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Agenda Item 8

CX/FFP 03/9-Add.1

JOINT FAO/WHO FOOD STANDARDS PROGRAMME CODEX COMMITTEE ON FISH AND FISHERY PRODUCTS

**Twenty-sixth Session
Ålesund, Norway, 13 - 17 October 2003**

PROPOSED DRAFT STANDARD FOR QUICK FROZEN SCALLOP ADDUCTOR MUSCLE MEAT

DISCUSSION PAPER ON THE MOISTURE CONTENT AND PHOSPHATES IN SCALLOPS (Prepared by Canada, France, Japan, Thailand and the United States)

INTRODUCTION

At the 25th Session of the Codex Committee on Fish and Fishery Products (CCFFP), June 2002, the Committee addressed a number of essential elements in the Proposed Draft Standard for Quick Frozen Scallop Adductor Muscle Meat¹. The provision regarding the moisture content of scallops as well as the section on food additives were among the topics discussed.

The main concern relating to moisture content in scallop meat is “added water” and the use of polyphosphates to help retain moisture. When scallops are excessively soaked in freshwater and polyphosphates are improperly applied (i.e. abused), the retention of added moisture can lead to unfair trade practices resulting in economic fraud.

There was also disagreement among the delegations regarding the expression of moisture content. Some delegations were in favour of its direct expression while others preferred that it be expressed in relation to protein content. It was furthermore noted that the moisture content would be dependent upon on the outcome of the consideration of polyphosphates.

The Committee was of the view that consideration of provisions on additives and especially on moisture required in-depth technical background and discussion, therefore it was agreed that Canada with the cooperation of France, Japan, Thailand and the United States, should prepare a paper in this regard for consideration at the next session.

PURPOSE

The purpose of this discussion paper is to outline the key issues in connection with (1) establishing a moisture content limit, (2) food additives - polyphosphates and (3) expression of moisture content and propose some options for the consideration by the CCFFP.

DRAFTING PROCESS

The Working Group agreed to electronically exchange and share information on moisture content and phosphate in scallops as it applies to their commercial harvesting and processing practices. A questionnaire was developed and adopted by the Working Group. From this exercise, the Working Group was able to gain a better understanding of the factors that were needed to be considered in developing this paper. The questionnaire can be found in Annex I. The summary of Working Group’s responses can be found in Annex II.

¹ *Proposed Draft Standard for Scallops* (CX/FFP 02/10)

BACKGROUND

Establishing a Moisture Content Limit

In this standard, the moisture content limit is a value that best describes the natural attribute of scallops and can be practically applied as a basis for determining whether excessive moisture has been added to the product.

As described in the Proposed Draft Standard for Scallops document (CX/FFP 02/10, Appendix I)², “Shucked scallop meats of all commercially harvested species readily lose natural moisture and can also absorb water, particularly fresh water (i.e., no salt) from the environment. The adductor muscle of a scallop is made up of parallel strands of fibers that can absorb water through capillary action. Over time shucked scallop meat will lose natural and added moisture, through a process known as drip loss, until it is only a fraction of its original weight. Significant amounts of water-soluble nutrients can be lost as well. Drip loss is enhanced by freeze/thaw cycles because of damage to the muscle cell structure³.”

“Fresh sea scallops, because they must be held in ice on board the fishing vessel to avoid spoilage, have ample opportunity to absorb water before they reach shore. Ice melt occurs around the bagged scallops in the hold during the time that the boats are out, and the scallop meats absorb this water. In the warmer months, when ice-seawater slush combinations are used on deck to prevent thermal abuse of the shucked product before bagging, absorption can occur even before the scallop meats are stored in the hold.”

“A joint study by the Department of Fisheries and Oceans Canada (DFO) and the Fisheries Council of Canada (FCC)⁴ showed that water absorption increased with the number of days the scallop meats (*P. magellanicus*) were held in ice (under commercial conditions). After 10 days of storage, the moisture content of the scallop meats had increased by 2%, on average. Due to the common fiber structure of the adductor muscles, increases would also be expected to occur for all other types of scallops when exposed to moisture, especially in the form of fresh water.”

Besides commercial harvest practices, there are a number of other factors that needs to be considered in reconciling an internationally acceptable moisture content limit.

Food Additives - Polyphosphates

At the 25th Session of the CCFFP, the Committee held an extensive debate on the issue of food additives. Some delegates proposed that the use of polyphosphates be permitted if those polyphosphates were clearly declared on labels. It was pointed out that polyphosphates are safely used in their respective countries and that there are specific benefits to their use, including the prevention of moisture loss. Several other delegations pointed out that scallops are natural and high value products and that there was no need to use any additives. The Committee agreed to engage in further discussions regarding this section before making a final decision.

Expression of Moisture Content Limit

The Committee, at its 25th Session, was also introduced to two ways in which moisture content can be expressed. The moisture content can be expressed as a percentage calculated by proximate analysis (oven drying) or as a ratio of the moisture content to protein content calculated by proximate analysis (oven drying and Kjeldahl analysis). There are advantages and disadvantages to each method that need be discussed by the Committee.

² **Discussion Paper on Establishing an Acceptable Upper Limit Moisture Content for Scallops** (Prepared and submitted by the United States), 25th Session of the Codex Committee on Fish and Fishery Products, 2002.

³ **Seafood Scams and Frauds**, Ian Dore, Urner Barry Publications, published 1992. pg. 100-104.

