# STRUVITE CONTROL IN CANNED TUNA

The purpose of our pH testing program is to eliminate struvite crystals in our canned tuna product. These crystals are actually the compound magnesium ammonium phosphate. They are formed by substances that are normally present in tuna but which only combine under certain circumstances into a crystalline formation. The occurrence of struvite in our products has, for many years, been our main cause of customer complaints as they are mistaken for chips of glass.

Through experiments carried out by our Research Department, it was determined that the occurrence of struvite crystals was closely associated with the pH or acidity of the tuna. The average pH value of raw tuna is approximately 5.7 to 5.8, with the extreme range being from 5.5 to over 6.7. Our research work showed that only fish above a pH value of 6.1 when raw were likely to form struvite crystals when canned. We also found that the only type of fish normally having these high pH values was Japanese longline-caught albacore and yellowfin. This can probably be explained by the manner in which these fish die. Longline-caught fish are free to swim about after being hooked and actually die of exhaustion in the presence of the normal oxygen supply available in the water. Purse seine-caught fish, on the other hand, normally die of suffocation as large numbers of them are quickly restricted to a limited area during the netting operation.

These two radically different types of death have a definite influence upon the final body chemistry of the fish. The longline-caught fish tend to burn up the lactic acid present in the living fish muscle and as a result the pH value is usually higher (less acid) than that found in the purse seine-caught fish. Some longline-caught albacore have been found to have pH values as high as 6.8. Purse seine-caught fish, on the other hand, seldom have pH values above the 6.10 danger point.

Basis these findings, a program for individually testing all longline-caught albacore was undertaken. This is done with specially designed pH meters and electrodes. By segregating all fish above pH 6.05 and blending them with normal pH fish into a chunk pack, the chances for struvite formation are almost eliminated. The remaining normal pH fish can then be packed as solid with very little chance of struvite crystal formation.

There are several very important precautions that must be taken in order to achieve the maximum struvite protection from our pH testing program. The effectiveness of this entire program is dependent upon each of these following steps being properly performed.

1. Prior to being tested for pH, all fish must be thawed to at least 5° C at the depth to which the electrode tip will be inserted. If this is not done, ice crystals in the flesh will cause abnormally low pH readings on the meter, and fish that appear to be of normal pH may

actually be high pH and potential struvite producers. Quite often the outer layers of the fish may be adequately thawed while the inner layers are still frozen. For this reason the electrode must not be forced deeply into the fish where the temperature is below 5° C. Accurate pH readings will be obtained as long as the electrode tip is inserted just beneath the skin. The hole that is cut for insertion of the electrode should be as shallow as possible. If, during the testing operations, individual fish are found that are not adequately thawed they should either be considered high pH or set aside until properly thawed and then tested.

2. It is also very important that the fish be positioned on the butchering table with sufficient space between them to enable the pH value of each to be accurately registered on the meter. This requires 2 to 3 seconds with the electrode inserted in the fish. If this allowance is not made, then the meter will not have adequate time to reach the final, accurate pH reading. As a result, many fish may be considered as having normal pH values when in actuality they are high pH.

   This may mean that butchering operations will have to be slowed down to some extent over what would otherwise be possible if testing was not being done. An alternative possibility is to use two pH meters simultaneously and have each person doing the testing check every other fish. The person who is doing the pH testing should also have a means for stopping the butchering table when necessary. This must be done at frequent intervals to calibrate the meter and electrode with pH 6.00 buffer solution.

3. All racks of high pH fish must be carefully marked so that they will not be accidentally mixed with normal pH fish during the remainder of the processing operation.

4. In order to eliminate the chances of struvite formation in chunk codes, it is necessary to carefully blend off the high pH loins. The maximum blending level is 40% high pH loins to 60% normal pH loins. A lower blending level should be used if practical, however, as the probability of struvite formation decreases as the blending level decreases. A recent rise in consumer complaints on import albacore chunk codes indicates that the high pH loins have not always been carefully blended.

