

## Whale Products as Food

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### I. Introduction

Unlike most other peoples, the Japanese have long been eaters of whale meat and other whale products because of their dependence on marine sources for edible animal protein. Japan being a small insular country, livestock supplies have never been adequate. The people therefore early took to the sea; and as the fishing industry grew, so did whaling. The history of Japanese whaling can be traced back several centuries. As an industry, Japanese whaling differs from that of other countries in that the objective is the production of meat and other edible products as well as oil.

### II. Catch Restrictions

Although there are more than sixty species of whales, only the large species are suitable for big-capital operations from the economic standpoint. But since indiscriminate catching of the large species that resulted from growth of the whaling industry gave rise to fears of stocks being

seriously depleted, an International Whaling Commission was established to devise means for their conservation. Among the restrictive provisions adopted by this Commission was one listing the species that might be caught and the permissible minimum body length of each species (see tabulation).

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|  |        |
|--|--------|
| Blue whales ( <i>Balaenoptera musculus</i> ) | 70 ft. |
| Fin whales ( <i>Balaenoptera physalus</i> )  | 57 ft. |
| Humpback whales ( <i>Megaptera nodosa</i> )  | 35 ft. |
| Sei whales ( <i>Balaenoptera borealis</i> )  | 40 ft. |
| Sperm whales ( <i>Physeter catodon</i> )     | 38 ft. |

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With rare exceptions, therefore, whales of the various species actually caught are generally larger than the minimum limits imposed by the International Whaling Commission. One specimen measuring above 100 ft. in length is known to have been caught.

Most of the countries that engage in whaling, and all of those engaged in Antarctic whaling, are represented in the International Whaling Commission. This body has worked out numerous provisions relating to maintenance and conservation of whale stocks; these provisions are revised from year to year to meet changing conditions.

Provisions relating to matters other than whale species and body lengths that have a direct bearing on the quantity of products obtained from whales caught in the Antarctic are the following as established in 1957.

(a) The total number of whales other than sperm whales that may be caught during one whaling season is 14,500 blue whale units.

"Blue whale unit" is a unit devised for convenience of computation, the conversion of the various species in terms of blue whales being fixed as follows:

$$1 \text{ blue whale} = 2 \text{ fin whales} = 2.5 \text{ humpback whales} = 6 \text{ sei whales}$$

This conversion rate is without scientific backing. It is based rather on the number of whales of each species from which approximately the same quantity of oil can be obtained as from one blue whale, and hence is nothing more than a system born of long experience.

(b) Taking of humpback whales is restricted to 4 days during the Antarctic season.

(c) There is no restriction on the number of sperm whales that may be taken.

(d) Whale carcass must be completely processed within 30-35 hours after the catch.

The average number of whales of each species caught in accordance with the provisions of the International Whaling Commission by the fleets

of the various participating nations from 1959/60 to 1961/62 are shown in Table I. Table II gives the 1959/60 to 1961/62 average total Antarctic catch compared with 1949/50 to 1951/52. This shows the drastic decline in blue and humpback whales. Although Antarctica is the major production area of the world, whales are also caught at other places, as shown by the International Whaling Statistics (Anonymous, 1962). Major catch

