Packaging as a tool to improve the shelf life of poultry meat

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Abstract. In this paper, recent findings about poultry meat spoilage and packaging systems are discussed. Poultry meat is widely consumed and its consumption has been growing for decades. Raw poultry meat is a highly perishable food with short-term shelf life, and thus, novel strategies for maintaining safety and quality must be applied to meet the demands of the modern consumer. The main cause of meat spoilage is bacterial growth and the goal of this paper is to highlight the importance of GHP (Good Hygiene Practice) in the chain of processing, packaging, storage, and distribution of poultry meat in order to avoid economic losses and meet consumer expectations.

1. Introduction

According to OECD (Organisation for Economic Co-operation and Development) data, consumption of poultry meat has been increasing for decades, and the latest data show it is about 24 kg per capita per year in EU countries [1]. Consequently, production in the poultry meat industry is steadily growing, especially in developing countries. It is estimated that poultry meat will account for the largest share of the growth of meat consumed over the next decade to 2025 [2]. In the total production of poultry meat, broiler meat makes up 75%, followed by turkey and duck meat [3]. Therefore, in a context of increasing consumption and production, ensuring the safety and quality of poultry meat products is an important issue. In order to achieve this goal, more efforts are being invested in packing practices that should improve meat safety and quality, as well as extend the shelf life.

In most European countries, poultry meat is reported as an important source of foodborne infections, with Campylobacter spp. being responsible for the highest disease burden followed by Salmonella spp. [4, 5]. On the other hand, spoilage of raw poultry meat products is a common cause of withdrawal from the market and causes significant economic losses. Microbial spoilage is actually the most common cause of alterations in food quality [6], and meat spoilage is usually caused by proliferation of microorganisms [7].

Nowadays, it is well known that microbiological safety and preservation of raw meat depends on production hygiene, type of packaging and maintenance of the cold chain during processing, storage, and distribution of the product. These three factors are equally important for obtaining quality and safe products, and they complement each other. In this paper, recent knowledge about the microbiological spoilers and packaging techniques for improving the safety and quality of poultry meat are presented.

2. Spoilage bacteria in poultry meat

The shelf life of meat and meat products is the storage time until spoilage, where the point of spoilage can be defined by the maximum counts of certain bacteria, or by the development of an unacceptable
off-odour/off-flavour or appearance [8,9]. When large numbers of microorganisms are present in raw meat, there will be changes such that it becomes unappealing and unsuitable for human consumption [7,10]. Generally, it is assumed that spoilage is caused only by some representative species that develop from the initial microbial association with the meat. Thus, microorganisms present on the surface of the chilled poultry carcass originate from the animals (feathers, feet and bodies), slaughterhouse environment (air, water), equipment surfaces and food handlers, and subsequently contaminate cuts and processed meat products. With respect to others sources, animals are the main source of contamination in processing abattoirs. Various microbiotas are hosted in the digestive tract, lungs, skin and feathers. In relation to the aforementioned, evisceration is the most critical point of carcass contamination, because of the microbiota present at high counts in the digestive tract. Commonly reported genera from freshly cut meat are Acinetobacter, Pseudomonas, Brochothrix, Flavobacterium, Psychrobacter, Moraxella, Staphylococcus, Micrococcus, various genera among the lactic acid bacteria and different genera of the family of Enterobacteriaceae [11].

The survival and growth of specific spoilage bacteria are further affected by a diversity of environmental condition. These factors, including meat constituents, temperature, pH, oxygen or carbon dioxide (packaging atmosphere) and competing microbiota are important in maintaining meat quality over time [12]. In the context of spoilage, several bacteria are reported as spoilage bacteria of fresh poultry meat cuts. Brochothrix thermosphacta, lactic acid bacteria, Enterobacteriaceae, Pseudomonas spp. and Aeromonas spp. are considered as potential spoilers of poultry meat [13-16], but authors point out that the involvement of these bacteria in spoilage could not be clearly concluded. Spoilage of marinated poultry meat is mainly caused by the growth of several species of lactic acid bacteria, which is influenced by the specific composition of marinades and confirmed by metagenomic analysis [17].

3. Poultry meat packaging

In recent decades, consumers’ perception of food has changed. Consumer demand for fresh and minimally processed foods inspired food researchers to improve food safety and quality and to increase the shelf life of such products. The cutting and wrapping of meat in paper or waxed paper by butchers upon demand were replaced by store cutting and display of the packages in refrigerated self-service display cases, and now, much meat is packaged in the processing plant and stored and displayed in case-ready forms for both raw chilled and processed meat [18]. In order to meet consumer demands, the packaging of fresh meat and fresh meat products to ensure safety, quality, nutrition and convenience is necessary. Furthermore, the packaging of fresh meat products should endure the stresses of handling, transportation, storage, sale, and consumer contact. Meat safety and quality properties are highly dependent on the applied packaging materials and technologies [10]. Packaging of poultry meat and poultry-based meat products has always been challenging because of the meat’s perishable nature due to high sensitivity to spoilage and pathogenic microorganisms [19].

Survival and growth of spoilage bacteria are greatly affected by the gaseous composition of the atmosphere surrounding the meat. The recent methods used in poultry industry include vacuum packaging (VP), modified atmosphere packaging (MAP), controlled atmosphere packaging (CAP), active packaging, smart packaging, etc., which strive to enhance the food safety and quality in an as natural way as possible. Modern meat packaging methods maintain a low microbial load while optimising the sensory quality of a product. It is well known that aerobic storage can accelerate spoilage due to the fast growth of Pseudomonas spp., while VP and MAP can favour the dominance of facultative anaerobic bacteria including lactic acid bacteria, B. thermosphacta and Enterobacteriaceae [11]. However, to improve microbiological quality during the shelf life of the packed product, the initial microbial load should be as low as possible. Although it is not easy to determine the count of bacteria at which bacterial spoilage occurs, most authors set a value of 7 log CFU/g as the limit [20,21]. The storage period to reach spoilage (estimated as the time for total viable counts to exceed 7 log CFU/g) can be prolonged by CO2-enriched atmospheres when compared to storage under air. With respect to the temperature of storage and distribution, the shelf life of fresh poultry meat before
spoilage occurrence can be extended from six days under air to 12 and 15 days under MAP with 30% CO$_2$–70% N$_2$ and 70% CO$_2$–30% N$_2$, respectively [14] or from 5 to 8 days with 30% CO$_2$–70% N$_2$ [22].

4. Conclusion
Packaging has an important role in preserving the safety and quality and prolonging the shelf life of fresh poultry meat particularly when correct conditions of hygiene and temperature during processing, storage, and distribution are respected. Development of novel active and intelligent packaging systems has led to the creation of new barriers for food hazards and presents a new approach to food packaging research. However, the massive use of new technologies depends on the price of their application, which is reflected in the price of the final product.

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