⁴ **A Study of the Seasonal Variations of the Moisture Content of Sea Scallop Meats Harvested by Canadian Fishing Vessels in the Georges Bank Area**, DRAFT ABSTRACT, 1995, Mills, R.E. et al.

POINTS TO CONSIDER

ESTABLISHING A MOISTURE CONTENT LIMIT

1. Types of Scallops

Based on the contributions of the Working Group, it was possible to assemble information regarding a slightly broader range of species than those considered previously by the Committee. In addition to the sea scallops (*Placopecten magellanicus*), bay scallops (*Argopecten irradians*), calico scallops (*Argopecten gibbus*), other species included are: Coquille Saint Jacques - France (*Pecten maximus*), scallops - Japan (*Patinopecten essoensis*).

2. Commercial Harvest Practices

2.1 Length of voyage

Generally, there are two categories of voyages characterized by the proximity of the harvest site (fishing ground) relative to the land based processing establishment. They are: “short haul voyages” (1 - 2 days in the case of wild caught fisheries and daily as in the case of aquaculture controlled harvest (particularly Japan)) and “long haul voyages” (Typically fishing voyages last 10 days or less, although in the United States, they are 12 - 15 days).

2.2 Shucking

Shucking of live scallops on board fishing vessels generally occur on long haul voyages.

2.3 Washing

Before they are stored in refrigerated storage on board fishing vessels, shucked meats are either washed with salt water prior to being packed in clean cotton bags (Canada) or scallop meats are washed using fresh water (U.S.). In the case of live scallops, these are washed and packed in clean bags that have been soaked in sea water before being shucked (France).

2.4 Chilling and Refrigerated Storage

In all cases, after the live scallops/meats have been packed in cotton bags (approximately 30 lbs.), the products are kept chilled by the application of freshwater ice and placed in appropriate refrigerated storage.

3. Scientific Literature and Research Conducted on Moisture Content Levels in Scallop Adductor Muscle Meat (at time of harvest/off-loading)

Scientific research and studies have shown that a considerable range of moisture levels in scallop meats can be observed. Based on the information collected, the heterogeneity of scallops and its production presents a significant challenge in reconciling a single moisture content limit that can best describe the natural attribute of this product.

- 3.1 In 1992, Botta & Cahill⁵ examined the effects of species, time of season and method of determining “added water.” The scallops in the experiment were caught during April and September. Samples were taken near the end of the fishing voyage and were held alive. Live specimens were then transferred to a chilled 5°C seawater system in a research laboratory, processed immediately (shucked, vacuum packaged) and kept frozen until moisture content analysis was carried out. Based on a total of 48 samples, moisture content of sea scallops (*P. magellanicus*) at harvest (immediately after shucking) ranged from 74.63% to 80.20% - **a variance of 5.57%**. Moisture content of Icelandic scallops (*C. islandicus*) at harvest ranged between 75.28% to 81.25% - **a variance of 5.97%**. The seasonal trend for moisture content in sea scallops and Icelandic scallop meat were similar (i.e. April’s moisture content values were low relative to September). The study concluded

⁵ **Moisture Content of Scallop Meat: Effect of Species, Time of Season and Method of Determining “Added Water”**, Botta, J.R. and Cahill, F.M., as published in the Conference Proceedings from the Annual Conference Tropical and Subtropical Fisheries Technological Conference of the Americas (August 29 - September 1, 1993, Williamsburg, Virginia, U.S.A.), pg. 43 - 50.

that the “moisture content of meats from both species was vividly affected by the time of season.”

- 3.2 In the 1993-1994 joint DFO and FCC research project⁶, a study was carried out using Atlantic sea scallops (*P. magellanicus*) that were harvested under commercial conditions. It examined the effect of seasonality on the moisture content in scallops. Three harvest periods were investigated: fall (September - October), winter (December - February) and summer (July - September). Scallops storage times ranged from 0 days (control) to 10 days. The moisture content of 387 samples within the storage time period ranged from 74.19% to 80.94% - **a variance of 6.75%**, with a mean of 78.70%. A comparison of the results by season showed that scallops harvested in the winter have a higher moisture content than those in the fall season. Similarly, fall season values are higher than those in the summer season. Also, based on these findings, the cumulative percentage distribution of the % moisture content values confirmed that none of the moisture content values exceeded 81%.
- 3.3 In a study by the Virginia Institute of Marine Sciences (VIMS)⁷ published in 1996, the researchers assessed the natural and ex-vessel (before processing) moisture content of sea scallop meats (*P. magellanicus*) harvested from most of the commercially fished areas in the Atlantic Ocean over an extended period of time.
 - 3.3.1 The Proposed Draft Standard for Scallops document (CX/FFP 02/10, Appendix I)⁸ presented a description of this study as follows: “the moisture content of scallop adductor muscle meat is affected by various biological and environmental factors. Therefore, in order to get a true picture of the range of moisture levels in sea scallop meats, the researchers collected samples over a period of three years at numerous commercial fishing areas from Virginia to George’s Bank.”
 - 3.3.2 “Scallop meat samples were taken from freshly shucked scallops at the time of harvesting. At a minimum, samples were taken daily, and the frequency was increased when different locations were fished in a single day. Samples were also taken at off-loading from the boat, before processing, from bags marked with harvest location and date of bagging and storage.”
 - 3.3.3 “Moisture content of scallop meats at harvest (immediately after shucking) ranged from 73.7 to 78.9%. A total of 136 samples were analyzed. Each sample was a composite of seven scallop meats. At off-loading from the harvest vessel, the values ranged from 74.2% to 82.5%. A total of 91 composite samples were analyzed. The broader range in moisture levels at off-loading, compared to the moisture values at harvest, was attributed to the added variables that influence moisture uptake during on-board processing and storage, such as whether ice-seawater slush’s were used on deck, and the length of time the scallop meats were stored in the ice hold.”
 - 3.3.4 “The results at off-loading were statistically analyzed to determine what the upper limit for moisture content would have to be in order for all the samples collected in this study to be in compliance with a hypothetical upper limit for scallop meat moisture. The study report states that to achieve a 95% probability of compliance, the upper limit would have to be 81.6 %. For the probability of compliance to be greater than 95%, the upper limit for moisture content would have to be 82.0%.”

