PHYSICOCHEMICAL PROPERTIES AND SENSORY ATTRIBUTES OF BEEF SUBJECTED TO COLD PRESERVATION

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ABSTRACT

This study investigated the physicochemical properties and sensory attributes of beef subjected to cold preservation at -18^{0}C. Twenty-one (21kgs), of beef samples were procured from abattoir, and were allotted into 7-treatment in a completely randomized design, Treatment 0 (T0: Fresh beef), while beef stored for 1, 2, 3, 4, 5, and 6 weeks. Samples were assessed for physicochemical properties such as pH cooking loss, and water holding capacity (WHC). Sensory attributes were assessed for freshness, texture, odour, spoilage/decay and overall acceptability by twenty (20) trained panellists, selected among departmental staffs, students using the 7-point hedonic scale. Data were analyzed using ANOVA at α0.05. The result revealed significant difference among parameters measured for physicochemical properties except for pH. It was observed that cooking loss (CL) and water holding capacity (WHC) of T0 were significantly higher (33.10% and 59.83%) than other treatments, it was also seen that CL and WHC decreased along the treatment from T0 to T6, with T6 having the lowest value of 38.32 and 50.41 respectively. Tenderness and flavor were seen to be significantly influenced among the parameters measured for sensory attributes. They both increased in value as the preservation weeks increased across the treatments. It was concluded that cold preservation of beef at -18^{0}C did not affect beef physical and sensory properties negatively. Sensory properties such as flavour, and tenderness can be improved through cold preservation. However, constant temperature must be maintained throughout the preservation process in other to meet the consumers' preference for freshness.

Keywords: Beef, Cooking Loss (CL), Water Holding Capacity (WHC) Tenderness, and Flavor,

INTRODUCTION

The global demand for meat continues to rise in tandem with population growth, as more people inhabit the planet, the demand for protein sources such as meat naturally increases (Parlasca, and Qaim 2022). This surge in demand is driven by various factors, including rising incomes, urbanization, and changing dietary preferences. As people become more affluent, their consumption patterns shift towards protein-rich diets, with meat being a primary source of high-quality protein.

Despite the growing need for animal protein, consumer behavior clearly shows preference for premium, fresh meat (Stampa et al., 2020). This preference stems from the idea that undercooked or stale meat is unhealthy and loses its nutritional value. Fresh meat is thought to be higher in vital elements such as proteins, vitamins, and minerals, necessary for a balanced diet (Geletu et al., 2021).

Furthermore, there are significant health risks associated with consuming unfresh meat. As meat spoils, it becomes a breeding ground for harmful bacteria, such as Salmonella, E. coli, and Listeria. These pathogens can cause severe foodborne illnesses, leading to symptoms such as nausea, vomiting, diarrhea, and in extreme cases, death. The risk of infection is particularly high if the meat is not stored or handled properly, which can exacerbate bacterial growth (Alimi *et al.,* 2022).

To address these concerns, meat producers and retailers implement stringent measures to ensure the freshness and safety of meat products. This includes proper storage at appropriate temperatures, timely transportation, and clear labeling to inform consumers about the meat's shelf life.

Cold preservation techniques, such as refrigeration and freezing, are widely recognized for their ability to maintain the nutritional quality of meat and significantly extend its shelf life (Xiong, 2023). These techniques prolong the freshness and safety of the meat by slowing the growth of germs and other pathogens.

Despite the effectiveness of cold preservation, there is still a lack of comprehensive understanding about the precise duration for which these benefits can be sustained. It's a popular misperception that meat will lose its nutritional content, flavor, and quality after being preserved for an extended period of time.

However, this study tends to provide information/insight into the physicochemical properties and sensory attributes of beef subjected to cold preservation.

MATERIALS AND METHODS

Study Location

The study was carried out at Biology Laboratory of Ekiti State Polytechnic, Isan-Ekiti, Nigeria.

Experimental Samples

21kgs samples (beef) were purchased from the abattoir. They were divided into 7 parts and each parts were further splitted into 20 pieces, with each piece measuring 150g each. The beef were rinsed, and packed and well tagged. Thereafter, the treatments subjected to cold preservation were placed in the refrigerator at -18^{0}C. Physicochemical properties like cooking loss, pH, and water holding capacity were also determined, while sensory attributes such as color, aroma, juiciness, tenderness and overall acceptability were observed. The fresh beef was used as the control experiment i.e. not subjected to cold preservation.

Physicochemical Properties

Water Holding Capacity (WHC)

The estimation of the water holding capacity (WHC) was determined according to the method described by Bora *et al.,* (2022).

