QUALITY ISSUES IN SHRIMP PROCESSING

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The evaluation of the general quality and shelf life of fish and fish products is based on organoleptic, chemical and microbiological tests. However, in quality evaluation of crustaceans, particularly shrimps, there are certain specific spoilage problems mostly associated with the high free aminoacid content of shellfishes. Shrimp spoils rapidly compared to fishes on account of its neutral pH, high content of moisture, free amino acids and nitrogenouscompounds. Itswholesomeness under iced storage isaffected by chemical changes, bacterial growth and melanosis. The major problems associated with shrimp processing is black spot formation or melanosis and indole formation.

Melanosis

The darkening of pigments in membranes and meat just under the shrimp shell (melanosis) is commonly known as black spot. Blackspot formation in shrimp is harmless but objectionable discoloration occurring primarily along the swimmerets, head, tail and nearby shell areas reduces the consumer's appeal over the product. Blackspot is caused by a system of enzymes known as polyphenoloxidase (PPO) that are naturally present in the shrimp. PPO oxidizes phenols to quinones and auto-oxidation of the quinines in turn giving rise to dark pigments of melanin. Its intensity varies among species as it is dependent on substrate and enzyme concentration.

Melanosis has no impact on the flavor of shrimp and is not harmful to consumers. However, the black spots can drastically affect consumer acceptability of the products and significantly diminish their market value. Since blackspot is caused by enzymes naturally present in the shrimp, the darkening occurs before bacteria grow and causes deterioration and spoilage.

Control of Melanosis

None of the acceptable processing techniques are totally efficient at controlling melanosis. Good harvest practices along with a strict control of the cold chain is found to be effective in slowing down enzymatic reactions, but can necessarily does not stop the reaction. Hence, it is very important to avoid every chances of occurrence; because once melanosis starts, it is irreversible.

Frozen storage can effectively retard physicochemical changes of shrimp, however, black spot formation (melanosis) can take place after thawing. One method to retard melanosis is by keeping the material completely immersed in a medium of ice and chilled water with a distinct layer of water above the material. Beheading of shrimp immediately after harvesting and subsequent storage in ice also reduces the black spot formation as the enzyme is concentrated in the head region. However, after removing the head, care should be taken to thoroughly wash the tails to eliminate the enzyme that can promote melanosis.

Chemical treatment

Several melanosis inhibitors including sulfiting agent and 4-hexylresorcinol have been used in conjunction with iced storage.4-hexylresorcinol blocks the enzyme responsible for black spot and maintains a GRAS (generally regarded as safe) status; however, the compound is currently not authorized in the E.U countries. Metabisulfite, a relatively inexpensive inorganic chemical that has been used for more than 40 years. Metabisulfite acts with the intermediate reaction elements of melanosis, in particular quinone and sulfaquinone, by reducing the oxygen available for oxidation reactions. However, a small percentage of consumers are allergic to sulfites. Also if this chemical is used in excess hydrogen sulfide gas will be produced, which is very poisonous, and presents a serious health risk for people entering the hold for unloading. Hence, USFDA has recommends every sulfited and packaged shrimp products should include a statement that the product contains sulfites. Metabisulphites have been in use for many years to control melanosis development. However, metabisuphitesare treated as allergens and the European Union demands labeling on shrimp packages where sulphite residue exceeds 10 ppm (Mark Edmonds, 2006).

Antioxidants

Since oxygen is needed for PPO activity, removal of oxygen will help in reducing the black spot formation**.** Reducing agents like ascorbate, erythrobate and reducing sugars will not only utilize the sugar but also converts quinines to back to diphenols thus reducing the progress of melanosis. These treatments can temporarily retard the black spot formation, however, black color returns after thawing.

The maximum black spot permitted is 10% by count in shell-on types and 5% by count in peeled type.

Metabisulphite dip treatment schedule for shrimp

As there is much variation in the general harvest technology (net harvesting, mechanical harvesting etc.) and product form (head-on, headless etc) the treatment schedule and the concentration of metabisulfite may also vary and a generalised post harvest treatment can not be suggested. Also, there exists a wide variation in PPO activity between different species, and different body parts. USFDA and codex Alimentarius suggest a 1 min dip in a 1.25 % solution of sodium bisulphite as a part of good manufacturing practice for prawn or shrimps. However, this schedule may vary depending on the species and importing country's specifications.