TABLE I<sup>a</sup>  
ANTARCTIC (INCLUDING SOUTH GEORGIA) WHALE CATCH: AVERAGE FOR  
1959/1960-1961/1962

| Country                             | Unit <sup>b</sup> | Species of whale |       |          |       | Total  | Sperm whale |
|-------------------------------------|-------------------|------------------|-------|----------|-------|--------|-------------|
|                                     |                   | Blue             | Fin   | Humpback | Sei   |        |             |
| Japan                               | No                | 688              | 9,888 | 164      | 1,355 | 12,095 | 1,338       |
|                                     | BWU               | 688              | 4,944 | 66       | 226   | 5,924  | —           |
| Norway                              | No                | 128              | 8,594 | 76       | 632   | 9,430  | 1,609       |
|                                     | BWU               | 128              | 4,297 | 31       | 105   | 4,561  | —           |
| U.S.S.R.                            | No                | 410              | 4,259 | 431      | 1,465 | 6,565  | 1,032       |
|                                     | BWU               | 410              | 2,130 | 172      | 244   | 2,956  | —           |
| U.K.                                | No                | 88               | 2,826 | 83       | 903   | 3,900  | 349         |
|                                     | BWU               | 88               | 1,413 | 33       | 150   | 1,684  | —           |
| Netherlands                         | No                | 50               | 1,639 | 34       | 28    | 1,751  | 222         |
|                                     | BWU               | 50               | 820   | 14       | 5     | 889    | —           |
| Falkland Isles<br>(1960/61-1961/62) | No                | 3                | 675   | —        | 467   | 1,145  | 86          |
|                                     | BWU               | 3                | 338   | —        | 78    | 419    | —           |
| Argentina<br>(1959/60 only)         | No                | 6                | 467   | —        | 426   | 899    | 33          |
|                                     | BWU               | 6                | 234   | —        | 17    | 311    | —           |
| S. Africa<br>(1956/57 only)         | No                | 9                | 1,381 | 13       | 118   | 1,521  | 75          |
|                                     | BWU               | 9                | 691   | 5        | 20    | 725    | —           |
| Panama<br>(1955/56 only)            | No                | 107              | 2,115 | 199      | —     | 2,421  | 309         |
|                                     | BWU               | 107              | 1,058 | 80       | —     | 1,245  | —           |

<sup>a</sup> Yearbook of Fishery Statistics (FAO), Vol. 14, 1961.

<sup>b</sup> No = number of whales; BWU = blue whale units.

TABLE II  
ANTARCTIC (INCLUDING SOUTH GEORGIA) WHALE CATCH: AVERAGE FOR  
1949-1951 AND 1959-1961

| Season                       | Unit | Species of whale |        |          |       | Total  | Sperm whale |
|------------------------------|------|------------------|--------|----------|-------|--------|-------------|
|                              |      | Blue             | Fin    | Humpback | Sei   |        |             |
| 1949/50-1951/52 <sup>a</sup> | No   | 6,120            | 20,681 | 1,780    | 900   | 29,481 | 4,393       |
|                              | BWU  | 6,120            | 10,341 | 712      | 150   | 17,323 | —           |
| 1959/60-1961/62 <sup>b</sup> | No   | 1,367            | 27,810 | 787      | 4,870 | 34,834 | 4,619       |
|                              | BWU  | 1,367            | 13,905 | 315      | 812   | 16,399 | —           |

<sup>a</sup> Yearbook of Fishery Statistics (FAO), Vol. 4, Part 1 (Production), 1952-1953.

<sup>b</sup> Yearbook of Fishery Statistics (FAO), Vol. 14, 1961.

reductions were introduced in the catch season 1963/1964, bringing the total outtake down to 10,000 blue-whale units. This was, according to the Director-General of FAO, not sufficient to save the stocks, so he appealed in 1964 for further restrictions and fixed quota for all species.

The humpback whale was protected at all times south of the equator and the blue whale was protected south of 40° south latitude except between 9° and 80° east longitude and north of 55° south latitude.

It will be noted that when the figures for the various species are converted to terms of blue whale units, their total for a season does not coincide with the seasonal maximum total of 14,500 heads stipulated by the International Whaling Commission. The reason for this discrepancy is easy to explain:

Throughout the Antarctic season, the total of whales caught by each fleet is reported weekly by the Government concerned to the Commission headquarters located in Oslo. And when the total of 14,500 is approached, the headquarters fixes the day on which operations are to end and notifies all the fleets. Since the notice is given approximately a week in advance, the grand total for the season is bound to be slightly more or less than 14,500 because of the impossibility of the central headquarters estimating exactly the number that will be taken during the time intervening between the dispatch of the notice and the season's end.