Cooking Loss

Meat samples of about 5g were taken thrice each week, cooked in a moist-heat to an internal temperature of 72^{o}C. The water released after cooking and cooling was manually separated and the weight of the cooked meat was taken to obtain the cooking loss.

Cooking loss = weight t of sample before cooking – weight after cooking
Wt before cooking] x 100

PH

The meat pH was measured using a digital pH meter.

Sensory Properties

Cooked beef samples were analyzed for their freshness, texture, odour, spoilage/decay and overall acceptability by twenty (20) trained panellists, selected among departmental staffs, students and trained according to the American Meat Science Association guidelines (AMSA, 1995). Sensory evaluation was carried out in individual booths under controlled conditions of light, temperature and humidity. Prior to sample evaluation, all panellists were oriented in order to get familiarize with the scale attributes (Appearance, Tenderness, Taste, Flavour/Aroma and Juiciness, Overall Acceptability). Sensory qualities of the samples were evaluated after thawing and after cooking using a 7-point hedonic scale. Sensory scores were 7 for like extremely, 6 for like very much, 5 for like, 4 for neither like nor dislike, 3 for dislike, 2 for dislike very much, 1 for dislike extremely. All samples were served using petri dish. Sensory evaluation was accomplished at control, week 1 days, week 2, week 3, week 4, week 5, week 6 and week 7 respectively.

Statistical Analysis

Data collected were subjected to SAS Statistical package while DUNCAN multiple range test was used to differentiate means difference.

RESULTS AND DISCUSSION

Table 1: Physicochemical Properties of Beef Subjected to Cold Preservation

PARAMETERS	TO	T1	T2	T3	T4	T5	T6	P-VALUE
PH	6.05	5.89	5.62	5.50	5.47	5.31	5.29	0.05
WATER HOLDING CAPACITY	59.83^a	59.15^a	57.87^{ab}	56.50^{ab}	52.73^c	50.92^d	50.41^d	0.04
COOKING LOSS	33.10^a	33.82^{ab}	35.04 ^{b}	36.18^c	36.69^c	37.15^d	38.32^d	0.03

T0- Control with no cold temperature storage, T1- Week 1, T2- Week 2, T3- Week 3, T4- Week 4, T5- Week 5, T6- Week 6

According to Arifin *et al.* (2021), physicochemical properties of meat refers to the physical and chemical characteristics of meat. Table 1 shows physicochemical properties of beef subjected to cold preservation over a period of 6weeks. The result shows significant difference among the parameters measured, except the pH.

Water Holding Capacity (WHC) indicates the maximum level of moisture that muscle proteins can retain. It directly affects the color and texture of meat (Shariat Zadeh et al. 2019). In this study, it can be noticed that beef subjected to 1-3 weeks of cold preservation were statistically similar to the beef not subjected to cold preservation. It was also noted that as the preservation weeks increases, the WHC reduces, this can be as a result of freeze-thaw cycles. It was observed that as WHC increases, Ph increases. This is similar to the findings of Patinho *et al.* (2024). They observed a synergy between WHC and pH, in their study on assessment of beef sensory attributes and physicochemical characteristics. It was observed that beef with high WHC had higher pH values.

Cooking Loss (CL) measures the reduction in weight or volume of food during cooking process (Taşkıran *et al.,* 2020). It was observed that cooking loss significantly increased across the treatment. The lowest CL was seen on treatment that was not subjected to cold preservation. However, it was noted that treatments subjected to cold preservation had higher CL values. This trend could be as a result of enzymatic reaction by ionic sublimation which aids in disintegrating the myofibril protein and the connective tissue (Bruce et al., 2004).
Meat pH measures meat's acidity or alkalinity (King *et al.,* 2023). In this study, it was observed that pH was not significantly influenced across the treatments. However, it was noted that the control had higher pH values than the beef subjected to cold preservation. This implies that the control had a darker color than those subjected to cold preservation (Ribeiro *et al.* 2021).

Table 2: Sensory Attributes of Beef Subjected to Cold Preservation

PARAMETERS	T 0	T1	T2	T 3	T4	T5	T6	P- VALUE
APPEARANCE	5.90	5.80	5.70	5.40	5.50	5.30	5.30	0.47
TENDERNESS	4.10^{ab}	4.60^{ab}	4.90^{ab}	4.90^{ab}	5.10^{ab}	5.30^{a}	5.70^{a}	0.00
TASTE	5.30	6.10	5.00	5.80	5.40	5.60	4.90	0.05
FLAVOUR	4.30^{b}	5.40^{ab}	5.30^{ab}	5.30^{ab}	5.60^{ab}	6.00^{a}	6.40^{a}	0.00
JUICINESS	4.70	5.60	5.20	4.80	5.20	5.80	5.50	0.07
OVERAL ACCEPTABILITY	5.60	5.90	5.30	5.10	5.50	5.80	5.60	0.27

