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Impact of Dry-Aging and Wet-Aging Methods on Physicochemical and Sensory Characteristics of Beef

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Abstract

The purpose of this 21-day research was to compare the quality of beef after dry-and wet-aging. The beef strip loin samples were either aged dry at a temperature of 0-3°C with regulated humidity and air movement, or wet under vacuum at the same temperature, using cattle of the same breed and genetic background. The greater rate of moisture loss (20.5 ± 1.2%) in dry-aged beef compared to wet-aged beef (2.3 ± 0.5%), which may be explained by the fact that moisture evaporates throughout the dry-aging process. Warner-Bratzler shear force, which measures tenderness, showed that dry-aged beef (32.1 ± 2.8 N) was more tender than wet-aged beef (35.4 ± 3.1 N). There were small biochemical alterations indicated by a slightly higher pH in the dry-aged samples (5.68 ± 0.04) compared to the wet-aged samples (5.61 ± 0.03). It was found by color analysis that wet-aged beef was lighter (L* 41.5 ± 1.3) than dry-aged beef (38.2 ± 1.1). The sensory panel found that dry-aged beef had greater taste and tenderness (8.7 ± 0.3) and juiciness (8.5 ± 0.4) ratings, compared to wet-aged beef. There are clear differences in quality qualities affected by the age procedures;

dry-aging improved taste and tenderness but reduced moisture content, whereas wet-aging kept meat juicy but made it lighter in color.

Key words: Aging a dry aging; a wet aging; a PH

Introduction

Color, tenderness, juiciness, and rate of intramuscular fats are some of the physicochemical traits that affect meat quality, which in turn determines customer acceptability. An animal's breed, age, feeding schedule, slaughter weight, and muscle type all have a role in shaping its traits (1). Mammalian muscle fibers exhibit a wide range of structural, metabolic, and functional characteristics. The development of various types of muscle fibers affects not only the total amount of muscle mass in slaughtered animals, but also the quality of the meat (2).

In addition to varying proportions of each fiber type, the composition of intramuscular fat and connective tissue, the color of the meat, and its water-holding ability may all contribute to muscle variety. In addition to the factors that affect the meat's technical value, the kind of muscles it contains and the quantity of polyunsaturated fatty acids (PUFAs) determine its health value (3). the quality of the meat for human consumption is directly related to how it ages after slaughter. Several changes occur in the micro and ultrastructure of the meat as it ages, and these changes influence when the tenderization process begins, which is triggered by the calcium-dependent calpain systems (4).

Aged beef was associated with improvements in its ability to retain water. There are undeniably positive effects of post-slaughter beef maturation, but there are other processes, such as lipid oxidation and color instability, that can reduce its ultimate value (5). One of the most common and efficient ways to make meat last longer is to freeze it. However, many people believe that fresh, never-frozen meat is of higher quality than frozen or thawed meat (6).

Major quality difficulties with frozen or thawed beef include increased water loss during cooking or thawing, discoloration, and rapid lipid/protein oxidation. Texture issues also arise from this excessive water loss. Using sufficient postmortem aging before freezing and thawing (AFT) has recently been proposed as a way to produce frozen meat with better quality (7). Studies have shown that aged meat while it is still frozen may increase its water holding capacity (WHC) and make it softer than frozen/thawed meat without ageing (8). Muscle type, chilling conditions, and animal species all have a role in how long it takes for meat to mature, a quality indication. Nowak (2005) determined that pork should be matured for 6-10 days and chicken for 12-24 hours, but (9), beef should be kept for 6 weeks. The effects of aging on the physicochemical properties of lamb's flesh are studied at various intervals between 7 and 30 days following slaughter, as well as at 60 days. The purpose of this study was to examine the effects of ageing and freezing on the quality of beef.