⁶ ***A Study of the Seasonal Variations of the Moisture Content of Sea Scallop Meats Harvested by Canadian Fishing Vessels in the Georges Bank Area***, DRAFT ABSTRACT, 1995, Mills, R.E. et al.

⁷ ***Natural and Ex-Vessel Moisture Content of Sea Scallops (*Placopecten magellanicus*)***, DuPaul, W.D. et al., Virginia Marine Resource Report # 96-5, November 1996.

⁸ ***Discussion Paper on Establishing an Acceptable Upper Limit Moisture Content for Scallops*** (Prepared and submitted by the United States), 25th Session of the Codex Committee on Fish and Fishery Products, 2002.

- 3.4 During 1989 to 2002, the Abashiri Fisheries Experimental Station, one of the municipal research stations in Hokkaido, Japan, tested the scallop adductor muscle (*P. essoensis*) moisture content after harvesting. Japan indicated that their harvesting practices do not have an adverse effect on the moisture content of their products. Based on raw data provided from scallop sampled at the Monbetsu Area, the moisture content of all the samples after harvesting ranged from 73.7% - 80.6% - **a variance of 6.9%**, with a mean of 76.8%.
- 3.5 A study conducted by the North Carolina State University Seafood Laboratory in 1993 assessed the moisture levels in bay scallops (*A. irradians*), calico scallops (*A. gibbus*), and sea scallops (*P. magellanicus*)⁹.
- 3.5.1 The Proposed Draft Standard for Scallops document (CX/FFP 02/10, Appendix I)¹⁰ recalled that “the study included a random survey of scallop meat moisture levels after shucking, after processing, and in retail establishments. Live bay scallops (shellstock) were obtained from North Carolina dealers and processors. Live calico scallops (shellstock) were obtained from shipments coming from the west coast of Florida. Commercially shucked and processed bay and calico scallop meats were obtained from North Carolina processors. Samples of bay, calico and sea scallops were also purchased at retail markets across North Carolina.”
- 3.5.2 “Live bay and calico scallops were shucked at the North Carolina State University Seafood Laboratory and the moisture levels determined. The moisture levels in the bay scallop meats after shucking ranged from 77.5-82.5 %; for calico scallops the moisture levels ranged from 76.1- 79.2%. The moisture levels in the commercially processed bay scallop meats ranged from 81.8-84.3%; for commercially processed calico scallops, the moisture levels ranged from 77.7- 81.2%. For samples obtained at retail, the mean moisture contents were as follows: bay scallop meats - 82.6%; calico scallop meats - 78.6%; sea scallop meats - 86.3%.
- 3.5.3 “This study is significant because it provides data on moisture levels in bay and calico scallops, as well as sea scallops. Interpretation of the data is difficult, however, because this was not a controlled study. It is not known how the commercially processed scallop meats and the scallop meats obtained at retail were handled or processed.”

Based on the information presented, it can be shown that moisture content level in scallop meat varies greatly depending on the species, seasonality, harvest practices (length of voyage) and geographical location (i.e. effect on water chemistry).

FOOD ADDITIVES - POLYPHOSPHATES

4. Polyphosphates

The use of phosphates in scallops is prohibited in some countries. Authorities are concerned that the organoleptic changes to seafood, such as a soapy taste and glassy appearance, that are associated with the excessive application of polyphosphates, could render the product undesirable to consumers¹¹. More importantly however, there is a significant potential misuse of polyphosphates to improve the characteristics of poor quality products and/or to increase the water content of scallops. The excess water increases both the size and weight of scallops. Generally, consumers cannot distinguish between untreated scallops and those that have been soaked and/or processed with polyphosphates. As a result, consumers purchasing excessively soaked scallops are paying for added water.

⁹ **Moisture Content of North Carolina Bay, Calico, and Sea Scallop Meats at Harvest, Processing and Retail**, Green, D.P. et al., 1993, Department of Food Science, North Carolina State University.

¹⁰ **Discussion Paper on Establishing an Acceptable Upper Limit Moisture Content for Scallops** (Prepared and submitted by the United States), 25th Session of the Codex Committee on Fish and Fishery Products, 2002.

¹¹ **Functionality of Polyphosphates**, Regenstein, J., et. al, as published in the Conference Proceedings from the Annual Conference Tropical and Subtropical Fisheries Technological Conference of the Americas (August 29 - September 1, 1993, Williamsburg, Virginia, U.S.A.), pg. 21 - 42.

Phosphates are allowed for use in scallops in some countries. In the United States, the phosphate compounds used are “Generally Recognized as Safe” (GRAS) with no limitations for use when used within good manufacturing practices (GMP). In Japan, sodium pyrophosphate is allowed for use in scallops. In the European Community, Directive 98/72/EC allows the use of polyphosphate (E452) with a limit of 5 g/kg in mollusc.