The meat and other products obtained from all species, except the sperm whale, caught by Japanese fleets (Table I) are brought to Japan for use as food for its people. There is little demand for the sperm whale products because they do not seem to meet Japanese taste.

### III. Anatomy of the Whale; Weights of Various Parts of Carcass

Although the body length of a whale can be measured easily enough, accurate total weight is difficult to obtain because of the huge size of the carcass. So while estimates of the relation of body length to weight have been made, the actual relation has never been accurately worked out, probably because there is no acute practical need for doing so.

Although Japanese fleets have never been able to weigh a whale carcass whole, weights of all the parts of the carcass have been taken for several dozen specimens. In Tables III and IV are given the weights obtained for all the parts in fin, blue, and sperm whales.

The above total figures of course do not represent the true weight of the whales weighed; some 10% should perhaps be added to allow for the blood and other liquid substances lost during the processing. That, however, is at best only a rough estimate.

TABLE III  
WEIGHTS OF PARTS IN BALEEN WHALES IN 1950-1951  
(in kg.)

| Species and sex:           | Fin female | Fin male | Blue female     | Blue male |
|----------------------------|------------|----------|-----------------|-----------|
| Body length (ft.):         | 57         | 67       | 78              | 83        |
| <b>Blubber</b>             |            |          |                 |           |
| Blubber                    | 3,351      | 5,004    | 11,068          | 11,768    |
| Head blubber               | 616        | 1,177    | 2,122           | 2,370     |
| Blubber of ventral grooves | 2,227      | 3,965    | 12,305          | 11,200    |
| Blubber of lower jaw       | 514        | 840      | 1,460           | 2,205     |
| Flukes                     | 245        | 332      | 625             | 546       |
| Total                      | 6,953      | 11,318   | 27,580          | 28,089    |
| <b>Meat</b>                |            |          |                 |           |
| Meat                       | 16,213     | 19,889   | 25,860          | 40,954    |
| Ventral meat               | 662        | 237      | 885             | 3,406     |
| Connective tissues         | 753        | 1,684    | —               | —         |
| Total                      | 17,628     | 21,810   | 26,715          | 44,360    |
| <b>Internal organs</b>     |            |          |                 |           |
| Heart                      | 162        | 207      | 430             | 412       |
| Lungs                      | 343        | 414      | 730             | 960       |
| Tongue                     | 844        | 1,343    | 1,938           | 2,708     |
| Stomachs                   | 321        | 250      | 223             | 420       |
| Esophagus                  | 79         | 22       | ND <sup>a</sup> | 67        |
| Small intestine            | 334        | 177      | 1,001           | 824       |
| Large intestine            | 347        | 607      | 667             | 380       |
| Pancreas                   | 28         | 20       | ND              | 40        |
| Spleen                     | 4.5        | 5        | ND              | 16        |
| Kidney                     | 134        | 142      | 262             | 290       |
| Liver                      | 397        | 503      | 625             | 1,047     |
| Bladder                    | 16         | 21       | ND              | 22        |
| Penis (uterus and vagina)  | 0.5        | 44       | ND              | 105       |
| Testes (ovaries)           | 30         | 5        | 39              | 64        |
| Diaphragm                  | 142        | 218      | 325             | 490       |
| Internal fats              | 770        | 1,769    | 2,798           | 5,952     |
| Total                      | 3,952.0    | 5,747    | 9,038           | 13,797    |
| <b>Bones</b>               |            |          |                 |           |
| Skull                      | 1,186      | 2,048    | 2,645           | 5,328     |
| Vertebrae                  | 2,569      | 3,605    | 6,510           | 10,109    |
| Ribs                       | 174        | 1,281    | 1,040           | 2,409     |
| Jaw bones                  | 544        | 880      | 1,668           | 1,907     |
| Scapula                    | 158        | 263      | 475             | 393       |
| Hyoid bone                 | 42         | 45       | ND              | 175       |
| Nasal cartilage            | ND         | 110      | ND              | 230       |
| Total                      | 4,673      | 8,232    | 12,338          | 20,551    |
| <b>Miscellaneous</b>       |            |          |                 |           |
| Gums                       | 131        | 129      | ND              | 450       |
| Jaw ligaments              | 191        | 321      | 370             | 985       |