Material and methods

2.1 Sample Preparation and Aging Procedures

Beef strip loin samples were obtained from cattle of similar breed, age, and feeding background to ensure consistency. The samples were divided into two groups for aging treatments (10):

- **Dry-Aging:** Beef cuts were hung in a controlled environment chamber at 0–3°C with 75–80% relative humidity and good air circulation for 21 days. The samples were exposed to open air without packaging, allowing moisture evaporation and enzymatic activity.
- **Wet-Aging:** Beef cuts were vacuum-sealed in oxygen-impermeable plastic bags and stored at 0–3°C for 21 days. This method preserved moisture by preventing evaporation as figure 2.

Figure 1: Fresh Beef Meat

2.2 Moisture Loss Measurement

Moisture loss was calculated by measuring the weight difference of each beef sample before and after aging. Samples were weighed using an analytical balance (±0.01 g accuracy) immediately prior to aging and after completion of the aging period. Moisture loss (%) was calculated as (11):

$$Moisture\ Loss\ (\%)\frac{Initial\ Weight-Final\ WeightInitial\ Weight}{Initial\ Weight}$$

×100

Figure 2: Wet drying Beef in plastic bags

2.3 Shear Force Measurement

Tenderness was assessed by measuring the Warner-Bratzler shear force (WBSF). After aging, beef samples were cooked to an internal temperature of 71°C, cooled to room temperature, and six cores (1.27 cm diameter) were extracted parallel to the muscle fibers. Shear force was measured using a TA-XT Plus texture analyzer (Stable Micro Systems, UK) equipped with a Warner-Bratzler blade. The maximum force (N) required to shear each core was recorded, and the mean value was reported (12).

2.4 pH Measurement

The pH of beef samples was measured 24 hours postmortem and after aging using a calibrated digital pH meter (HI 99163, Hanna Instruments, USA) equipped with a penetration probe. Measurements were taken in triplicate at different locations on each sample, and the average was calculated (13).

2.5 Color Measurement

Surface color was measured using a Minolta Chroma Meter CR-400 (Konica Minolta, Japan) standardized with a white calibration plate. The CIE L* (lightness) values were recorded at three different points on the meat surface after blooming for 30 minutes at 4°C. The mean L* value was reported (14).

2.6 Sensory Evaluation

A trained sensory panel of 10 members evaluated the aged beef samples for flavor, juiciness, and tenderness using a 10-point hedonic scale (1 = extremely poor, 10 = excellent). Samples were cooked under standardized conditions, cut into uniform pieces, and served warm in randomized order. Panelists cleansed their palate with water between samples. Scores were averaged across panelists and replicates.

2.7 Statistical Analysis

All measurements were performed in triplicate. Data are presented as mean ± standard deviation. Statistical differences between dry-aged and wet-aged beef were analyzed using Student's t-test with significance set at $p < 0.05$.

Results and Discussion

Beef are prepared for consumption by the process of ageing, which involves letting the connective tissue inside the flesh break down. The term "ageing" refers to the practice of preventing microbiological spoilage by keeping raw meat above freezing temperature. Making muscle pliable and pliable is called conditioning, tenderizing, ripening, or maturing meat (15). Keeping meat at temperatures between 0 and 3 ^{o}C (above freezing point) enables it to undergo a number of changes at a reasonable pace. The best way to make meat more tender, juicy, and flavorful is to let it age for a while. Enzymes in meat play a pivotal role, whereas bacteria have a little impact on the process. Due to the moisture evaporation that occurs throughout the dry-aging process, the moisture loss of dry-aged beef (20.5 ± 1.2%) was much greater than that of wet-aged beef (2.3 ± 0.5%) after 21 days of aging (16) as figure 3.

Figure 3: Dry aging Beef after 21 Days

According to the results, dry-aged beef had a lower shear force (32.1 ± 2.8 N) compared to wet-aged beef (35.4 ± 3.1 N), indicating that the former method resulted in flesh that was more tender. Six cores, each running parallel to a muscle fiber, were taken from cooked loins and used to measure cooking loss after chilling to below 10°C (1.27cm diameter). A hand-held coring device was utilized for this purpose. The TA-XT Plus texture analyzer was equipped with a Warner-Bratzler shear attachment, which was used to shear each core (Stable Micro System Ltd., UK). Peak shear forces were recorded via each core, with an average of six cores per pork chop, for a total of eighteen cores (18).

