	Center	74.9	21.8	3.11	1.28
	Tail	76.4	21.3	2.14	1.22
4	Nape	68.7	20.2	10.99	1.16
	Center	69.8	21.1	9.04	1.19
	Tail	73.5	21.8	4.56	1.19
5	Nape	73.0	21.3	5.35	1.26
	Center	73.4	22.3	4.07	1.27
	Tail	75.0	22.1	2.73	1.22
6	Nape	70.9	20.5	8.47	1.10
	Center	71.5	21.6	6.75	1.14
	Tail	74.2	21.9	3.92	1.14
7	Nape	73.2	21.2	5.65	1.22
	Center	73.4	22.1	4.65	1.26
	Tail	75.4	21.9	2.60	1.21
8	Nape	70.3	21.0	8.79	1.21
	Center	71.1	22.3	6.91	1.22
	Tail	73.8	22.4	3.96	1.21
9	Nape	68.0	20.3	11.65	1.13
	Center	69.6	21.7	8.66	1.17
	Tail	73.2	22.3	4.58	1.18
Av.	Nape	71.3	20.8	7.76	1.19
	Center	72.1	21.9	6.01	1.22
	Tail	74.6	22.0	3.41	1.20

Table IV. Composition of Lipid Deposits in Belly Flap, Dark Meat, and Dorsal Sections of 30 Silver Salmon

Lot	Section	Moisture, %	Protein, %	Oil, %	Ash, %
3	Belly flap	68.2	18.5	12.71	1.13
	Dark meat	65.8	16.3	17.05	1.01
	Dorsal	...	16.7	24.92	...
6	Belly flap	63.5	17.6	18.91	0.82
	Dark meat	58.0	14.9	26.84	0.93
	Dorsal	41.8	12.9	44.65	0.59
9	Belly flap	28.3	8.5	61.37	0.46
	Dark meat	52.8	14.2	32.28	0.87
Av.	Belly flap	53.3	14.8	30.99	0.80
	Dark meat	58.8	15.1	25.39	0.94
	Dorsal	41.8	14.8	34.79	0.59

sections taken at the nape, center, and tail of the fish. Greatest differences (Table III) were found in oil content, although protein and moisture varied slightly. The nape contained the highest oil and the lowest protein and moisture contents. The tail contained the lowest oil values, often less than one half that of the nape, but the amount of protein was similar to that in the center steak section.

The average oil content for edible flesh in each lot (Table II) was similar to the average values for the center steak sections. In the lots with higher oil values, the oil content in all three sections increased, indicating that the fish had increased in general fatness.

Composition of Lipid Deposits. Both the nutritionist and the processor are interested in the composition of lipid deposits and in whether these deposits should be removed. Removal of lipid deposits will significantly decrease total oil content and increase storage life of frozen fish. Three areas of silver salmon that contained high amounts of oil and low amounts of protein were the belly flap, the dark meat along the side, and the dorsal fatty layer along the back of the fish (Table IV). These sections were analyzed in the last lot of fish obtained each year, except that the lot in the third year contained so little meat in the dorsal fatty layer along the back that it could not be analyzed. In the other two lots, the dorsal meat had by far the greatest concentration of oil in the fish. The belly flap from lot 9, however, contained more oil (61.3%) than any other section in these three lots. The average values for oil content in these three sections are not significant because of the wide variation, but they do show that these areas definitely have concentrations of oil that may decrease storage life of frozen fish. Even when the fish had a low amount of oil—(e.g., Table II, lot 3 at 3.10%)—the belly flap, dark meat, and dorsal layer had high concentrations of oil (Table IV, 12.71, 17.05, and 24.92%, respectively).

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CELLULOSE DIGESTIBILITY

Birefringence of Plant Fibrous Cellulose and Microcrystalline Cellulose in Human Stools Freezer-Stored Immediately after Evacuation

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With pure crystalline cellulose (high alpha cellulose and microcrystalline cellulose, at least), celluloses which do not contain more than relatively small amounts of very low molecular weight hemicellulosic fractions, xylans, mannans, or mixed sugar polymers, chemical and/or physical degradation normally does not occur to any significant extent within the human digestive tract. Microscopic evidence of the retention of definitive birefringence of cellulose substantially intact in human feces, provided the stools are freezer-stored immediately after evacuation from the body, is presented.

The digestibility of cellulose in animals varies considerably, depending on the species of the animal, the source of cellulose, and the composition of the so-called crude fiber (*14*). The evidence (*6, 8, 9, 14*) for the utilization of cellulose by ruminant animals is not only extensive, but also quite convincing. On the other hand, the literature on the digestibility of cellulose in nonruminant animals and man appears to be not only confusing, but also contradictory (*2, 3, 5, 7, 11, 12, 14*).

One of the underlying variables that appears to have received insufficient attention is the fact that the cellulose source and the degree of its purity can influence digestibility data markedly. For example, Williams and Olmsted (*15*) and Hoppert and Clark (*6*) demonstrated that cellulose in fruits and some vegetables seems more digestible than the cellulose in, for example, cereal grain. Fung *et al.* (*3*) claim that even hemicelluloses are completely unmetabolized by the rat.

Various types of natural plant celluloses, however, are known to have wide variations in noncellulosic carbohydrate components. These noncellulosic carbohydrate materials have a fine structure distinctly different from pure cellulose. Some of them are amorphous, three-dimensional sugar polymers and do not exhibit a definitive x-ray diffraction pattern or sharp birefringence under crossed Nicols in the microscope. These latter noncellulosic carbohydrate components may be present in relatively large amounts in natural cellulose sources and in themselves may indeed show partial digestibility. Normally they are classed together with the material called crude fiber, which is then equated to pure cellulose by many of the available analytical procedures used to determine crude fiber in foods.

Commercial grades of alpha cellulose, which are so widely used in the preparation of control and test diets in animal feeding research programs, as well as in human research studies, also contain varying amounts of potentially digestible but not necessarily metabolizable noncellulosic carbohydrate fractions. This is true even though alpha cellulose is the end product of severe chemical purification treatments of raw material from which plant celluloses are extracted. For example, commercial fibrous alpha celluloses may contain as much as 4 to 12% of hemicellulose components. Because of the empirical nature of hemicellulose classification, the "hemicelluloses" in alpha cellulose normally contain xylan, mannan, and glucomannan fractions, and some of the

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