Austin Food Sciences

Open Access

Austin Publishing Group

Mini Review

Packaging Concepts for Fresh Meat: A Brief Overview

Schmid M[1,2]*, Saengerlaub S[1,2] and Mueller K[1,3]

[1]Fraunhofer Institute for Process Engineering and Packaging IVV, Germany

[2]Chair of Food Packaging Technology, Technische Universität München, Germany

[3]Department of Mechanical Engineering, Kempten University of Applied Science, Germany

***Corresponding author:** Markus Schmid, Fraunhofer Institute for Process Engineering and Packaging IVV, Germany

Received: March 01, 2016; **Accepted:** March 20, 2016; **Published:** March 24, 2016

Abstract

Fresh meat is a sensitive product. Consumers expect a minimum shelf-life of 10 days. Therefore fresh meat has to be protected against deterioration. Measures to preserve the quality are the use of suitable packaging materials and the application of an adapted packaging process. Key selection criteria for the packaging materials are mechanical properties and barrier properties against gases - in particular against oxygen and carbon dioxide.

Keywords: Fresh meat; Packaging; Modified atmosphere packaging

Abbreviations

MAP: Modified Atmosphere Packaging; PET: Polyethylene Terephthalate; EVOH: Ethylene Vinyl Alcohol; PP: Polypropylene; PE: Polyethylene

Introduction

The amount of packaged fresh meat on sale in shops has significantly increased over recent years. Especially for sensitive food products such as fresh meat, it is important to optimally adapt the packaging system to the product contents in order to be able to offer consumers healthy and safe foods. For fresh meat there are different packaging concepts available. The aim of this mini review is to provide a brief overview about these different packaging concepts for fresh meat.

Effect of the Modified Atmosphere on Meat Quality

Key quality parameters for fresh meat are its color and microbiological status. The red color is caused by the myoglobin. It exists in three forms [1,2]:

1. Oxymyoglobin (MbO_2) = desired brick-red color

2. Deoxymyoglobin (Mb) = desired purple color

3. Metmyoglobin (MMb^+) = non-desired gray-brown color

Depending on the respective form of myoglobin the color changes as indicated (Figure 1). The brick-red color (of oxymyoglobin) is preferred by consumers. It is formed when the oxygen concentration is high. For this reason the headspace of the packaging with fresh meat is filled with a protective gas that contains a high oxygen concentration (40 to 70% v/v), as indicated in (Table 1). The process is called Modified Atmosphere Packaging (MAP). The packaging material must have a sufficiently high gas barrier to reduce the loss of oxygen and carbon dioxide due to permeation into the environment.

In addition to promoting retention of the brick-red color, oxygen suppresses the growth of harmful anaerobic microorganisms such as *Clostridium botulinum*. However, oxygen has detrimental effects, too. In case of meat with a high fat-content a high oxygen concentration increases oxidation of lipids. This results in the formation of undesired odors. Additionally oxygen promotes the growth of aerobic microorganisms such as *pseudomonas sp.* Therefore the oxygen concentration should be adapted to balance the advantages and disadvantages of its application. MAP for meat contains additional carbon dioxide in order to suppress the growth of microorganisms. To hinder the growth of *pseudomonas sp.* the CO_2 level has to be above 20% v/v [2].

In MAP a headspace to meat volume ratio of 2 to 3 is sufficient to achieve the desired effects: It is essential that the packed meat is fully

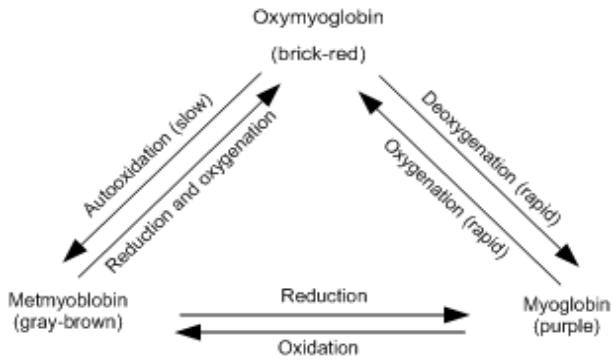

Figure 1: Changes in the color of meat [3].