TABLE III (Continued)

| Species and sex:               | Fin female | Fin male | Blue female | Blue Male |
|--------------------------------|------------|----------|-------------|-----------|
| Body length (ft.):             | 57         | 67       | 78          | 83        |
| Miscellaneous ( <i>cont.</i> ) |            |          |             |           |
| Baleen                         | 184        | 315      | 465         | 1,053     |
| Tendons                        | ND         | ND       | ND          | ND        |
| Flippers                       | 226        | 411      | 912         | 640       |
| Scraps                         | 2          | 10       | 1,336       | 7         |
| Total                          | 734        | 1,186    | 3,583       | 3,135     |
| Grand total                    | 33,940.0   | 48,293   | 79,254      | 109,932   |

<sup>a</sup> ND: Not determined.

TABLE IV  
WEIGHTS OF PARTS IN SPERM WHALES IN 1950-1951  
(*in kg.*)

| Parts                | Body length (ft.) |        |        |        |
|----------------------|-------------------|--------|--------|--------|
|                      | 46                | 48     | 51     | 54     |
| Blubber              |                   |        |        |        |
| Blubber              | 6,880             | 5,938  | 6,200  | 5,827  |
| Head blubber         | 3,306             | 4,223  | 5,015  | 6,482  |
| Blubber of lower jaw | 160               | 150    | 160    | 250    |
| Tail flukes          | 318               | 295    | 479    | 568    |
| Dorsal fin           | —                 | —      | —      | —      |
| Blubber of flipper   | 226               | 190    | 270    | —      |
| Other blubber        | 37                | 85     | 70     | —      |
| Total                | 10,927            | 10,881 | 12,194 | 13,127 |
| Internal organs      |                   |        |        |        |
| Heart                | 97                | 109    | 95     | 102    |
| Lungs                | 136               | 150    | 214    | 363    |
| Tongue               | 90                | 173    | 150    | 140    |
| Gum                  | —                 | —      | —      | —      |
| Esophagus            | —                 | —      | —      | 64     |
| Stomachs             | 210               | 199    | 210    | 301    |
| Small intestine      | 297               | 285    | 217    | 260    |
| Large intestine      | 102               | 131    | 123    | 162    |
| Pancreas             | —                 | —      | —      | 4      |
| Kidney               | 170               | 138    | 133    | 172    |
| Liver                | 463               | 492    | 380    | 517    |
| Bladder              | —                 | —      | —      | —      |
| Testes               | —                 | —      | —      | 11     |
| Penis                | —                 | —      | —      | 83     |
| Internal fats        | 250               | 280    | 197    | 347    |
| Diaphragm            | 157               | 209    | 196    | —      |
| Others               | 5                 | —      | 126    | —      |
| Total                | 1,977             | 2,166  | 2,041  | 2,526  |