The following practice may be followed during after the harvest of shrimp in order to reduce balck spot incidence

1. Dip the shrimp immediately after harvest in clean potable chilled water.
2. Immerse the baskets of shrimp for 1 minutes in a 1.25 percent solution of sodium metabisulfite (100 l of 1.25 % solution of sodium bisulphate is sufficient to treat 200kg fish)
3. Immediately after the treatment, store the shrimp in ice or ice water for transportation to the processing facility.

If the harvested shrimps have to be stored forprolonged time in ice, an additional treatment is necessary during storage. This is because, the chemical may slowly leach out of shrimp during storage, and melanosis may onset due to the deficit of chemical. Likewise, if the shrimp need to be transported farm to processing facility in immersed condition, and if takes a longer time, then the chemical concentration should be reduced to 0.25% (w/v). Hence the treatment schedule has to be ultimately charted out considering the condition and duration of storage and transportation.

Residual sulphite content in processed shrimp

Because some consumers may be sensitive to sulfating agents, the FDA has established a regulatory limit of 100 ppm for sulfite residue on shrimp. This level is adequate to prevent melanosis. Other countries have limits ranging from 60 to 100 ppm on raw shrimp and as low as 30 ppm for cooked products. Japan accepts a maximum of 100 ppm sulphite calculated as SO_2 residue in raw shrimp flesh and 30 ppm in cooked meat, while in the European Union, the rate varies according to the size of shrimp.

Indole formation in shellfishes

Indole formation depends exclusively on development of bacteria producing enzymes called tryptophanases, that oxidize the free L-tryptophan present in muscle tissues producing indole, skatole (methyl indole) and indolacetate. Several bacteria genera have species that are indole positive, particularly *Proteus, Escherichia, Edwardsiella*, *Flavobacterium, Aeromonas, Plesiomonas, Bacillus*, etc. Indole detection has long been used as an indicator of shrimp spoilage. Based on data collected by the Food and Drug Administration-FDA/USA, indole levels in fresh shrimps are lower than 1 mg/100g and there is a good correlation between indole concentration and organoleptic evaluation. According to these studies, shrimps are classified in class 1,when they do not show any organoleptic evidence of spoilage; when spoilage is first detected, they go to class 2, and when spoilage is clearly defined they are classified in class 3; the corresponding indole levels are < 25 µg/100g for class 1, and > 25 µg/100g for classes 2 and 3. Indole levels have been used to confirm the sensory evaluation of shrimp decomposition and a limit of 25 µg/100g has been used in several countries to differentiate passable shrimp from shrimp in the first stage of decomposition the indole could be considered a useful indicator in assessing the history of shrimp if high temperature is suspected or bad hygiene conditions have been applied.

Veterinary residues in farmed shrimp

It is a common practice to use antibiotics (medicinal drugs) in shrimp farms to control the outbreak of diseases. Excess use of antimicrobials, contaminated feed and pesticide residue in water can cause high levels of contaminants in harvested shrimp. Presence of chemical residues in shrimp leads to rejection of the product by the exporting countries. Misuse, overuse and improper withdrawal periods of antimicrobials could result in harvested products containing certain chemicals above the established maximum residue levels (MRL). These malpractice can also lead to the development and propagation of antimicrobial resistance (AMR) along the food chain which could result in death of 10 million people annually by 2050. As these products pose a health risk to consumer, they are not allowed on the market. Residues of veterinary medicinal products in food are potentially harmful to the consumers eg., chloramphenicol causes aplastic anaemia and nitrofurans are carcinogenic. Nitrofurans are a group of synthetic antibiotics that were chemically derived from furans and contain a characteristic 5-nitrofuran ring. Nitrofurans include nitro-furazone, nitrofurantoin, furaltadone and furazolidone. Nitrofuran parent compound metabolise rapidly after ingestion by the shrimp to form currosponding tissue bound metabolites. These metabolites will bind to the shrimp tissue proteins fro many weks after treatment. Nitrofuran metabolites are stable during storage and are not destroyed by cooking, frying, grilling, roasting and microwaving of meat. The EU has established a minimum required performance limit (MRPL) of 1 μg/kg (1 ppb) for nitrofuran metabolites and 0.3 μg/kg for chloramphenicol in aquaculture products (E U, 2003). Prudent use of antibiotics, proper regulation on the usage of antimicrobials, surveillance of AMR in bacterial pathogens in aquatic food products, creating awareness on the implications of the antibiotics in aquaculture will curtail the AMR and antibiotic residues in aquaculture environment.