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CANNING TUNA

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INTRODUCTION

Second only to salmon in value of production, canned tuna is among the most popular canned products in the domestic market that takes most of the production. After the first commercial pack of tuna - 2,000 cases - made in 1909, the industry grew slowly until after the first World War. Thereafter, production mounted rapidly until 1940 (the last year before second World War conditions affected production) when the pack amounted to 4,186,689 cases with a value to the packer of \$23,713,966.

Tuna-canning methods discussed here refer particularly to those used in California, since the industry, at present, is largely concentrated in that State. Some tuna, however, is canned at Gloucester, Mass., on the Atlantic coast, and a considerable amount is canned in a new development in the lower Columbia River area. In fact, some of the newest ideas in cannery construction and layout are incorporated in the Columbia River tuna canneries.

SPECIES CANNED

Canned tuna is produced from four species within the mackerel family. Bonita, another species of this group, is canned tuna style, but may not be labeled as tuna; neither may the yellowtail, belonging to the family of jacks (Carangidae). Some Pacific mackerel is also canned tuna style. The different tuna in order of commercial importance are:

The yellowfin tuna (Neothunnus macropterus), which species may be recognized by the long pectoral fin. The pectoral reaches or almost reaches the front of the anal fin but not past it, as in the albacore. The series of 8 or 9 finlets following the second dorsal and anal fins and the tail show a yellowish tint, giving the species its name. The color of the body is dark blue on the back and upper sides, shading into iron gray below. The State of California has set legal catch-size limits, with minimum at 7.5 lbs. and maximum at 150 lbs. The average size is about 30 lbs.

The bluefin tuna (Thunnus thynnus), which is the largest of the tunas, is also known as the "horse mackerel" or "leaping tuna". It is said to be of the same species as the European tuna. Its distinguishing features are a pectoral fin shorter than the head, with finlets and tail fin bluish in color. The color of the back is deep blue, shading into iron gray on the sides and silvery below. The maximum legal size limit is 150 lbs. but the fish may attain a weight of over 250 lbs. The average size is approximately 30 lbs.

The skipjack (Euthynnus pelayus), which is also known as the "striped tuna", is the smallest of the tunas. Its principal distinguishing characteristics are the four or five dark stripes which extend horizontally along the lower side of

the body. The color of the body is bright blue above, which becomes dull after the fish dies, shading into silver along the sides and below. Skipjack range in weight from about 3 to 20 lbs., but it is illegal under California law to land fish weighing less than 4 lbs.

The albacore (*Germo alalunga*), which was the first species of tuna canned in California, is the only one that may be labeled as white meat tuna. The chief distinguishing characteristic of the albacore is the great length of the pectoral fins which reach some distance past the front of the anal fin; the secondary common name of "long-finned tuna" has been given it on this account. The color of the albacore is dark steel blue above, shading into dull silver below. While the albacore may reach a maximum of 80 lbs., the average commercial specimen weighs approximately 25 lbs.

The bonito (*Sarda chiliensis*), which has a flesh somewhat darker and more strongly flavored than the tunas, is relished in certain markets. It resembles the tunas generally, but the body is more slender, the pectoral fins are short, and the tail has a fleshy keel on each side. The body is striped obliquely, or horizontally, above the lateral line, with narrow blackish stripes. The color is dark blue above, with greenish reflections and a metallic luster, shading into silvery below. The maximum weight is 20 lbs., but the average is approximately 8 lbs.

Fishing areas

The area fished by the southern California fleet reaches to and slightly beyond the equator, extending from the continental mainland to points approximately 800 miles offshore. It includes areas around practically all the islands within these general limits, including the Revilla Gigado Islands, Clipperton Island, Cocos Island, and the Galapagos Islands. The albacore fishing area off the coast of Oregon and Washington is not yet definitely established, but centers off the mouth of the Columbia River. Commercial landings have been reported from British Columbia to southern Oregon, with catches made from 5 to 50 miles offshore.