TABLE IV (Continued)

| Parts                | Body length (ft.) |               |               |               |
|----------------------|-------------------|---------------|---------------|---------------|
|                      | 46                | 48            | 51            | 54            |
| <b>Bones</b>         |                   |               |               |               |
| Skull                | 1,370             | 1,873         | 2,020         | 2,745         |
| Vertebrae            | 1,385             | 1,452         | 1,941         | 2,337         |
| Ribs                 | 382               | 530           | 630           | 676           |
| Jaw bones & teeth    | 84                | 175           | 300           | 326           |
| Scapula              | 96                | 90            | 110           | 150           |
| Hyoid bone           | —                 | —             | —             | 2,223         |
| Pharyngeal bone      | —                 | —             | —             | 135           |
| Other bones          | 336               | 404           | 290           | 10            |
| Total                | 3,653             | 4,524         | 5,291         | 8,602         |
| <b>Miscellaneous</b> |                   |               |               |               |
| Spermaceti sac       | 3,661             | 4,820         | 6,497         | 1,255         |
| Fibrous head tissue  | 91                | 66            | 178           | 8,007         |
| Spermaceti           | 1,275             | 2,078         | 2,371         | 2,020         |
| Suprarenal body      | —                 | —             | —             | —             |
| Other                | 565               | 605           | 850           | —             |
| Total                | 5,592             | 7,569         | 9,896         | 11,282        |
| <b>Grand total</b>   | <b>29,984</b>     | <b>32,283</b> | <b>37,007</b> | <b>44,762</b> |

Detailed anatomical investigation of various parts of the whale carcass has been made, but because of a whale's tremendous size and the consequent difficulty of determining the correct natural position of the various organs once the carcass has been dissected, it has not so far been possible to prepare an anatomical chart of a complete whale.

#### IV. Processing of Whale Carcass

If too much time is allowed to elapse between the catching of the whale and the freezing of its meat, the meat will lose its freshness and its value as food will thereby be reduced. Robinson *et al.* (1953) found no significant growth of *Clostridium* or aerobic bacteria in whale meat before rigor. Aerobic bacteria play a subsidiary role in the spoilage of fresh whale meat. Although the International Whaling Commission, not being concerned with the utilization of the meat for human food, allows 30 hours until start of processing, the Japanese fleets have found such time to be much too long and have set their goal at 10 hours in order to prevent deterioration in quality.

There is, however, a definite limit to the processing capacity of a whaling factory ship. When so many whales are taken at one time as to exceed the factory ship's processing capacity, it not infrequently happens that the catcherboats are ordered to suspend operation until the factory

ship can catch up. Even then, if all whales already brought in cannot be completely processed in 10 hours, the excess whales are processed for oil rather than meat; such parts as are not suitable for oil production are thrown overboard.

Because Japanese fleets bring back meat and other parts for use as food, they have devised a dissection method best suited for that purpose. It differs from the method used by other countries mainly interested in the production of oil.

On the average, the total quantity of meat and other edible products from a single blue whale is 17–18 tons. It can produce 7–10 tons of choice cuts of lean meat.

## V. Freezing and Salting

### A. FREEZING

In addition to meat, such edible products as blubber and fluke are obtained from whales. The meat is classified into red meat, tail meat, and ventral meat. Most of the blubber is used for extracting oil, but a certain portion, known as ventral blubber, is used for food. Fresh whale meat or meat frozen while fresh does not have a "fishy" flavor. This characteristic is thought to be associated with oxidative rancidity of the fat.

From the factory ship these parts are taken by small transports to a refrigeration ship where they are washed with sea water and subjected to a preliminary cooling process. Then they are cut up into cubes of suitable size (each cube weighing approximately 8 lb.), quick-frozen, and placed in cold storage chambers of the refrigeration ship. Shipment to Japan is by special reefer ships. Such organs as pancreas and liver, from which pharmaceuticals are produced, are also frozen before shipment to Japan. Drip during defrosting of whale meat, as of other meat, lowers the nutritional value. Tanaka and Tanaka (1956a,b, 1957a,b, 1958) investigated this problem. Although quick freezing generally renders less drip for most meat, frozen pre-rigor whale meat seemed to be an exceptional case in which slow freezing gave less drip. For defrosting, dielectric heating was as effective as circulating air at 10°C. (50°F.).