Table 1: Suitable gas mixtures for storing meat in MAP at temperatures between 1-4 °C [4,5].

Product	O_2 [%]	N_2 [%]	CO_2 [%]
Beef, raw (slices, chopped meat / minced)	50-70	20-30	0-30
Pork, fresh (Schnitzel, chopped meat / minced)	50-70	20-30	0-30
Pork, cured		60-80	20-40
Pork, fresh, spiced		70	30
Pork for pan frying		60	40
Pork, fresh, salted/cured	40	40	20
Lamb cutlet, raw		70	30

Citation: Schmid M, Saengerlaub S and Mueller K. Packaging Concepts for Fresh Meat: A Brief Overview. Austin Food Sci. 2016; 1(1): 1005.

Table 2: Antimicrobial substances [9].

Classification	Substance, examples, properties
Metals	Silver (salts, nanoparticles, zeolite complexes), copper
Enzymes	Lysozyme, glucose oxidase (catalyses the oxidation of Glucose to pH reducing gluconic acid and hydrogen peroxide), peroxidase
Organic acids and their salts	Sorbic acid (E 200), Benzoic acid (E 210), active in acid, foods; occur naturally in cranberries, blueberries, and honey
Bactericides/Antibiotics	Nisin (from Lactococcus lactis), pediocin, natamycin (from Streptomyces natalensis)
Fungicides	Imazalil, Benomyl
Other natural substances	Horseradish/radish extracts, rosemary, pepper, thiosulfinates, isothiocyanates, flavonoids, chitosan (from crustaceans); usually strong odor or taste, or astringent, bitter taste
Volatile substances	Ethanol (in sachets), CO_2 (liberated by CO_2 emitters), SO_2 (liberated by the reaction of calcium sulfite with acids), hinokitiol (from tree bark)

surrounded by the headspace gas. Contact of the meat with the lid film should be avoided, since the contact area of the meat with the lid film tends to graying [1].

Packaging Materials for Protective Gas Packaging Systems

MAP-systems for fresh meat normally consist of trays made of deep-drawn plastic films. They contain a liquid absorbent sheet and a transparent covering lid. On often used material for the trays is Polypropylene (PP). Although PP has high oxygen transmission rate compared to other plastics (e.g. Polyethylene Terephthalate, PET), it is sufficiently to keep the oxygen and carbon dioxide in the packaging for the period of shelf-life. The oxygen transmission rate of a PP tray is in the range of 5-10 cm^3 O_2/ (tray day bar). Multilayer barrier films are used as lid film.

A typical example is a PET/EVOH/PP/PE layer structure. The oxygen transmission rate of such film is around 0.1 cm^3/ (packaging day bar) and consequently several times smaller than the oxygen transmission rate of the tray. Thus the barrier performance of the lid is "over-designed" for that application.

Assuming the packaged meat is free of microorganisms and that it is stored continuously under refrigerated conditions, the shelf-life of fresh meat in MAP in refrigerated shelves (4°C) is 6 to 8 days. It is considerably longer than the shelf-life of fresh meat in standard packaging where it is 2 to 3 days [6].

Vacuum-packed Fresh Meat

Larger pieces of meat are mostly vacuum-packed. They are intended for later division in smaller portions, such as those used in gastronomy. Due to the low oxygen concentration, dark red deoxymyoglobin is prevalent. At 0 to 1°C the vacuum-packed meat has a shelf-life of 4 to 6 weeks. Vacuum-packaging is also used for the so-called maturing bags. Predominantly beef for quick frying (fillet, rump steak, etc.) is aged and tenderized in these bags at temperatures just above the freezing point and at very low oxygen partial pressures [2,5,7].

The transfer of oxygen into vacuum packaging must be prevented in order to avoid the formation of gray and hence undesired metmyoglobin. The packaging materials that are used are multilayer films. They are made of Polyvinylidene Chloride (PVDC), Polyamide (PA) and Polyethylene (PE). The PVDC-layer acts as a barrier to oxygen and water vapor. The PA-layer provides mechanical strength. And the PE-layer acts as sealing material. Chlorine-containing PVDC has been replaced by Ethyl-Vinyl-Alcohol (EVOH) in some applications. The disadvantage of EVOH is its interaction with humidity. Above a relative humidity of ca. 70% the oxygen barrier is significantly reduced [8].

