PhD THESIS

# The meat quality control during the aging process of "*Longissimus thoracis and lumborum*" cuts from Romanian Spotted and Black Angus breeds

(SUMMARY OF PhD THESIS)

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## 1. Introduction

The thesis focuses on the meat quality control during the aging process of "*Longissimus thoracis and lumborum*" cuts from Romanian Spotted and Black Angus breeds. Meat has historically been a vital part of human diets, offering essential nutrients like protein, iron, and B vitamins. Early hunter-gatherers benefited from a diet rich in meat and leafy greens, leading to robust health. However, the shift to agriculture around 10,000 years ago introduced starchy grains, resulting in decreased stature and bone health due to lower nutrient intake and increased disease (McGee & Book, 1984).

Currently, meat remains crucial in diets worldwide, although consumption varies significantly. Beef is particularly valued for its nutritional benefits, being lower in cholesterol and saturated fats compared to other meats (Banu, 2009; Soare et al., 2015). In Romania, beef consumption is low at 4.7 kg per capita, but it is gradually increasing as dietary trends shift (FAO, 2013; Hallström & Börjesson, 2013; Grodea, 2017).

Romania's beef production relies on both imported and domestic breeds, but production remains limited, necessitating imports. Future growth in the sector is anticipated through both family farms and industrial units (Dabija et al., 2021; Holtcamp et al., 2019; Jiu et al., 2019; Pesonen et al., 2012).

### 1.2. State of the art

The literature review covers beef breeds, their composition, and aging processes, emphasizing the Black Angus and Romanian Spotted breeds under-researched status. Black Angus and Romanian Spotted Cattle Breeds

The Black Angus breed, prevalent in the United States, is renowned for its high carcass yield, rapid growth, and adaptability to harsh environments. Despite its high marbling, there is room for improvement in the proportion of highly marbled carcasses. In Romania, Black Angus was reintroduced after 2010 and has adapted well due to favorable agricultural conditions. However, challenges like small herd sizes and inadequate fodder quality limit production. Black Angus beef is considered ideal for its taste and health benefits, but consumption in Romania remains low at 4.9 kg per capita annually (Gociman et al., 2019; INS, 2017).

The Romanian Spotted breed, derived from crosses with Simmental cattle, is prominent in Romania and other parts of Europe. Known for its mixed utility in milk and meat production, this breed adapts well to various ecological zones. It offers high-quality meat with a good balance of muscle and fat. Despite a decline in livestock production, Romanian Spotted cattle remain popular among farmers due to their robust constitution and adaptability (Bureš & Bartoň, 2018).

### 1.3. Nutritional Composition of beef meat

Both Black Angus and Romanian Spotted meats are rich in proteins and essential micronutrients like iron, selenium, zinc, and vitamin B12. While beef generally contains about 20 grams of protein per 100 grams, fat content varies between 3.3 and 7.6 grams, depending on the cut (Pereira & Vicente, 2013).

### 1.4. Gap of knowledge

There is extensive research on Black Angus, but Romanian Spotted cattle are less studied, particularly regarding meat aging techniques. This study aims to fill this

gap by exploring the potential of Romanian Spotted cattle to produce high-quality aged beef, thereby enhancing its commercial value and promoting the use of domestic breeds in the meat industry.

### 1.5. Beef aging procedures

Beef aging enhances meat flavor and tenderness through enzymatic activity, which breaks down proteins and fats into flavorful amino acids and fatty acids. The two main methods of aging: wet aging and dry aging.

Wet Aging: Introduced in the 1970s, this method involves storing beef cuts in vacuum-sealed packages. It is the most common aging method due to its economic benefits, such as reduced weight loss and efficient space use, while maintaining the meat's palatability and extending its shelf life (Kim et al., 2018; Terjung et al., 2021).

Dry Aging: This traditional method, dating back to the 1960s, involves storing beef without protective packaging, allowing water to evaporate and creating unique flavors and aromas. Dry-aged beef is known for its enhanced tenderness and distinct beefy, roasted flavors, which differ from the metallic notes of wet-aged beef. This method is considered premium due to its flavor profile and the meat loss involved during the process (Lancaster et al., 2022; Laster et al., 2008).

Overall, dry-aged beef is highly valued for its unique taste and texture, commanding higher market prices compared to wet-aged beef (Campbell et al., 2001; Warren & Kastner, 1992).

#### 1.5.1. Dry aging parameters and conditions

Dry aging of beef is a practice used by high-end food service restaurants and upscale meat markets to create valued products with distinct flavors and improved tenderness (Capouya et al., 2020; Savell, 2008). Dry aging involves storage a primal or a subprimal of meat for an extended period in refrigerated temperatures without protective packaging. This extended storage time allows proteolytic enzymes to function, resulting in more tender meat (Campbell et al., 2001; Capouya et al., 2020; Khan et al., 2016).