Sharp and Smith (1952) found that only polyvinylidene chloride film gave marked protection against dehydration and oxidation in whale meat stored at  $-10^{\circ}\text{C}$ . It was found that frozen whale meat kept covered with ice glaze or adequate wrapping would keep 10 months at this temperature without deterioration (Sharp and Marsh, 1953).

### B. SALTING

If it were possible, the ideal would be to freeze all of the edible products. But because of the limitations of freezing and transport facili-



ties, a part has to be salted. The salted meat also is shipped to Japan in reefer ships.

TABLE V<sup>a</sup>  
PRODUCTION OF PROCESSED WHALE PRODUCTS BY JAPANESE FLEETS IN THE ANTARCTIC  
(INCLUDING SOUTH GEORGIA) IN VARIOUS SEASONS

| Seasons  | Products        |       |         |           |       |         |            |       |         |
|----------|-----------------|-------|---------|-----------|-------|---------|------------|-------|---------|
|          | Whale oil       |       |         | Sperm oil |       |         | Whale meat |       |         |
|          | World           | Japan | % Japan | World     | Japan | % Japan | World      | Japan | % Japan |
| 1949/50– |                 |       |         |           |       |         |            |       |         |
| 1953/54  | 352.2           | 31.8  | 9.0     | 32.0      | 4.3   | 12.7    | 34.0       | 25.6  | 74.7    |
| 1954/55– |                 |       |         |           |       |         |            |       |         |
| 1958/59  | 334.8           | 73.0  | 21.8    | 48.3      | 13.5  | 28.5    | 108.6      | 91.8  | 81.1    |
| 1959/60  | 331.9           | 93.7  | 28.2    | 33.4      | 11.2  | 33.5    | 145.9      | 119.5 | 81.9    |
| 1960/61  | 343.1           | 101.2 | 29.5    | 36.4      | 12.2  | 33.5    | 166.1      | 136.3 | 82.1    |
| 1961/62  | na <sup>b</sup> | na    | —       | na        | na    | —       | na         | na    | —       |
|          | Whale liver oil |       |         |           |       |         | Other      |       |         |
|          | World           | Japan | % Japan | World     | Japan | % Japan |            |       |         |
| 1949/50– |                 |       |         |           |       |         |            |       |         |
| 1953/54  |                 | 0.2   | 0.1     | 50.0      |       | 1.1     | 0.7        | 70.5  |         |
| 1954/55– |                 |       |         |           |       |         |            |       |         |
| 1958/59  |                 | 0.2   | 0.2     | 93.3      |       | 14.9    | 13.0       | 87.3  |         |
| 1959/60  |                 | 0.2   | 0.2     | 100.0     |       | 14.9    | 13.0       | 87.3  |         |
| 1960/61  |                 | 0.2   | 0.2     | 100.0     |       | 40.5    | 35.7       | 88.1  |         |
| 1961/62  |                 | na    | na      | —         |       | na      | na         | —     |         |

<sup>a</sup> (1) Yearbook of Fishery Statistics (FAO), 1952–1953, 1958, 1959, and 1961.

(2) Abstr. of Statistics on Agriculture, Forestry and Fisheries, Japan, 1961, 78.

<sup>b</sup> Not available.

The quantities of products obtained by Japan's Antarctic whaling fleets during past seasons are shown in Table V.

## VI. Whale Meat and Other Products; Use as Food

### A. DIRECT CONSUMPTION

Frozen whale meat, cooked very much the same as beef or pork, is widely used by the people of Japan. Also fluke and ventral blubber, both frozen and salted, are quite popular; they are either cut into small slices and suitably seasoned or cooked together with various other ingredients. Even such parts as liver, tongue, kidney, intestine, and nasal cartilage have long been eaten by the Japanese, each preparing them for the table to suit his taste; but the demand for them today is too small to make them an economic factor in the Antarctic operations. While never extremely popular, whale meat has been eaten in Europe for centuries. It

was brought to London from Rouen as early as 1000 A.D. It was sold elsewhere at early dates, e.g., Utrecht in 1024, Nieuport in 1163, Damme in 1252, and Calais in 1300 (Slijper, 1962). Even today whale meat is regularly processed in Iceland and Norway. Some is exported to Britain and Germany where it is used to a limited extent for human food, but more frequently for pet food.