T0- Control with no cold temperature storage, T1- Week 1, T2- Week 2, T3- Week 3, T4- Week 4, T5- Week 5, T6- Week 6

Sensory Properties
The sensory properties of beef subjected to cold preservation over a period of 6weeks is presented in Table 2. Sensory properties of food are the characteristics of food that stimulate our senses as perceived by the senses of sight, smell, taste and touch (Ray, 2021). It was observed that the cold preservation did not significantly influence all parameters measured except for tenderness and flavour that were statistically different.
Flavor is the sensory impression of food or other substance as determined by the chemical senses of taste and smell (Ray, 2021). It was observed that the flavour of beef subjected to cold preservation were significantly similar among the treatments subjected to cold preservation, and significantly different from the control. This could be associated to some enzymatic activities that occur during cold preservation which enhance the meat's flavor over time. Aging process in beef enables enzymes break down proteins and fats to create more complex and desirable flavors (Xiong, 2023). Rahman et al. (2023) stated that cold preservation helps to improve meat flavour has it helps to slows down oxidation of fats and proteins in meat, which can help maintain its original flavor for a longer period compared to meat left at room temperature.
Warner et al. (2021), defines meat tenderness as the quality of meat gauging how easily it is chewed or cut. It was observed that the tenderness increases as the period of cold preservation increases, with T6 (week 6) having the highest value of 5.70, while the lowest value was observed from T0 (control). This is due to muscle proteins and connective tissue breakdown, which is a primary action of enzymes calpain and cathepsin, which become active at refrigerated temperatures, increasing tenderness over time.

CONCLUSION AND RECOMMENDATION

Cold preservation of beef at -18^{0}C did not affect the beef physical and sensory properties. The findings from this study revealed that sensory properties such as flavour, and tenderness can be improved when beef are subjected to cold preservation. However, constant temperature must be maintained throughout the preservation process in other to meet the consumers' preference for freshness in terms of the sensory meat quality.

REFERENCES

Arifin, N., Hanifah, N. F. M., & Yahya, H. N. (2021). Physicochemical Properties, Nutritional Composition and Sensory Acceptance of Chicken Meat Sausages with Chia Seed Powder Substitution. *Malaysian Journal of Science Health & Technology*, *7*(1), 34-42.

Bora, B., Arya, A., Rawat, B. S., & Rani, R. (2022). Evaluation of quality characteristics of meat and edible by products of indigenous native chicken: Uttarafowl and its cross.

Feng, Y. H., Zhang, S. S., Sun, B. Z., Xie, P., Wen, K. X., & Xu, C. C. (2020). Changes in physical meat traits, protein solubility, and the microstructure of different beef muscles during post-mortem aging. *Foods*, *9*(6), 806.

King, D. A., Hunt, M. C., Barbut, S., Claus, J. R., Cornforth, D. P., Joseph, P., ... & Weber, M. (2023). American Meat Science Association guidelines for meat color measurement. *Meat and Muscle Biology*, *6*(4).

Patinho, I., Cavalcante, C. L., Saldaña, E., Gagaoua, M., Behrens, J. H., & Contreras-Castillo, C. J. (2024). Assessment of beef sensory attributes and physicochemical characteristics: A comparative study of intermediate versus normal ultimate pH striploin cuts. *Food Research International*, *175*, 113778.

Rahman, M. M., Hashem, M. A., Azad, M. A. K., Choudhury, M. S. H., & Bhuiyan, M. K. J. (2023). Techniques of meat preservation-A review. *Meat Research*, *3*(3).

Ribeiro, F. A., Lau, S. K., Furbeck, R. A., Herrera, N. J., Henriott, M. L., Bland, N. A., ... & Calkins, C. R. (2021). Ultimate pH effects on dry-aged beef quality. *Meat science*, *172*, 108365.

Taşkıran, M., Olum, E., & Candoğan, K. (2020). Changes in chicken meat proteins during microwave and electric oven cooking. *Journal of Food Processing and Preservation*, *44*(2), e14324.

Warner, R., Miller, R., Ha, M., Wheeler, T. L., Dunshea, F., Li, X., ... & Wheeler, T. (2021). Meat tenderness: Underlying mechanisms, instrumental measurement, and sensory assessment. *Meat and Muscle Biology*, *4*(2).

Xiong, Y. L. (2023). The storage and preservation of meat: I—Thermal technologies. In *Lawrie's meat science* (pp. 219-244). Woodhead publishing.