Phosphates are generally applied by dipping, spraying or tumbling in phosphate solution¹¹.

Legitimate functional goals of using polyphosphates in seafood are: retention of natural moisture (i.e. to prevent drip loss) and flavour, inhibiting fluid losses of fresh shipments during transport and prior to sale, emulsification, inhibiting oxidation flavours and lipids by chelation of heavy metals and cryoprotection, thereby extending shelf life¹². To consistently achieve these beneficial functional goals, the processor should systematically control the application process. This will help ensure that polyphosphates are properly used. However, if inadequately controlled, undesirable organoleptic defects could result. Unfortunately, a standard polyphosphate treatment in seafood that can be used as a basis for developing such controls is lacking and scientific studies in this area are sparse. Standards are difficult to develop since many factors influence polyphosphate uptake in the muscle. These factors include thickness of muscle, muscle type, polyphosphate type used, concentration of polyphosphate solution, contact time, post-mortem age, and etc⁵.

- 4.1 In 1993, a collaborative study was published by the Virginia Institute of Marine Sciences (VIMS), the University of Florida and Virginia Polytechnic Institute and State University explored the effects of sodium tripolyphosphate (STP) treatment on moisture content as well as other sea scallops (*P. magellanicus*) attributes. The research examined: (1) the effect of certain processing practices on the retention and addition of moisture in scallops; (2) the effect of these processing practices on nutritional composition; and (3) the effect of these processing practices on consumer preference¹³.
- 4.2 The Proposed Draft Standard for Scallops document (CX/FFP 02/10, Appendix I)¹⁴ presented a description of this study as follows: “In order to obtain as uniform a sample as possible, the scallops used for the study were harvested from the same geographic area (off Cape Cod), within as short a time as possible. The scallops were harvested midway through the fishing trip so that the shucked meats would be in the ice-hold for about seven days (the mid-point of a typical commercial run for U.S. scallop boats, according to the report). Scallops of uniform size were chosen, and were all treated in the same manner from shucking to off-loading from the harvest vessel.”
- 4.3 “Moisture and protein contents were determined at harvest and again at off-loading from the boat. At harvest, moisture levels ranged from 76.7-77.4% with a mean of 77.1%. Protein levels ranged from 17.9-18.8% with a mean of 18.6%. At off-loading, moisture levels ranged from 77.9-79.6% with a mean of 78.6%. Protein levels ranged from 16.4-17.1% with a mean of 16.7%.”
- 4.4 “Onshore, the scallops were divided into six subsamples. The six subsamples were subjected to four different processing methods, with one method further subdivided into three different soaking times, as follows:
 1. “**FW Wash:**” washed for twenty minutes with fresh water;
 2. “**STP Processed:**” soaked in a 2.5% STP and 1.0% sodium chloride aqueous (i.e., water) solution, for five hours, thirteen hours, and twenty-four hours, respectively;
 3. “**STP Wash:**” washed for twenty minutes in a 4.0% STP and 1.0% sodium chloride aqueous solution;

¹² ***Polyphosphates: Rationale for Use and Functionality in Seafood and Seafood Products***, Lampila, L., as published in the Conference Proceedings from the Annual Conference Tropical and Subtropical Fisheries Technological Conference of the Americas (August 29 - September 1, 1993, Williamsburg, Virginia, U.S.A.), pg. 13 - 20.

¹³ ***An Evaluation of Processed Atlantic Sea Scallops (*Placopecten magellanicus*)***, DuPaul, W.D. et al., Virginia Marine Resource Report #93-1, March 1993.

¹⁴ ***Discussion Paper on Establishing an Acceptable Upper Limit Moisture Content for Scallops*** (Prepared and submitted by the United States), 25th Session of the Codex Committee on Fish and Fishery Products, 2002.

4. “**STP Dip:**” washed for twenty minutes with fresh water and then dipped for one minute in a 10.0% STP and 1.0% sodium chloride aqueous solution.”
- 4.5 “After being treated according to one of the four methods described above, the moisture content of each scallop sample was again determined. The results for the moisture contents of scallop meats before and after processing are summarized in Table 1 below:

Table 1: MEAN MOISTURE CONTENTS OF SCALLOP MEAT BEFORE AND AFTER PROCESSING

	Mean Moisture Contents (%)
At Harvest	77.1
At Off-loading	78.6
"STP Processed"	
5 hours	81.6
13 hours	82.4
24 hours	83.9
"FW Wash"	82.5
"STP Wash"	79.7
"STP Dip"	81.3

- 4.6 “In their report, the researchers explained their results on moisture absorption in scallop meats as follows. For the three "STP Processed" samples, moisture absorption was a function of soaking time, i.e., the amount of moisture absorbed increased as the soaking time went from 5 hours up to 24 hours.”
- 4.7 “The results for the "FW Wash" versus the "STP Wash" samples led the authors to conclude that given the same contact time (which, for each of the two "Wash" processes, was 20 minutes), scallop meats will absorb more moisture if they are washed with fresh water than if they are washed with a 4% aqueous STP solution.”
- 4.8 “The fact that more moisture was absorbed by the "FW Wash" sample than the "STP Dip" sample, even though the "STP Dip" treatment included a 20 minute fresh water wash prior to dipping, was attributed to water migration out of the washed scallop into the dip solution. All of these conclusions are consistent with the physics of solutions containing dissolved solids¹⁵.”
- 4.9 “The effect of processing on drip loss from scallop meats during iced storage was also evaluated. Scallop meats processed using each of the four methods described above were packed in plastic containers and stored in ice for a total of 15 days. On days 4, 6, 8, 11 and 15, the containers were opened and the amount of drip loss was determined.”
- 4.10 “Drip loss generally increased as a function of storage time for all of the processed scallops. The "FW Wash" scallops showed significantly greater drip loss than any of the STP

¹⁵ *Cell Physiology*, Giese, A.C., Third Edition, 1968.

processed scallops. By day 15, these scallops had lost a total of 4.5% of their initial weight through drip loss.”