It must not be forgotten that whales are a very important item in the Eskimo diet. Whale meat contains 4.8% fat as compared with an average of 12% for beef.

#### B. CANNED FOOD

Both frozen and salted whale meat, seasoned with sugar and soy sauce, are canned for the market in large quantities. Also put up in cans are roast whale meat, whale meat "sukiyaki," and corned whale meat, the last being somewhat similar in taste to corned beef. Outside of Japan some frozen whale meat is canned and sold as meat roll stews and as meat and vegetable packs of "steak and kidney" (Anonymous, 1949a).

#### C. SAUSAGE

To the two main ingredients, frozen or salted whale meat and tuna, are added various condiments and seasoning; the mixture is packed in artificial casing and then boiled and pasteurized. Schulze (1949) found sausages containing 3.6-4% whale meat meal to be perfectly good. However, 10% gave a too fishy taste.

#### D. EDIBLE GELATIN

This is produced from the head blubber and connective tissue around spermaceti, both frozen and salted. Japan is probably the only country in which the production of gelatin from whales has been developed as an industry, and even in Japan there is only one factory devoted to this. The factory also produces gelatin for photographic and other industrial uses; its production constitutes a very substantial portion of total gelatin production in Japan.

Characteristic properties of edible gelatin produced from whales are given in Table VI.

#### E. RENGI

In Iceland a dish is made from whale belly by pickling the fat in acid. Rengi has a cucumber-like taste. Most foreigners do not like it (Slijper, 1962).

#### F. DRYING

Robinson *et al.* (1949) found that the total number of bacteria in dried whale meat was low for this type of product. They found about

TABLE VI  
PHYSICAL AND CHEMICAL PROPERTIES OF WHALE AND COW GELATIN

| Kind of gelatin       | Moisture (%) | M.P. (°C.) | S.P. (°C.) | Viscosity <sup>a</sup> (sec.) | Jelly strength <sup>b</sup> |
|-----------------------|--------------|------------|------------|-------------------------------|-----------------------------|
| Whale (blubber)       |              |            |            |                               |                             |
| Gelatin A             | —            | 28.9       | 25.0       | 56.3                          | 582                         |
| Gelatin E             | 15.89        | 30.4       | 26.3       | 107.6                         | 580                         |
| Gelatin F             | 17.70        | 31.5       | 26.6       | 161.7                         | 1275                        |
| Cow                   |              |            |            |                               |                             |
| DEG<br>(Germany)      | 18.11        | 33         | 27         | 55.3                          | 339                         |
| Winterthur<br>(Swiss) | 18.63        | 34         | 27         | 73.5                          | 314                         |
| Nelson<br>(England)   | 17.43        | 31.5       | 26         | 60.4                          | 340                         |
| A Company 1           | 19.58        | 34         | 28         | 55                            | 320                         |
| A Company 2           | 19.57        | 33.5       | 28         | 57                            | 313                         |
| A Company 3           | 19.18        | 32.5       | 28         | 59.3                          | 301                         |
| B Company 1           | 18.26        | 34         | 28.4       | 112.9                         | 515                         |
| B Company 2           | 17.77        | 31.8       | 26.7       | 67                            | 280                         |

<sup>a</sup> Viscosity is shown in seconds of 50 ml. gelatin solution at 50°C. by the Redwood viscosimeter.

<sup>b</sup> Jelly strength is shown of 5% or 10% solutions.

equal numbers of *Clostridium* and aerobic bacteria. No *Clostridium* pathogenic to the mouse was found.