The results of each day's pH testing are reported to Central Quality Control on the Daily pH Control Record. This form also includes information from the Packing Room regarding the chunk codes into which the high pH loins are blended. A pH distribution chart is also plotted for every 5th lot of fish tested. This information enables CQC to audit the pH programs at the various plants and detect such possible problems as improper testing techniques, faulty equipment, and improper blending. Charts showing the % high pH fish found each day at every plant are also plotted by CQC to show seasonal variations and plant to plant comparisons.

The packing rooms are currently being equipped for the addition of sodium acid pyrophosphate (SAPP) to certain import albacore solid packs. This materiel inhibits the formation of struvite crystals and is being added through special broth systems. The use of SAPP will not eliminate the need for our pH testing operations in the fish room as it is not fully effective upon extremely high pH fish. It will, however, enable the cut-off point for high pH fish to be raised from 6.05 to 6.25 providing SAPP is added to all solid packed from these fish on the following day. This means that all solid lines on which this fish is to be packed must be equipped with the special facilities for adding phosphated broth. If only normal broth were used, then a high incidence of struvite would result.

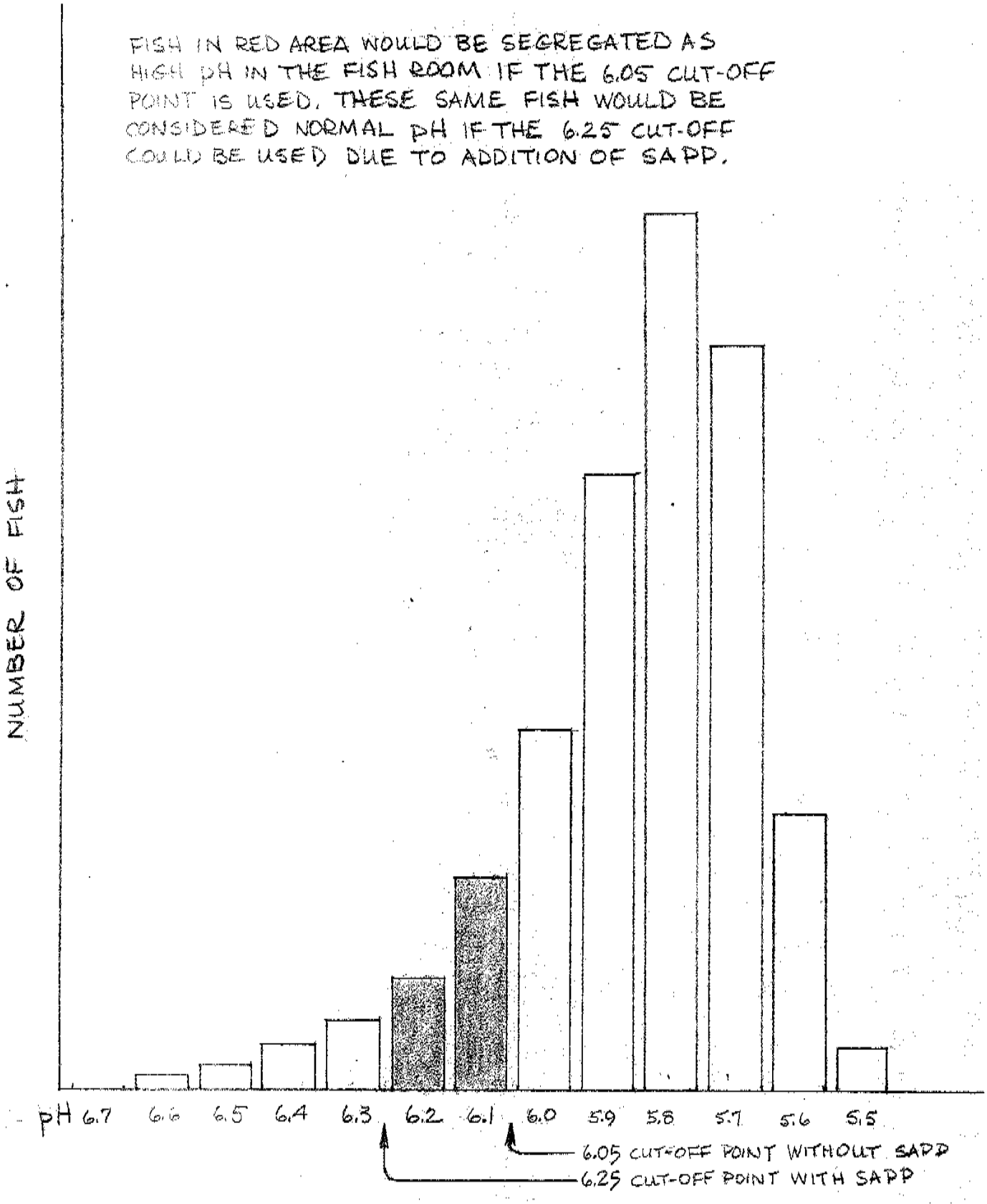
We are currently equipping plants to add SAPP only on 1/4# and 1/2# lines. It may later be approved for use in 1# cans, but it appears that it can never be used in 4# cans because the long retorting time destroys its effectiveness. For this reason plants that normally pack 4# solid will have to continue using the 6.05 cut-off point during pH testing.