- 4.11 “Of the three methods of processing using STP, the "STP Dip" method resulted in the lowest amount of drip loss during iced storage. Essentially no loss occurred until day 11, and after 15 days the amount of drip loss was less than 1% of the initial weight of the scallops. The "STP Wash" method resulted in the highest amount of drip loss during iced storage of the three STP processing methods evaluated. By day 15, these scallops had lost nearly 3% of their initial weight.”
- 4.12 “The study also addressed moisture loss of scallops due to cooking and to freezing/thawing. Results of these experiments are summarized in Table 2 below:

Table 2: MEAN MOISTURE LOSS FROM SCALLOP MEATS AFTER COOKING AND AFTER FREEZING/THAWING

	* Mean Cooked Weight Loss (%)	Mean Freeze/Thaw Weight Loss (%)
Untreated	16.7	
"STP Processed"		
5 Hours	14.1	7.5
13 Hours	14.6	6.7
24 Hours	15.1	5.9
"FW Wash"	19.0	15.0
"STP Wash"	13.1	3.4
"STP Dip"	12.4	0.9

*All scallop samples were broiled to an internal temperature of 70° C.

- 4.13 “Both untreated scallops and scallops treated according to the four processing methods described above were broiled to an internal temperature of 70°C and the percent weight loss determined. The “FW Wash” scallops lost the most weight during cooking (mean weight loss of 19.0%). The untreated scallops had a mean weight loss of 16.7%. All of the scallops treated with STP (“STP Processed,” “STP Wash,” and “STP Dip”) showed a lower percent weight loss during cooking than either the untreated scallops or the “FW Wash” scallops. The researchers attributed this result to the enhanced moisture binding capabilities of the scallop meat protein that results from STP treatment. The “STP Dip” scallops had the lowest mean weight loss (12.4%).”
- 4.14 “Similar results were obtained when processed scallops were frozen and then thawed. “FW Wash” scallops showed an average weight loss during freezing/thawing of 15.03 %. “STP

Wash” scallops averaged only 3.45% loss, and the “STP Dip” scallop meats showed a minimal average weight loss of less than 1%.”

- 4.15 “As expected, percent nutrient levels in scallop meats were found to be principally a function of moisture content. As scallop meats absorbed water during onboard storage or during processing, nutrient levels were reduced on a per weight basis. Also, drip loss resulted in loss of water-soluble nutrients (e.g. riboflavin, niacin and vitamin B₁₂), as did cooking. Treating scallop meats with STP reduced moisture loss and loss of water soluble nutrients. Of the processing methods evaluated in this study, the “STP Dip” was the most effective in retaining water-soluble nutrients.”
- 4.16 “Consumer evaluations of cooked scallops were also conducted as part of this study. Consumer panels were asked to rate various attributes (texture, moistness, aroma, flavor etc.) of scallops which had been processed by “FW Wash,” “STP Wash,” STP Dip” and “STP Processed.” Untreated scallops were not included in the evaluations. Overall, more consumers preferred the scallops that had been treated with STP over the “FW Wash” scallops in the various tests. However, the differences in ratings for the “FW Wash” versus the STP treated scallops, while generally statistically significant, were not large.”

Based on this study, a standard treatment may be possible if not at least a process to develop a standard may be possible. While this is only one study, more research on this model or other similar models is needed. Furthermore, polyphosphate treatment standard and polyphosphate application guidance could be incorporated in a GMP to help facilitate compliance to international or regulatory standards.

EXPRESSION OF MOISTURE CONTENT LIMIT

The moisture content could be expressed as a percentage calculated by proximate analysis (oven drying) or as a ratio of the moisture content to protein content calculated by proximate analysis (oven drying and Kjeldahl analysis).

For moisture content determination, the calculation involves:

$$\text{Moisture Content (\%)} = \frac{(\text{Sample weight} - \text{Sample weight after drying})}{\text{Sample weight}} \times 100$$

For Moisture/Protein (M/P) ratio determination, the calculation involves both the moisture content (above) and crude protein. The calculation for crude protein is based on total nitrogen (%) in a sample using Kjeldahl analysis (AOAC 928.08). The equation involves:

$$\text{Protein (\%)} = \frac{\% \text{ Nitrogen in Sample} \times \text{Nitrogen factor}}{\text{factor}}$$

A nitrogen factor value of 6.25 is typically used in the determination of crude protein in foods. For scallops, a specific nitrogen factor will need to be developed. The Kjeldahl analysis assumes that all proteins have nitrogen content of 16% by weight whereas the actual range is 13 -19%. It is also assumed that other forms of nitrogen could also be interpreted as protein (nitrates, nitrites, urea, nucleic acids, etc.). Given that the natural variability of the moisture content in scallops (species, seasonality, location of catch, etc), has an effect on protein content, the development of a scallop nitrogen factor would need to consider these and other factors. Work on developing a specific nitrogen factor and validation of this work can take considerable time, labour and expense.