Several studies have found that dry-aging enhanced palatability attributes of meat, especially flavor. This aging treatment is often associated with brown-roasted, beefy, buttery, nutty, roasted-nut, and sweet flavor notes (Campbell et al., 2001; Corbin et al., 2015; Ribeiro et al., 2021; Warren & Kastner, 1992).

In their research, Ersel Obuz et al. in 2014, aged the loin sections for 2 or 23 days at 2.2°C. The cuts were placed on wire racks, with the subcutaneous fat surface down. Another research was carried out by Fumiko Iida in 2016 and the beef carcasses were kept until 60 days after slaughter.

#### 1.5.2. Wet aging parameters and conditions

In wet aging, meat is stored at refrigerated temperatures in a sealed, oxygen-impermeable barrier package and exposed to air at controlled temperature and relative humidity (Obuz et al., 2014; Parrish Jr et al., 1991). This type of aging has shorter storage time than dry aging. For example, the research made by Nicole Lebedova et al., in 2022

find that the samples were vacuum-packed and aged in a refrigerator at +4 ◦ C for 7 days. In another research carry out by Daniel Bureš and Luděk Bartoň (2012), the samples of meat from Aberdeen Angus, Gascon, Holstein and Czech Fleckvieh bulls were kept at +4 ◦ C for 6 days. They wanted to compare the chemical composition and sensory characteristics. One of the interesting research projects was carried out in 2019 by Minh Ha et al., when they aged the meat cuts until 56 days of slaughtering in a wet-dry aging combination. First, they kept the cuts in vacuum-packaging until 21 days and then, dry-aged the cuts for the rest of the days.

### 1.5.3. Aging room specifications

Generally, the aging room is a chamber with a multi batch chiller loaded with movable racks. Whole racks serve as support for meat products. Cuts need to be moved to different positions within the chiller depending on the stage of dry aging and length of time of aging.

The level of relative humidity (RH) in the chamber is critical to encourage drying, especially for dry. The RH in the chamber ranged from 53.5% to 100.0% with an average RH of 89.4% over the experimental period. The temperature of the chamber varied from 1.3°C to 4.1°C, an average recorded temperature of 2.1°C. In a central position air speed varied between 0.75 and 1.2 m/s. There were two UV light units fitted to the ceiling of the chiller (Ha et al., 2019; Mikami et al., 2022).

## 2. Particularities of Research

The hypothesis posits that aging enhances meat's sensory characteristics. The study aims to assess aging methods for Romanian Spotted beef, comparing it with Black Angus. The experimental design included controlled aging conditions and comprehensive analysis of meat quality.

**Hypothesis:** The study hypothesizes that meat consumption is a sensory experience, with consumers seeking high-quality meat with distinct flavor, aroma, and tenderness. The aging process enhances these sensory characteristics without affecting juiciness. Despite extensive research on meat aging, Romanian beef breeds have been underexplored. The study aims to validate this hypothesis by comparing aging methods and assessing Romanian beef breeds' potential for producing high-quality aged meat, using Black Angus as a reference (Obuz et al., 2014; Sitz et al., 2006).

**Aim and Research Objectives:** The research aims to evaluate the suitability of three aging processes for Romanian Spotted beef. The objectives are:

O1. Compare meat quality and chemical attributes of Romanian Spotted vs. Black Angus.

O2. Assess the most common beef aging methods: dry-aging, wet-aging, and additional methods.

O3. Evaluate consumer acceptability of Romanian Spotted aged meat compared to Black Angus.

The research was guides by following experimental design (Figure 1.1).