Current Research - Antimicrobial Packaging Materials

Different antimicrobial packaging materials are currently developed. They utilize the circumstance that microorganisms start to growth at the surface of foods. Antimicrobial packaging systems act via two different mechanisms. (1) The antimicrobial substances are chemically bonded (anchored) to the packaging surface, (2) whilst in others they are able to migrate into the surface of the food. Except for the volatile systems, the packaging materials must have direct food contact in order to guarantee release and migration of the active substances onto the food. That is why this packaging concept is particularly suitable for vacuum packaging. In principle all antimicrobial substances can be used (Table 2).

The EU Regulations 450/2009 and 1935/2004 define the requirements for the use of active packaging materials (including antimicrobial packaging systems). Active substances which migrate to the food are considered to be additives and must hence comply with food legislation. Particularly promising from a legal point of view are antimicrobial substances which have already been approved as food additives. This is the reason why the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising (Germany) is developing antimicrobial packaging materials that contain, widely used antimicrobial substances such as benzoic acid [9].

In addition to matters relating to food legislation and health aspects, the antimicrobial agents must be stable for processing. They should not change the sensorial properties of food as well. Furthermore, other key properties such as sealability, transparency and flexibility must be ensured.

Conclusion

Fresh meat is a sensitive product. Consumers expect a minimum shelf-life of 10 days including the preservation of the brick-red color (of oxymyoglobin) which is formed when the oxygen concentration in the headspace is high. Therefore fresh meat has to be packed in appropriate packaging materials with sufficient high gas barrier properties. Beef is often packed in MAP with 70% O_2 and the atmospheric O_2 concentration is approx 21%. Therefore the driving force for permeation, the partial pressure difference, is much higher

than in most other MAP concepts. On the other hand vacuum packed meat is very sensitive against even low oxygen levels. This needs to be addressed by the packaging material selection in addition to the high relative humidity the barrier packaging is exposed to in case of fresh meat packaging.

References

1. Mueller K, Gibis D, Schmid M. Schutzgasverpackungen für Frischfleisch. Der Lebensmittelbrief, 20. Jahrgang. 2009.
2. Belitz HD, Grosch W, Schieberle P. Food Chemistry : with 634 tables, Berlin; Heidelberg, Springer. 2009.
3. Robertson GL. Food Packaging "Principles and Practice", Taylor and Francis Group, London, New York. 2006.
4. Bergmair J, Washuttl M, Wepner B. Prufpraxis für Kunststoffverpackungen. 1. Auflage, Behr's Verlag; Hamburg. 2004.
5. Buchner N. Verpackung von Lebensmitteln; Springer-Verlag Berlin-Heidelberg. 1999.
6. Pfeiffer T, Menner M. Schutzgas-Verpackung fur SB-Frischfleisch – Veranderungen der Gasatmosphare wahrend der Lagerung. Die Fleischwirtschaft 79. 1999; 12: 79-84.
7. Zhang M, Shrestha S. Effect of Oxygen Concentration on the Shelf-Life of Fresh Pork Packed in a Modified Atmosphere. Packaging Technology and Science. 2005; 18: 217-222.
8. Heiss R, Eichner K. Haltbarmachen Von Lebensmitteln: Hemische, Physikalische Und Mikrobiologische Grundlagen Der Qualtitatserhaltung, Berlin, Heidelberg, Springer Verlag. 2001.
9. Saengerlaub S, Hauser C, Mueller K, Rieblinger K. Aktive Verpackungsfunktionen-Teil 2 Feuchteabsorbierende und antimikrobiell wirksame Verpackungen. Kunststoffe International. 2010; 101.

Austin Food Sci - Volume 1 Issue 1 - 2016
Submit your Manuscript | www.austinpublishinggroup.com

Citation: Schmid M, Saengerlaub S and Mueller K. Packaging Concepts for Fresh Meat: A Brief Overview. Austin Food Sci. 2016; 1(1): 1005.