According to France, a limit concerning the addition of water to scallop muscle meat is necessary; however, it opposes the proposal for using a limit of 80% moisture content limit. They noted that the amount of water that could be added to scallop adductor muscle, either by ice storage or soaking, depends on natural moisture content and method of determining added water. When scallops are treated by soaking in water, nitrogen content decreases as the water content increases¹⁶. Consequently, France proposed to use a M/P ratio of <5, which has been claimed to be more likely to detect the presence of excess water added by process rather than by natural causes.

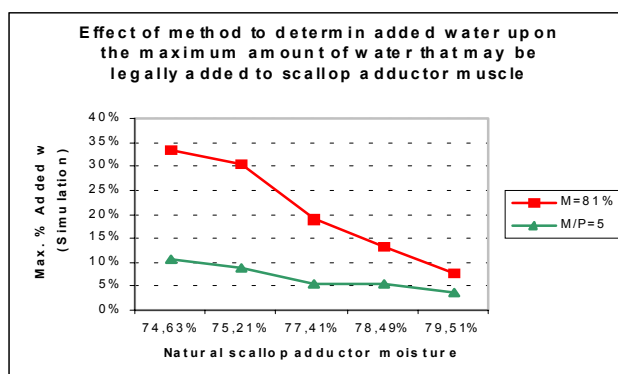
¹⁶ *Dielectric studies of added water in poultry meat and scallops*. Kent, M., & Anderson, D. (1996). Journal of Food Engineering, 28, 239-259.

Furthermore, simulation of added water that can be added to scallop, upon limit Moisture Content < 81% and limit M/P < 5, on different scallop muscles shows important characteristics. First, M/P ratio appears to be much more likely to detect added water in scallops that naturally contained lower moisture content. Secondly, it appears to be more tolerant with natural moisture variations¹⁷.

Scallop Muscle			
Composition			
P %	M %	Other %	M/P
17,02%	74,63%	8,35%	4,38
16,81%	75,21%	7,98%	4,47
16,57%	77,41%	6,02%	4,67
16,75%	78,49%	4,76%	4,69
16,65%	79,51%	3,84%	4,78
P(g)	M (g)	Other (g)	
17,02 g	74,63 g	8,35 g	
16,81 g	75,21 g	7,98 g	
16,57 g	77,41 g	6,02 g	
16,75 g	78,49 g	4,76 g	
16,65 g	79,51 g	3,84 g	

Added water simulation			
Target value M/P= 5			
P %	M %	Other %	M/P
15,41%	77,03%	7,56%	5,00
15,44%	77,22%	7,33%	5,00
15,72%	78,58%	5,71%	5,00
15,91%	79,56%	4,52%	5,00
16,05%	80,25%	3,70%	5,00
P(g)	M (g)	Other (g)	Added water
17,02 g	85,10 g	8,35 g	10%
16,81 g	84,05 g	7,98 g	9%
16,57 g	82,85 g	6,02 g	5%
16,75 g	83,75 g	4,76 g	5%
16,65 g	83,25 g	3,84 g	4%

Added water simulation			
Target value M = 81%			
P %	M %	Other %	M/P
12,75%	81,00%	6,25%	6,35
12,88%	81,00%	6,12%	6,29
13,94%	81,00%	5,06%	5,81
14,80%	81,00%	4,20%	5,47
15,44%	81,00%	3,56%	5,25
P(g)	M (g)	Other (g)	Added water
17,02 g	108,16 g	8,35 g	34%
16,81 g	105,68 g	7,98 g	30%
16,57 g	96,30 g	6,02 g	19%
16,75 g	91,70 g	4,76 g	13%
16,65 g	87,35 g	3,84 g	8%



In discussing the expression of moisture content, the cost associated with conducting the analysis for regulatory purposes should also be carefully considered. For the expression of moisture content as a percentage, the method of analysis is a relatively simple that require little training. The capital and operational costs are low. In comparison, for the expression of moisture content as a ratio, expenses associated with training and lab equipment and chemical (acids, etc.) will result in increased costs. Additionally, analysts' and lab time will be increased.

CONCLUSIONS

FOR THE PROPOSED DRAFT STANDARD:

A. In establishing **a moisture content limit**, the Committee should consider the following options:

Option # 1:

- Retain the moisture content limit of 81.0% for "untreated scallop meat"*.

* Processing practices (i.e. application of food additives) should not be included in the development of this moisture content limit.

NOTE: The Moisture/Protein ratio value might replace the percentage value, pending the outcome of discussions by the Committee on the expression of moisture.

- A new statement can be added as follows: "A moisture content limit of 82% could be applied for scallop meat where unavoidable water gain occurs during harvesting and processing in accordance with GMPs"

¹⁷ **Moisture Content of Scallop Meat: Effect of Species, Time of Season and Method of Determining "Added Water"**, Botta, J.R. and Cahill, F.M., as published in the Conference Proceedings from the Annual Conference Tropical and Subtropical Fisheries Technological Conference of the Americas (August 29 - September 1, 1993, Williamsburg, Virginia, U.S.A.), pg. 43 - 50.