### G. PICKLING

In Norway, the same type of brine and vinegar procedure used for their "silver herring" product has been successfully used for whale meat (Anonymous, 1949b).

### VII. Whale Oil

The collective term "whale oil" as popularly used includes oil obtained from blue whales, fin whales, humpback whales, and sei whales, but not that from sperm whales. The oils of these four species are so similar in character that no distinction is made between them by the trade.

Whale oil, after being hardened by hydrogenation and deodorized, becomes the raw material for the production of margarine. The equipment and process used for this hardening and deodorization are the same as in the case of ordinary fish oil.

Since whale oil is extracted by causing the protein to be digested

under steam pressure, it contains far less impurities than does ordinary fish oil produced as a by-product of fish meal by subjecting the fish to hydraulic pressure. As raw material for hardened oil, therefore, whale oil is considered superior to fish oil.

Sperm oil, unlike ordinary whale oil which is made up of glycerine and fatty acids, is a compound of higher fatty alcohols and fatty acids; hence it is said to be injurious to health if eaten, because of the presence of higher fatty alcohols. It has actually been proven by animal feeding tests that overuse of feed containing sperm oil can prove fatal.

In coastal regions of Japan where sperm whales are caught, however, the people have long been using sperm oil regularly in their cooking without any indication of special harmful effects traceable to the use of the sperm oil. In human feeding tests in which individuals were given sperm oil daily equal in quantity to the average daily intake of fats in Japan, it was noted that the rate of absorption from the digestive organs was about the same for sperm oil and other fats and hence that there was little nutritive difference between them. In other human feeding tests employing margarine made from hydrogenated oil, the main ingredient of which is sperm oil, nothing could be found of harm from the standpoint of nutrition. Although intensive study of this problem is being continued in Japan, past tests appear to have revealed enough to give room for doubt as to the soundness of the view so long held that sperm oil is harmful to the human body.

#### VIII. Research on Whale Meat

The only use made of whale meat in England at present seems to be for livestock feed. But immediately after World War II when that country was suffering from acute shortage of beef, production of whale meat was begun in order to supplement the country's meat supply; both fresh and canned meat was supplied to the people.

Since this was a field in which the British people had little experience, a basic study of whale meat was then begun by personnel of the Food Investigation Board and the Low Temperature Research Station with cooperation from members of the whaling industry. The results of their studies are reported in Special Reports No. 58 and 59 (1953) of "The Food Investigation" published by the Food Investigation Board.

But in Japan, where whale meat has been used as human food for so long, biological research on whales for scientific purposes and more practical study of whale meat for use as food have been pursued quite extensively. Regarding the latter study, however, there is relatively little to be found in the way of published reports, the reason being that most

of such study is carried on by the whaling companies for the purpose of improving their respective production, preservation, and processing.

### IX. Conclusion

Together with the conservation of the whale stock, the complete utilization of the whale carcass is an important mission of the International Whaling Commission. It is for this reason that one of the provisions of the Commission stipulates that such parts of the carcass as are not used for food must be put into the press-cooker for separating oil, in order to obtain the maximum quantity of oil from each whale.

Compliance with that stipulation may appear to be in conformity with the purpose of "complete utilization." In practice, however, when lean meat is thrown into the boiler the protein is dispersed; the dispersed protein not only increases emulsion in the oil, but tends to reduce the oil yield by adsorbing some of the oil on its surface. Therefore, use of the meat for human food would appear to be more significant and in closer conformity to the Commission's important mission than is the requirement of "complete utilization" as laid down by the International Commission. If all of the fleets of other countries that operated in the Antarctic in the 1958 season had produced whale meat in the same proportion as the Japanese fleet, total production would have been 270,000 tons.

Since the huge quantity of whale meat is a source of edible protein obtainable in a short period and with relative ease as a by-product, the possibility of supplying it to countries where people are suffering from shortages of animal protein deserves serious study as one of the major problems bearing on future Antarctic whaling.

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