Fishing craft and methods

The greater portion of the tuna catch is made by "live bait" boats, large craft up to 148 feet in length. They are so called because live sardines are carried in large tanks of sea water on deck, through which sea water is circulated. When tuna are sighted, the live sardines are scattered over the water to attract and hold the tuna near the fishing boat. The tuna are then taken by lures with barbless hooks. As the tuna strike at the lures they are pulled aboard partly under their own impetus. Some tuna are also taken by purse seine, and the procedure here is no different from that followed in other fisheries except that the net must be heavier and the set made more rapidly. In the Oregon albacore fishery "jigs", or artificial lures of the same type used in the early days of the California tuna fishery, are employed. The fish are taken by much the same method as are salmon - by trolling - so that salmon trollers have taken readily to fishing for albacore.

Transporting and unloading

The fishing vessels themselves also deliver their catches packed down in finely crushed ice in insulated bins. For most of the fleet, mechanical

refrigeration supplements the ice, delaying its rate of melting; the newer vessels depend entirely on mechanical refrigeration. The fish are placed in large tanks of brine chilled to a low temperature and kept in constant circulation. This is drawn off and the fish are held in dry storage when freezing is completed.

The fish are not gutted or headed but stowed away "in the round", partly because the fishermen are paid by weight. In addition, cleaning the catch before stowing causes leaching of the flesh by ice, extra bruising and damage to the flesh during stowage and unloading, and delay in getting the tuna into the hold. It has also been found that gutting attracts sharks making it impossible to fish.

Equipment and procedure in unloading depend upon location of the cannery. The tuna may be trucked into the cannery or some type of conveyor used; in all cases, however, they are subject to careful examination when unloaded from the vessel, and fish found unfit for canning immediately condemned.

Much of the tuna is frozen upon arrival at the cannery, and must be thawed. The usual practice in the San Diego area is to hold the tuna in tanks of running water. In the Terminal Island (Los Angeles) district the fish are left to thaw in the air. If thawed in running water, tuna under 10 lbs. may be sufficiently soft in 2 to 2½ hours; fish from 15 to 30 lbs., 3 to 5 hours; larger specimens, 5 to 8 hours. There is a wide variation in time in air thawing. During warm weather a small skipjack weighing 5 to 10 lbs. may thaw out in 4 hours, but in cool weather 12 to 15 hours may be required. A medium-sized fish will air thaw in anywhere from 12 to 36 hours, while a large tuna may require as much as 48 hours.

Dressing or butchering

In the smaller or older type plants, the tuna are butchered or cleaned on a small portable cleaning table with a washing tank in the middle or at one end. In the larger or newer type plants, especially at San Diego, the butchering table is a wooden slat conveyor running from the bin at the end of the outside conveyor. A man standing by the bin arranges the fish on the conveyor. The butchers stand next. One worker makes a long slash down the ventral side to the vent, then slashes the viscera free at both ends of the body cavity. Another worker at his side then tears out the viscera. Next comes a man who washes out the belly cavities with a spray of water under heavy pressure, and removes any bits of viscera. He is followed by a state cannery inspector who grades the fish, condemning all unfit material by determining the odor of the belly cavity. The cannery also has an inspector to cull out stale or tainted fish.

The dressed and washed fish are placed in 15" x 30" wire-mesh baskets, which are fitted into wheeled racks of angle iron. These baskets will hold six small, three medium, or one fairly large tuna. Sometimes baskets 36 and 42 inches long are used to hold still larger fish. Tuna are stacked in the baskets belly down for better draining during cooking.

Precooking

The racks of tuna are wheeled into horizontal, rectangular steam chests where they are precooked in preparation for filling into the cans. The average tuna cooker is built of sheet iron, is either 13 or 20 feet long, and will hold either five or eight racks, depending upon its size. The chamber must be brought up to

cooking temperature gradually, and the time length here varies according to the size and condition of the fish: tuna brought in fresh, for example, require less time than frozen fish; while large sizes must be given more time than small. Length of "comeup" or "log" time also depends upon the routine practice established by the individual packer. Representative periods are 20 minutes for skipjack and albacore under 15 lbs., 30 minutes for tuna 15 to 30 lbs., 40 minutes for fish 30 to 40 lbs., and 60 minutes for tuna 50 lbs. or larger.