- Based on the information presented, the heterogeneity of scallops and its production presents a significant challenge in establishing a moisture content limit. Recognizing that there may not be a harmonized acceptable moisture content limit that can be practically applied as a basis for determining whether excessive moisture has been added to the product, a new statement can be added as follows: **“Where countries wish to establish their own limit, the following criteria should be considered in developing a moisture content limit:**
 - species
 - harvest practice
 - seasonality
 - geographical location”

For illustrative purposes, the proposed wording for Section 3.3.2 would be as follows:

A lot of scallop meat shall not have a moisture content greater than 81.0%* or a moisture/protein ratio equal to 5* or higher, and recognize that harvest practice can result in unavoidable water gain (*NOTE: the expression of moisture is pending Committee discussion*).

*** Processing practices (i.e. application of food additives) should not be included in the development of this moisture content limit.**

A moisture content limit of 82% or a moisture/protein ratio equal to "to be elaborated" could be applied for scallop meat where unavoidable water gain occurs during harvesting and processing in accordance with GMPs.

Where countries wish to establish their own limit, the following criteria should be considered in developing a moisture content limit:

- species
- harvest practice
- seasonality
- geographical location

[If the moisture content has been exceeded, the label must indicate that water was added or a statement to this effect].

Option # 2:

It may not be possible to establish one acceptable upper moisture limit for scallop meat therefore Codex may be in a better position to provide guidance to countries on establishing their own moisture content limit. The moisture content limit should be based on criteria presented in this paper. In this case, the following criteria should be considered by countries in developing a moisture content limit:

- species
- harvest practice
- seasonality
- geographical location

The Committee may also wish to consider other criteria that could be added to those already that relate to the amount of water uptake that inevitably will occur during processing in accordance with GMPs.

Option # 3:

Retain the current moisture content in square brackets for further discussion. The Committee should study this issue by gathering additional and relevant information from interested countries that had carried out studies in this area.

- B. In assessing the **expression of moisture content**, the Committee should consider the advantages and disadvantages of both approaches. It was suggested that both methods of expression could be

included in the standard provided that they produce identical results. To validate this proposal, a controlled comparison study would need to be carried out.

In considering the M/P ratio, the Committee should note that a specific nitrogen factor for scallops might need to be developed. This work would require collaboration with interested countries.

C. In regards to polyphosphates, the Committee should discuss whether polyphosphates should be permitted in scallop meat as this is a natural and high value product. If polyphosphates are allowed, the Committee will also need to consider an acceptable limit that this additive could be applied. It should be noted that the Codex Committee on Food Additives and Contaminants (CCFAC) is in the process of a review of food additives that includes phosphates. Therefore, it may be premature to either include or exclude this additive in the Scallop standard. One option might be to defer for the time being to the CCFAC.

Another option could be the following:

"The use of phosphates should be governed by national legislation. If phosphates are allowed, their use should be in accordance with GMPs and should not result in the uptake of excessive water so that the treated scallop meat contains more moisture than is natural for the scallop plus any additional, unavoidable water gain that occurs during harvesting and processing."

PROPOSED NEW WORK:

C. The following new work is proposed, especially if the Scallop standard allows for the use of polyphosphates:

A Code of Practice for the Processing of Scallops

It is emphasized again that freshwater in contact with scallop adductor muscle meat will increase its moisture content over time. The use of polyphosphates in scallops will bind added water and if used improperly, can potentially lead to consumer fraud and unfair trade practices. Product labelling can help minimize economic fraud by providing information to consumers so that informed purchasing choices can be made. However, proper processing controls should also be in place by the processor to ensure that polyphosphate use meets international and regulatory standards. (i.e. GMP's must be properly applied and adhered to by the processor.) The Committee should consider developing a code of practice for the processing of scallops and include it as a new section in the Codex Code of Practice for Fish and Fishery Products. Elaborating on a code of practice would:

- Clearly emphasize the principle of preventing consumer fraud and to ensure fair trade practices (fresh and frozen products);
- Foster the principle that scallops are natural and high value products and that soaking scallop adductor muscle meat in freshwater is not an acceptable practice;
- Be able to codify the discussions by the Committee on the issues regarding GMP's and address controls/standards for polyphosphate treatment and use of water during processing; and
- Help ensure compliance with the standard.

Proposed Draft Standard on Quick Frozen Scallop Adductor Muscle Meat
Questionnaire on Moisture Content and Phosphates

Objectives:

- 1) To compile information on the different types of scallops commercially produced in your country;
- 2) To gather information regarding moisture content (% moisture), added water and use of sodium tripolyphosphate for the species of scallops in your country;
- 3) To assemble scientific data regarding the highest reasonable level of moisture content in untreated scallops under commercial practices.

Questions:

- A. **List types of scallops produced** (common name and scientific name) **and their annual production** (volume (in tonnes) and value (in U.S. dollars))
- B. **Describe typical commercial harvest practice(s) which might affect moisture content in the product**
- C. **Provide moisture content and phosphate limits enforced** (including units of measure expressed)
- D. **Describe or reference method of analysis for the determination of moisture content and phosphate**
- E. **Where phosphates are allowed and used in processing, list the types of phosphates and describe the method(s) of application**
- F. **Provide/cite relevant scientific papers and/or research data available in your country on background levels of moisture content in scallop adductor muscle meat at time of harvest and at time of off loading, if applicable.**