## 2.1. Experimental design

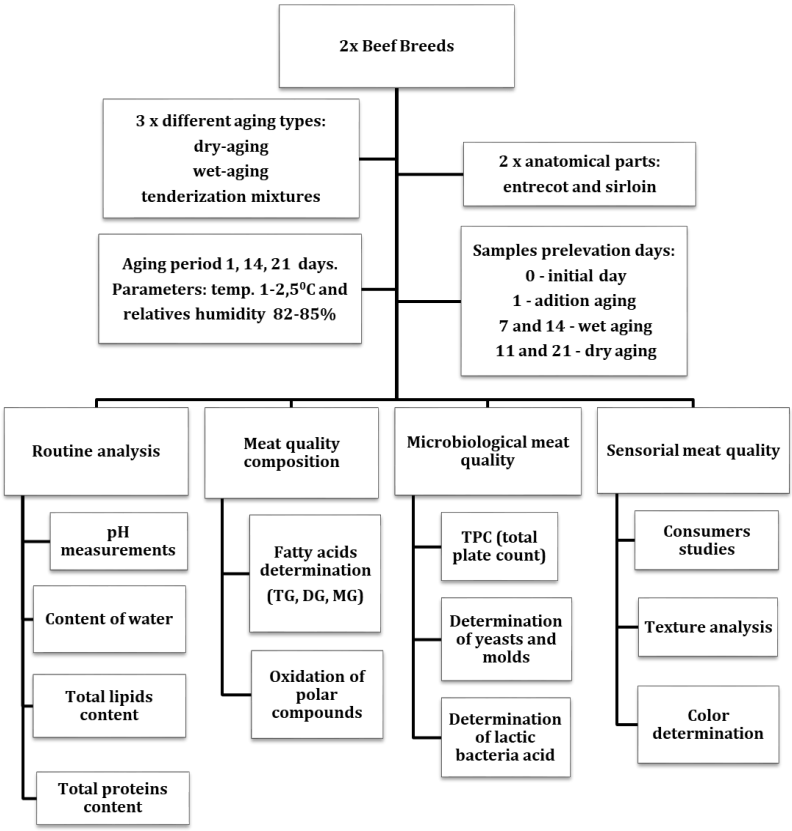


**Figure 1.1 Diagram of experimental design**

From a local farmer, two cattle breeds were identified for growing and feeding in the same conditions. According to the literature, the three most common aging procedures were chosen (dry, wet and with addition) and the two of most used anatomical parts to be aging (*longissimus thoracis* and *lumborum*).

Based on the classification of the carcass on the day of slaughter, the following aging periods were chosen: 0 and 1 days for addition, 0, 7 and 14 days for wet aging, 0, 11 and 21 days for dry aging. All the samples were aged in the same professional chamber.

At the end of each aging period, the samples were individually prepared for analysis. The laboratory analyzed were divided into routine analysis (content of water, fat and protein, pH determination), meat quality composition (determination of fatty acids (FA) and polar compounds), microbiologically meat quality (total plate count (TPC), development of lactic bacteria and determination of yeast and molds), and not the end, evaluation of sensorial meat quality (sensory analysis, instrumental analysis: texture and color determination).

The samples preparation for analysis were performed according to each analysis protocol.

## 3. Research results

### 3.1. Results of routine analysis

The research performed routine analyses such as pH measurement, water and fat content, and protein analysis. It also covered microbiological quality and sensory evaluations, providing insights into consumer preferences. The pH measurement during wet aging, of Black Angus (BA) and Romanian Spotted (RS) beef recorded decreased trend, with BA entrecote reaching the lowest pH. In dry aging, BA entrecote also showed the lowest pH, while RS parts exhibited a linear decrease throughout the aging period.

The physico-chemical changes presented in the study, found significant differences in water content between RS and BA, with RS showing higher protein content. Fat content was higher in sirloin than entrecote for both breeds, contrary to expectations.

### 3.2. Results of meat quality composition

The study analyzed the fatty acid profiles, triacylglycerols, and other chemical components of the meat. It highlighted the differences between breeds and aging methods, revealing unique biochemical dynamics.

The fatty acids presented in the study revealed distinct fatty acid profiles between breeds and aging methods. RS showed higher levels of certain fatty acids like C18:1w9, while BA had higher C18:0 and C20:0 levels. Aging methods influenced fatty acid dynamics, with notable differences in intramuscular and subcutaneous fat. The triacylglycerols profile recorded differences between breeds, with RS showing higher levels in certain compounds compared to BA.

### 3.3. Results of microbiological and sensorial quality

Microbiological assessments included total plate counts and lactic acid bacteria analysis. Sensorial quality was evaluated through consumer studies and instrumental analyses of texture and color. The total plate count (TPC) shown in both breeds, variations in microbial counts across aging methods, with dry aging generally resulting in higher microbial loads compared to wet aging.

The lactic acid bacteria (TLB) levels were higher in dry-aged samples, indicating increased microbial activity during this process.

### 3.4. Results of statistical analysis

Statistical methods, including ANOVA and principal component analysis (PCA), were used to interpret the data, highlighting significant differences between breeds, aging methods, and anatomical parts.

The statistical analyses confirmed significant differences in chemical and sensory attributes between breeds and aging methods. Principal Component Analysis (PCA) highlighted the influence of breed and aging method on fatty acid profiles and sensory characteristics.

## 4. Conclusions

The research concluded that Romanian Spotted beef has distinct aging characteristics and potential commercial value. It emphasized the importance of using local breeds in meat production and provided valuable insights for the meat industry. These results underscore the unique qualities of Romanian Spotted beef and its

potential for producing high-quality aged meat, offering valuable insights for the meat industry.

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