The temperature of the precook will average 216° F., though it may be as much as 220° F. The usual custom in cooking is to maintain 1 or 2 lbs. steam pressure in the cooker. The length of time required for the precook will vary from 1½ to 8, even 9 hours.

General precooking times and temperatures are as follows:

Table 1

Species	Weight in lbs. <u>1/</u>	Time of precook in hours (216° F.)
Albacore	10 - 14	3 - 5½
"	18 - 40	4 - 4½
Bluefin and yellowfin	8 - 18	2
" " "	18 - 50	3
" " "	50 - 60	4
" " "	60 - 200	5 - 9
Skipjack (striped) tuna	5 - 12	2 - 2½
Bonito and yellowtail	5 - 12	2 - 2½

When the fish have been cooked sufficiently they are run out into a cooling room and held until the flesh is cold and firm enough to handle. Length of cooling time depends upon the size of fish and atmospheric temperature: for most sizes of tuna, 12 hours is average; large bluefin tuna are preferably cooled 24 to 36 hours. The maximum length time precooked tuna may be allowed to stand without spoilage is 24 hours during warm, summer weather.

Cleaning and cutting

Cleaning may be done in a separate room, or the tables set up close by and parallel to the packing line. Methods do not vary between canneries or with different species of tuna: the heads are broken off, tails and fins removed, and the skin is scraped away. After this, the body is separated into two halves exposing the backbone, which is removed together with the adhering rib bones. The halves are split longitudinally and the dark meat, located in a V-shaped layer along the lateral line, is scraped away quickly and thoroughly with the blade of a small paring knife. The pieces of light meat are placed on trays 16" x 24".

1/ The average loss of weight from precooking runs from 25 to 30 percent. The tuna oil cooked out is sometimes recovered from the steam chests and sold as a byproduct.

Before it is sliced, the cleaned meat is inspected to see that it is well cleaned and that no meat unfit for canning because of discoloration, staleness, or honeycombing is included. The waste may also be inspected before it is discarded to determine that the cleaner is throwing away no light meat.

Various types of slicing machines have been used, but an automatic cutter of the guillotine type is favored at present. The meat is always cut across the grain. In packing 1/4-lb. cans of tuna, the slices should be approximately 7/8" wide; 1/2-lb. cans, 1" to 1-1/8"; while for 1-lb. cans, the width must be 1-9/16". Some packers cut the larger fish only for 1-lb. cans.

Grading

Three grades of tuna are packed: "fancy"; "standard"; and "flakes", or "salad". The "fancy" pack consists of large pieces of solid meat with no small fragments. In a "standard" pack, three pieces of solid meat are placed in each can, with sufficient small fragments to give the desired net weight. The common practice in packing "standard" tuna is to fill in 25 percent flakes. "Flake" tuna consists entirely of small crumbs or finely divided meat, packed into a more or less solid cylinder. Meat going into the flake pack is of the same quality as in "fancy" or "solid pack" tuna, and is by no means of inferior quality.

Filling

The container most used in tuna canning is the 1/2-lb. tuna (307 x 113) can. An average of 80 percent of the total tuna pack is canned in this container. Other containers used are the 1/4-lb. tuna (211 x 109) can, and the 1-lb. tuna (401 x 206) can. A small amount is packed in 4-lb. cans, mostly flakes for hotel and institutional trade. Most of the packers use plain cans; but since some trouble has been experienced with sulfide discoloration, a number of packers are now using cans with an inside lining of C-enamel, seafood formula.

Tuna meat is filled into the cans by hand, though some machine-filling is possible for the tuna flake pack. An inspector checks the filling to ensure proper workmanship and correct weight. A 3/8" space is left in the top of each can after the meat has been filled in; but when the oil is added and the top sealed on, the headspace will not be more than 3/16" after processing. Fill-in weights of meat depend on the moisture content of the fish and are approximately as follows: 1/4-lb. tuna can, 3 1/2 oz.; 1/2-lb., 5 1/2 to 5-3/4 oz.; 1-lb., 11 to 11 1/2 oz.; and 4-lb., 46 oz.