Aged dry beef had slightly higher pH values (5.68 ± 0.04) than wet-aged beef as figure 2. (5.61 ± 0.03), suggesting small biochemical changes that occur throughout the aging process. The lightness value of wet-aged beef was greater (L* 41.5 ± 1.3) compared to dry-aged beef (38.2 ± 1.1), indicating that the former seemed lighter according to the color measurements. Based on the sensory panel's assessments, dry-aged beef had greater taste (8.7 ± 0.3) and tenderness (8.5 ± 0.4), while wet-aged beef had somewhat better juiciness (8.3 ± 0.4 against 7.9 ± 0.5), perhaps because it retained more moisture. In general, wet-aging turned out meat that was lighter in color and retained more moisture, whereas dry-aging improved taste and tenderness but reduced moisture content.

Table1: Effect of Aging Method on Meat Quality Parameters (after 21 days)

Parameter	Dry-Aged Beef	Wet-Aged Beef
Moisture Loss (%)	20.5 ± 1.2	2.3 ± 0.5
Shear Force (N)	32.1 ± 2.8	35.4 ± 3.1
pH	5.68 ± 0.04	5.61 ± 0.03
Color (L*)	38.2 ± 1.1	41.5 ± 1.3
Flavor Score (1–10)	8.7 ± 0.3	7.2 ± 0.4
Juiciness Score (1–10)	7.9 ± 0.5	8.3 ± 0.4
Tenderness Score (1–10)	8.5 ± 0.4	8.1 ± 0.3

Values are mean ± standard deviation; flavor, juiciness, and tenderness scores are based on sensory panel evaluation.

The idea of high-quality beef as per the ISO 8402-94 standard, a company's quality may be defined as its ability to meet the specific and expressed requirements of its clients and customers. This description (20) shows that quality is real and ever-changing. The idea of high-quality beef Is believed to encompass meat’s overall properties, comprising its chemical, physical, biochemical, morphological, microbiological, scientific, sensory, hygienic, healthful and culinary qualities (21). Look, shape, juiciness, water retention, hardness, tenderness, aroma, and taste are often the determining factors for meat quality in the eyes of the buyer. As stated in, these are some of the most prominent and obvious features of meat, which impact both the initial and ultimate quality choice made by customers (22). Furthermore, producers involved in the processing of value-added meat products find that poultry meat has a consistent texture that accumulates proven meat properties like water retention, compressive restraint, pH, nutritional value, collagen value, protein solubility, cohesiveness, and fat binding capacity (23). The nutritional quality, sanitary quality, technical quality, and sensory quality are four specific traits that may be used to characterize the quality of chicken meat, as stated by (24). One way to describe meat quality is by looking at its composition (the ratio of lean to fat) and how it tastes (its aroma, texture, firmness, juiciness, and tenderness, among other things). This is according to the Food and

Agriculture Organization of the United Nations (FAO). Although the nutritional value of meat may be shown empirically, the subjective quality of "eating" it is highly dependent on the individual (25).

Conclusion

A key step in meat preparation, aging prevents microbiological deterioration by elevating the meat's temperature above freezing and enzymatically breaking down connective tissues, which increases tenderness, taste, and juiciness. As a result of water evaporation during the drying process, dry-aged beef had a much greater moisture loss (20.5% vs. 2.3% after 21 days) than wet-aged cattle. The shear force was lower in dry-aged beef, which means it's more tender, and the pH readings were somewhat higher, which means there were biochemical changes. According to sensory evaluations, dry-aged beef had a better taste and was softer than wet-aged beef, although wet-aged meat looked lighter (higher L* value) and kept more juice. Meat quality is determined by a combination of chemical, physical, sensory, and sanitary variables, as stated in ISO 8402-94. These aspects impact customer approval. There are clear advantages and disadvantages to both dry- and wet-aging; the former enhances taste and tenderness at the expense of moisture, while the latter maintains juiciness and color.

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