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Processing-related Physicochemical and Microbiological Changes in Dry-cured Tuna

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Abstract

Dry-cured tuna, a traditional delicacy with roots in Mediterranean cuisine, is a product of a meticulous process that involves salting and air-drying the fish to preserve it. This method not only imparts a distinct flavor and texture to the tuna but also extends its shelf-life. The transformation from raw to dry-cured tuna involves a series of physicochemical and microbiological changes that influence the final product's quality and safety. This article delves into the intricate processes and the subsequent alterations that occur during dry-curing, shedding light on the pivotal role of factors like salt content, water activity, microbiota, and enzymatic activities.

Keywords: Drying • Food quality • Water activity

Introduction

Dry-curing is fundamentally a preservation method that relies heavily on the antimicrobial properties of salt. The application of salt initiates the osmotic dehydration of the tuna, which leads to a reduction in water activity (aw) within the fish tissue. This decline in aw inhibits the growth of spoilage microorganisms and pathogens, effectively preserving the tuna.The relationship between salt content and water activity is crucial in determining the success of the dry-curing process. Generally, a higher salt concentration results in a lower water activity, creating an environment that is inhospitable to microbial proliferation. However, an excessively high salt concentration can adversely affect the flavor and texture of the final product.

Dry-curing induces profound changes in the protein structure of the tuna. The salt interacts with the proteins, causing denaturation and subsequently affecting the texture of the fish. The process of denaturation leads to the formation of a stable protein matrix, which contributes to the firm and dense texture characteristic of dry-cured tuna. Additionally, the enzymatic activities present in the fish play a crucial role in texture modification. Enzymes such as cathepsins and collagenases are activated during the curing process, breaking down connective tissues and proteins. This enzymatic action enhances the tenderness and palatability of the final product.

Literature Review

The salt-rich environment created during dry-curing exerts a selective pressure on the microbial community of the tuna. Halophilic and osmotolerant microorganisms thrive, while pathogenic bacteria are suppressed. The dominant species in the microbiota include various species of lactic acid bacteria, which contribute to the fermentation process and enhance the safety of the product. However, despite the inhibitory effect of salt, it is crucial to monitor the microbiological quality of the tuna throughout the curing process. Proper sanitation practices, salt concentration, and control of environmental conditions are paramount to prevent the proliferation of undesirable microorganisms.

The dry-curing process of tuna is a complex interplay of physicochemical and microbiological transformations. The judicious use of salt, coupled with controlled environmental conditions, initiates a cascade of changes that ultimately result in the creation of a flavorful, safe, and shelf-stable product. Understanding the intricacies of these processes is essential for ensuring the quality and safety of dry-cured tuna, while also offering opportunities for further refinement and innovation in this traditional culinary art.

The dry-curing process for tuna is a time-honored tradition, characterized by a series of steps that transform the fresh fish into a preserved delicacy. Understanding these steps is crucial to comprehending the physicochemical and microbiological changes that occur. The process starts with the careful selection of high-quality fresh tuna. The choice of tuna species and the size of the fish can significantly impact the final product. Smaller fish are often preferred for dry-curing due to their tenderness and reduced processing time. After selection, the tuna is eviscerated, and the head and tail are removed. The fish is then thoroughly cleaned to remove any surface contaminants.

Salting is a critical step in dry-curing tuna. It serves several purposes, including preservation, flavor enhancement, and texture modification. The salt acts as a preservative by inhibiting the growth of spoilage and pathogenic microorganisms. Additionally, it draws out excess moisture from the tuna, reducing the water activity and creating an inhospitable environment for microorganisms. The salt can be applied in various ways, such as dry salting, wet salting, or injection. Dry salting involves covering the fish with a layer of salt, while wet salting includes submerging the fish in a brine solution. Injection salting involves injecting a brine solution into the fish's muscle tissue to ensure even salt distribution.

After salting, the tuna is allowed to rest for an extended period, typically ranging from a few weeks to several months. During this resting phase, the salt gradually penetrates the fish's tissues, resulting in changes to its texture and flavor. The rest also helps break down proteins and fats, contributing to the development of a unique, concentrated umami flavor. Following the resting period, the tuna is hung or laid out to air dry. This phase can last for several months or even years, depending on the desired final product. The drying process is critical for moisture removal and the development of the characteristic texture and flavor of dry-cured tuna.

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Discussion

During drying, the fish undergoes several physicochemical changes. The gradual evaporation of moisture from the fish's flesh concentrates its flavors and increases its shelf life. Exposure to oxygen during drying can lead to lipid oxidation, which affects the flavor and aroma of the tuna. However, controlled oxidation can be desirable for flavor development. The drying process results in the formation of a firmer, denser texture, which is highly prized in dry-cured tuna. While salting and drying inhibit the growth of most microorganisms, specific beneficial bacteria and molds can develop on the fish's surface, contributing to the unique flavor profile.

One of the most significant physicochemical changes during dry-curing is the reduction in water activity. Water activity (aw) measures the amount of available water in a product and is an essential factor influencing microbiological activity and spoilage. As water activity decreases, the environment becomes less favorable for spoilage microorganisms, such as bacteria and yeasts, to proliferate. Through the combined effects of salting and air drying, dry-cured tuna typically achieves a water activity level of around 0.85 or lower, rendering it shelf-stable and safe for extended storage without refrigeration.

The removal of moisture and gradual oxidation during drying results in the concentration of flavor compounds in dry-cured tuna. The umami taste, associated with amino acids such as glutamate and inosinate, intensifies as the fish dries. Additionally, the Maillard reaction, which is responsible for the browning and development of rich, savory flavors, plays a significant role during the drying and aging process. The drying and aging process causes significant changes in the texture of dry-cured tuna. The fish becomes firmer, denser, and less pliable, making it suitable for slicing into thin, translucent sheets or flakes. This distinctive texture is highly sought after in dishes like sashimi, carpaccio, and salads.

During drying, the exposure of tuna to oxygen can lead to lipid oxidation, which results in changes to the fish's flavor and aroma. While excessive oxidation can be undesirable, controlled lipid oxidation contributes to the development of unique, complex flavors. Dry-cured tuna is not only about the physicochemical transformations but also the microbiological changes that enhance its flavor and safety. While the salting and drying processes are designed to inhibit most microbial growth, they create an environment conducive to the development of specific beneficial microorganisms. Certain bacteria and molds play a crucial role in shaping the final flavor and aroma of dry-cured tuna [1-6].

Conclusion

Tuna, a warm-blooded fish belonging to the Thunnini tribe, is an oceanic species that includes bluefin, yellowfin, and skipjack tunas, among others. These fish are highly valued in the culinary world due to their distinctive flavor and nutrient-rich flesh. However, tuna, like most seafood, is highly perishable and can spoil quickly if not preserved properly. Dry-curing is one such preservation method that has been used for centuries, particularly in Mediterranean regions, to transform fresh tuna into a delectable and long-lasting product. This process involves a combination of salt curing and air drying, resulting in unique physicochemical and microbiological changes that enhance the tuna's flavor, texture, and shelf-life.

These bacteria are responsible for producing lactic acid, which contributes to the preservation of the tuna by lowering the pH and inhibiting the growth of spoilage microorganisms. Lactic acid bacteria also play a role in flavor development through the fermentation of proteins and lipids. Molds, such as Penicillium spp., can colonize the surface of dry-cured tuna. They contribute to the formation of a protective rind and help control the moisture levels during the drying process. Some molds produce enzymes that break down proteins and fats, resulting in the development of characteristic flavors.

Acknowledgement

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Conflict of Interest

None.

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