The filled cans pass along a conveyor to an automatic salt dispenser. The approximate amounts of salt used per can are: 1/4-lb. can, 1/14 oz.; 1/2-lb., 1/7 to 3/14 oz.; 1-lb. 9/14 oz.; and 4-lb. 6/7 oz. The oil-dispensing apparatus is located on the canning line immediately following the salting machine. Winter-pressed cottonseed oil is used, although olive oil is required in at least one specialty pack. The oil is usually added hot, at temperatures varying from 180 to 200° F. The amount of oil filled into each can is supposed to average 3/4 oz. for 1/4-lb. cans, and 1-1/2 oz. for 1/2-lb. cans.

Exhaust or vacuum and sealing

A large part of the tuna pack is still given a heat exhaust in a steam exhaust-box, though vacuum closing-machines are coming into extensive use.

The exhaust averages three minutes at 208 - 212° F. and is believed insufficient since a 10-minute heat exhaust is recommended. The vacuum obtained by the pressure heat exhaust is 2" or less. The tuna cans have a vacuum of 9", when a vacuum closing-machine is used.

Processing

The sealed cans roll down a conveyor into a washing machine, thence into wheeled retort baskets. Horizontal retorts are used in all tuna canneries, but they differ widely in size and capacity; in California, for example, all retorts must be equipped according to specifications of the State Board of Health. When the retort is loaded and steam is admitted, from seven to 10 minutes are required to bring the retort to the processing point. This is known as the comeup or log time, and is not included in the processing time.

Processing times and temperatures specified by the State Board of Health are given in the following table:

Table 2
Tuna Processes

Can, Trade Name	Can Makers Designation	Initial Temperature	Process in Minutes		
			230° F.	240° F.	250°
(degrees F.)					
1/4-lb. tuna	211 x 109	70	125	65	40
1/2 " "	307 x 113	"	140	75	55
1 " "	401 x 206	"	170	95	80
4 " "	603 x 408	"	320	230	190

Although "equivalent" processes at 230° F. are listed, no commercial pack is processed at this temperature. Most canners process at 240° F. The 250° process is used in a few canneries as an additional safety measure. The cans are water-spray cooled in the retort after processing, then held in the warehouse at least 24 hours before labeling.

Storage and labeling

In California all cans carry a code registered in the State Cannery Inspection Service and stamped into the can lids when they are sealed. This makes it possible to identify any can, determine where and when it was packed, and secure a complete history of its packing. It is claimed that tuna should be held in storage at least three months, as oil and salt will not penetrate evenly in less time; in practice, however, some canners do not hold the pack in storage any longer than is necessary to find a buyer. Details of labeling and storage do not differ from methods followed with other fishery products. A standard case of tuna is 48 1-lb. cans though it may be packed 48 1/2-lb. cans to the case; quarter cases may be packed 48, but in many instances are packed 100 to the case; while 4-lb. cans are packed 12 to the case.

Tonno

Tonno is solid tuna meat packed in olive oil with about double the quantity of salt used in the regular pack. The meat is darker and stronger, as a more pronounced flavor is demanded in this style of pack. Bluefin and skipjack are packed as tonno, with skipjack preferred. Tonno is usually packed in 1/4-lb. cans, although small amounts are canned in larger size containers, and is sold principally to the Italian-American trade.

Inspection and examination

In California the inspector assigned to each tuna cannery boards the fishing vessel when it arrives; examines the catch; and records the source of the tuna (where caught), the length of the voyage, approximate amount of different species, the condition of the fish, and whether it had been preserved by ice or mechanical refrigeration. The odor is noted, and sample fish are thoroughly examined. After this, permission is given to unload.

The inspector observes the fish through the various packing steps. In addition to inspection at time of butchering, already described, he inspects the cooked fish, discarding doubtful ones. The meat is again inspected for texture, odor, and color after it goes through the slicing machine.

The inspector notes all codes used in the daily pack, and close control is maintained over details of processing. At the end of the day, an inspector draws a representative sample of each code packed. The samples are cut by a trained examiner who makes out a cutting report for each sample. A certificate is then issued releasing the code or codes for shipment, if production records and processing temperature curves are satisfactory and no stale or off odors are noted.