SUMMARY OF DRAFTING COUNTRY REPLIES TO THE QUESTIONNAIRE ON MOISTURE CONTENT AND PHOSPHATES IN SCALLOPS

QUESTION	CANADA	FRANCE	JAPAN	UNITED STATES
<p>MAJOR COMMERCIAL SCALLOP SPECIES</p>	<p>Sea Scallop (<i>Placopecten magellanicus</i>) ICELANDIC SCALLOP (<i>Chlamys islandicus</i>)</p>	<p>COQUILLE SAINT-JACQUES (<i>Pecten maximus</i> L.) PÉTONCLE VANNEAUX (<i>Aequipecten opercularis</i> L.) PÉTONCLE NOIR (<i>Chlamys varia</i> L.)</p>	<p>Scallop (<i>Patinopecten essoensis</i>)</p>	<p>Sea scallops (<i>Placopecten magellanicus</i>) Bay scallops (<i>Argopecten irradians</i>) Calico scallops (<i>Argopecten gibbus</i>)</p>
<p>Commercial harvest practices & moisture content</p>	<p>The harvest of scallops occurs year round. A typical inshore harvesting voyage range from 1 to 1 ½ days which is short compared to offshore voyages which are usually 10 days or less.</p> <p>Live scallops are harvested by using a “drag.” The scallops are hand shucked on board and the adductor muscle meat is washed using sea water. The meats are packed in cotton bags which hold approximately 40 pounds. The bags are then labelled to ensure the catch date is declared and the product is kept chilled with the application of fresh water ice. To reduce temperature rises during transportation, insulated totes (boxes) or refrigerated storage systems are used as appropriate.</p> <p>For the Canadian Icelandic scallop fishery, the harvested</p>	<p><i>Pecten maximus</i> is common on French coast and is found from Pas de Calais to Arcachon. Scallops are usually caught by a dredge. As soon as the catch comes aboard, scallops are sorted from stones and other unwanted materials. After sorting, the catch is thoroughly washed and packed in sacks that have been soaked in sea water. When stowed at chill temperatures, scallop can survive out of water for several hours. If scallop is alive, those practices do not affect significantly moisture content in the product. However, composition of scallop could change according to species, season or water salinity.</p>	<p>There is no such a handling practice that affects the adverse effect to the moisture content of the products at the time of harvesting.</p>	<p>Fresh sea scallops are shucked by hand onboard the harvest vessels as soon as possible after they have been taken from the water. The meats are continuously exposed to water starting from the time they are first shucked, throughout storage, until they are off-loaded from the vessels. The scallop meats are washed with fresh water to remove dirt and grit immediately after shucking. They are then placed in linen bags and held in ice storage for the duration of the trip. The scallops will absorb some moisture during the initial washing and will continue to absorb water during storage because of the porous nature of the linen bags and the fact that the bags are completely surrounded by ice exposing all surfaces to water resulting from ice melt. Moreover, the harvest vessels are typically out for 12 to 15 days, exposing some meats to ice melt for as long as the full 15 days of storage. Ice melt will occur more rapidly during the warmer months and to exacerbate the situation, the scallop meats chilled on the boat decks before bagging in ice/water slurries during the summer.</p>

	scallops may also be hand shucked, salt water washed and packaged fresh (as described above) in a land based processing facility.			
Moisture content and phosphate levels enforced	<p>A lot will be rejected when the scallop meats have a moisture content of 81.0% or higher.</p> <p>The Canadian regulations do not allow the use of phosphates in scallops. A lot will be rejected when the total phosphorus in raw scallops exceed 1.47% (calculated as sodium phosphate, dibasic).</p>	<p>Are considered illicit, in accordance with article 3 of the law of August 1, 1905 and memorandum of the 08/23/88, packs of scallop with a Moisture/Protein ratio less than or equal to 5.</p> <p>Directive 95/2/EC allows use of polyphosphate (E452) with a limit of 5g/kg in fish filet and frozen crustacean. Extend of those provisions to mollusc has been published in the Directive 98/72/EC.</p>	<p>No specific limit for moisture content in scallop meat is identified by the regulation.</p> <p>For sodium pyrophosphate, the residue limit is not specified, though it is allowed to use.</p>	<p>The U.S. has data that suggest that a possible upper moisture limit of 82% would be a reasonable number, regardless of whether STP is used or not. However, the U.S. Food and Drug Administration has not established a strict legal limit in the United States for moisture content.</p> <p>The phosphate compounds used are “Generally Recognized as Safe” (GRAS) with no limitations for use when used within good manufacturing practices (GMP).</p>
Moisture content & phosphate methods of analysis	As provided individually by Working Group countries			
Phosphates, types & application method	<p>Canadian regulations do not allow the use of phosphates in scallops. For export to countries which allow the use of phosphates, registered establishments operating under the Canadian Quality Management Program, may be permitted to apply phosphates (typically sodium tripolyphosphate) provided effective controls are in place to ensure phosphate/water added scallop products are properly produced (by soaking), labelled and distributed</p>	<p>Soaking scallop in water for 30 minutes increases the weight of muscle by about 3 per cent. When polyphosphates are added to the soaking bath, the uptake of water by the meat can reach 30 per cent of the weight after a 24 hours soaking.</p>	<p>Polyphosphate is used only for a limited type of products.</p> <p>Scallop meat may be soaked in sodium polyphosphate and sodium pyrophosphate solution after shucking and washing, followed by freezing.</p> <p>Concentration of the solution is, for example, three percent. Water content of adductor muscle meat after the treatment will usually not exceed 85%.</p>	<p>Following off-loading, some common industry practices occurring at the processing facilities will lead to additional water absorption. The fresh meats are again washed and may be stored in ice/water slurries before packaging. Often the meats are treated with sodium tripolyphosphate (STP) solutions to extend shelf life and prevent or reduce excessive drip loss. The only method of application that we are aware of involves a dip or soak in an STP solution (with and without the addition of ice).</p>