Salting Fish

Salt can be an important method of preserving smoked fish and controlling bacteria that are capable of causing food borne illness. However, the use of salt in fish to impart desirable flavours often varies according to taste preferences and generally over the years has changed to a lighter salting. The use of heat or smoke during processing, and subsequent storage at refrigerated temperatures are not always effective by themselves in the control of micro-organisms.

Why is Salt Content Important?

The combination of refrigeration temperatures and prescribed salt levels offer a high degree of assurance that bacterial growth will be retarded. High salt concentrations result in the osmotic transfer of water out of, and salt transfer into, the fish. The removal of water appears to limit bacterial growth and enzyme activity.

Due to the concern for botulism, smoked fish that is cryovacked or wrapped to exclude air must be frozen unless certain conditions are met. For room temperature storage, the product should be sterilized (canned or retorted) and be processed after sealing for a temperature and time to destroy all spores of *Clostridium botulinum*. For refrigerated storage, the product should be held in modified atmosphere packaging (this will reduce the risk of spoilage organisms, but because of the reduced oxygen actually enhances the risk for botulism). For this reason, the combination of salt, refrigeration and packaging is important to control the pathogen risks of *C. botulinum* and *Staphylococcus aureus.*

Water Phase Salt (WPS)

Water phase salt (WPS) is a term which means the amount of salt compared to the amount of moisture (water) in the flesh [1]. For example, fish with 3% salt and 60% moisture would have 4.8% WPS; i.e.:

$$WPS = \frac{\%SaltX100}{\%Moisture + \%Salt} = \frac{3X100}{63} = 4.8\%$$

As indicated WPS is a function of both the level of added salt and the final moisture content. The fish in the above example, if dried to 50% moisture, would have about 6% WPS (3/53 X 100 = 5.7%). Moist fish products require more salt than dryer fish products and will, therefore, taste saltier even if the WPS is the same.

Note: *The following formula can be used to compute percent moisture:*

$$\%Moisture = \frac{WeightLoss}{WeightofFishAfterDrying} X100$$

Water phase salt (WPS) can be monitored on-site with inexpensive laboratory equipment while water activity (A_w) measurements require sophisticated laboratory procedures. In addition to being less expensive, WPS is a good indicator of preservation and food safety.

According to the hazard guidance of the FDA[2] (i.e. to control for *C. botulinum* and *S. aureus* toxin formation) the following WPS values should be used for reduced oxygen (i.e. vacuum modified atmosphere packaged) fish products:

Fish product	WPS	Storage temp/Packaging
Surimi	2.5%	refrigerated/reduced oxygen
Smoked Fish	3.5%	refrigerated/reduced oxygen
Pickled Fish	5.0%	refrigerated/reduced oxygen
Salted Fish	20.0%	room temp/reduced oxygen

*(**Note:** for further details on pH and A_w recommendations for these products consult the FDA web-site[2]).*

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Furthermore, according to the *Food and Drugs Act* Regulation B.21.025, no person should sell fish products, that are packed in a container that has been sealed to exclude air and that are smoked or to which liquid smoke flavour or liquid smoke flavour concentrate has been added, unless the contents of the container contain not less than nine percent salt, as determined by official method FO-38, Determination of Salt in Smoked Fish, dated March 15, 1985 [3].

Even if fish products are salted so that they have a final water phase salt level of 9% or greater, it is essential to keep the product refrigerated.

Salt levels should be capable of reducing water activity (A_w) of the flesh to about 0.97 or less (the A_w of pure water is 1.0). Fish with a salt content greater than 3.5% **in the water phase** (WPS) will usually have an A_w of 0.97 or lower (the recommended value for refrigerated smoked fish products). In order for a product to be considered **stable** or safe to store at room temperature, a water activity of less than 0.85 is necessary, and this is achievable with 20% WPS.

Salting Methods

The most commonly used methods of salting fish are liquid brining and dry salting. In each case, the amount and rate of salt absorption are affected by a variety of factors.

Efforts to standardize these factors by strict adherence to processing procedures are critical when striving to produce a product with a known and consistent WPS level.

Brine injection systems are sometimes used to reduce the salt content uncertainty, but must be used with caution due to the increased risk of introducing contamination to the flesh.

Variables

Fish absorbs salt faster from higher salt brine concentrations. Strong brines with short brining periods, however, may not allow for an even distribution of salt.

Thicker pieces of fish also make it difficult to obtain a proportionate salt distribution. For instance, when the flesh thickness doubles, the time required to achieve an even distribution of salt may require a brining period that is three times longer. Loading arrangements should also be considered to have the proper salt exposure.

Even though fish will absorb salt faster as the brining temperature increases, it is best to standardize brining at a cool temperature 1 to 2°C (34 to 35°F). Besides discouraging bacterial growth, this will help achieve consistent and predictable results.

Tough or firm-textured fish and fish with a high fat content will absorb salt slower than soft-textured fish or low fat fish. Fish containing more fat, however, need less salt to obtain the desired WPS content. It is also notable that previously frozen fish or low quality fish have flesh characteristics which increase the rate of salt absorption.

In summary, sufficient salt levels in the final product are important for food safety, product preservation and consumer preferences. Due to the many variables it is critical to develop a processing formula for each species of fish and to ensure that it is rigidly followed. Regular salt level testing of the final product should be an integral part of the process.

References

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