The advantage of using the higher 6.25 cut-off is that it greatly reduces the number of fish segregated as high pH. The attached diagram illustrates why this is so. This permits a much higher percentage of the fish to be packed as solid.

Through the careful coordination of the pH testing and SAPP addition programs we should be able to eliminate all struvite in our canned product. This will require, of course, that every phase of the prescribed procedures be conscientiously followed. The failure to do any step carefully will greatly reduce the effectiveness of the entire program.

# TYPICAL pH DISTRIBUTION FOR LONG-LINE ALBACORE

FISH IN RED AREA WOULD BE SEGREGATED AS HIGH pH IN THE FISH ROOM IF THE 6.05 CUT-OFF POINT IS USED. THESE SAME FISH WOULD BE CONSIDERED NORMAL pH IF THE 6.25 CUT-OFF COULD BE USED DUE TO ADDITION OF SAPP.



# STRUVITE CONTROL PROGRAM - OUTLINE

A. Purpose of pH Testing:

1. What is struvite - magnesium ammonium phosphate.
2. Why are we concerned about it.
3. What is pH - acid, neutral, alkaline scale. Acid 1 ... 7 ... 14 / 6 Neutral / Alkaline
4. What effect does pH have upon struvite. 5.7 to 5.8 = Normal Tuna. 6.1 or over = Struvite.
5. Why pH only long-line caught fish.
   a. Effect of death - purse seine.
   b. Effect of death - longline caught. Burn up Lactic acid = high pH Less Acid.
6. Illustrate distribution of normal pH.
   a. Typical purse seine.
   b. Typical longline (showing higher pH fish)

B. Equipment Used to Measure pH and Procedure:

1. Beckman Model N meter, combination electrode
   a. Meter $350.00 ea. - 10 in use
   b. Electrodes $50.00 ea. - over 200 ($10,000.00)
2. Important precautions:
   a. Thaw to at least 5° C.
   b. Insert electrode to just under skin.
   c. Cut shallow hole.
   d. Set aside fish too cold to pH.
   e. Allow time for final, accurate reading.
   f. Restadardize frequently w/clean buffer.
   g. Carefully mark racks of high pH fish

3. Form used to record testing results.

   a. Plot % high pH in notebook for all plants.

4. pH charts to audit equipment, technique (every 5th lot tested).

C. Handling High pH Fish in Packing Room:

1. Proper blending into chunk required

   a. Maximum blend 40%

   b. The lower the blend the better the struvite protection.

2. Record chunk code and % blend on pH form.

D. Effect of SAPP on pH Program:

1. Purpose - inhibits struvite formation. - added in broth

2. Not fully effective on high pH fish.

3. Will enable the raising of cut off point if it can be added to all solid packs for the lot (use distribution chart to illustrate how number of high pH fish would be reduced).

4. Cannot be used in 4#.

5. Necessitates close packing room - fish room coordination.

# TYPICAL pH DISTRIBUTION FOR LONG-LINE CAUGHT ALBACORE

Fish in red area would be segregated as high pH in the fish room if the 6.05 cut-off point is used. These same fish would be considered normal pH if the 6.25 cut-off point could be used in conjunction with the SAPP addition program.