



The Shelf-Life of Second-Collagen-Containing Meat and Meat Products Depends on DMSO

Ayshan Salmanova

Scientist at Sheki Regional Scientific Center, Azerbaijan National Academy of Science Azerbaijan, Sheki, Azerbaijan

ARTICLE INFO

Article History:

Received: 2024/2/27

Accepted: 2024/6/5

Keywords:

Dimethylsulfoxide (DMSO),

Meat products,

pH Degree,

Preservation,

Shelf-life.

DOI: 10.22034/FSCT.21.150.162

*Corresponding Author E-Mail:
salmanovaayshan5@gmail.com

ABSTRACT

One of the most popular foods consumed worldwide is meat. According to its high protein and moisture content, it is highly susceptible to spoiling itself. Preservatives are therefore necessary to maintain its quality and lengthen its shelf life. The objective of this assessment is to draw attention to a certain technique for extending the shelf life of meat products. This study examined the shelf-life of secondary collagen-containing raw materials treated with varied concentrations of DMSO in terms of pH degree and total ion concentration (TIC). For this purpose, six meat samples were treated with different concentrated DMSO solutions under room temperature and aerobic conditions for 7 days. The outcomes of the experiment proved that meat treated with DMSO had a lower pH, C degrees, and a longer shelf life when compared to the control.

1- Introduction

The edible portion of an animal's skeletal muscle that was healthy at the time of slaughter is identified as meat. Meat has a variety of secondary components, including vitamins, enzymes, colors, and flavoring compounds, in addition to its four main chemical constituents: water, protein, lipids, and carbohydrates. Meat's distinct texture, flavor, color, and nutritional value are derived from the relative amounts of these components. Any single symptom or series of symptoms of overt microbial activity, expressed by changes in meat odor, flavor, or appearance is the definition of meat spoilage [1].

One of the main goals in the food industry is to extend the shelf life of food products, mainly meat, and meat products with a high caloric value, while maintaining the quality and nutritional value, under organoleptic and hygienic standards. Meat and meat-related products for human consumption are obtained after cattle slaughter. Meat preservation refers to the continuous struggle against microorganisms that cause deterioration and health risks [2].

Meat is a perishable food product that has been consumed since antiquity. One of the earliest known techniques of preserving meat is processing it with certain means [3].

The shelf life of meat and meat products is the period that is useful before it was spoiled. Environmental factors such as pH level, temperature, and storage time are among the main factors that can affect it [4]. Any change

in the quality of food that makes it less palatable, or even poisonous is referred to as spoilage; these changes can also affect the meal's taste, fragrance, texture, or appearance [5]. The short shelf-life is based on differences between pH indicators [6]. Microorganisms can multiply in a certain pH range. pH has a major impact on food microbiological purity and shelf life [7]. So, it is apparent that pH has a significant impact on shelf life [8]. Considering all of the variables, we can conclude that pH is the only factor that significantly increases shelf life [9].

Dimethylsulfoxide (DMSO) is an aprotic solvent that can increase the permeability of lipid membranes and cause cell fusion and differentiation. When wood pulp is processed, dimethyl sulfoxide [DMSO] is produced as a byproduct. Because of its strong capacity to increase skin permeability, DMSO is frequently utilized in topical or transdermal drug delivery. It can penetrate quickly throughout cellular barriers and biological membranes as well as human skin, obviously by altering lipid packing and also producing structural drawbacks in the bilayer [10], [11].

Because of its highly polar domain as well as two apolar groups, DMSO ((CH₃)₂SO) is an amphipathic molecule that dissolves in both organic and aqueous solutions (**Fig. 1**). These physical and chemical characteristics make DMSO a highly effective solvent for substances that are insoluble in water and a hydrogen-bound disruptor [12]. Additionally, DMSO prevents the chemotaxis process in meat and

meat products. It is well known that chemotaxis, which shifts cells into growth-friendly niches, enables mobile cells to react swiftly to environmental stimuli [13].

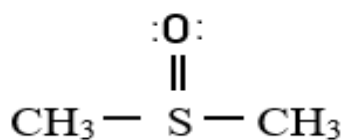


Figure 1: Chemical configuration of DMSO

Taking into consideration economic and human health, it is important to find effective and fast methods and tools to determine the causes of deterioration and, at the same time, to initiate measures to eliminate the problems and thus delay the deterioration to a minimum. The primary goal of this research is to increase shelf life by reducing the pH. The development of shelf-stable and ready-to-eat (RTE) products would not only save energy but also would additionally contribute significantly to the future development of the meat manufacturing industry [14].

2-MATERIALS AND METHODS

2.1 Chemicals

Pure DMSO (dimethyl sulfoxide) (99.9%) was purchased from Sigma Aldrich. Each day, it is used by diluting distilled water.

2.2 Preparation of samples

The pH and TIC indicators of meat were measured in a homogenous meat-water mixture using a pH meter [15]. For this procedure, the meat sample was mixed with distilled water and the pH of the obtained mixture was determined with S220-KIT Seven Compact pH/ion meter (Mettler Toledo).

The product used for the study was obtained from a local meat market, collected from only one animal to minimize errors (after 12 hours), wrapped in air-tight polyethylene plastic, and transported to the laboratory. The treatment process described below was chosen based on the experimental consistency observed in preliminary studies. The tripe undergoes cleaning under the subsequent rule: Separation of fat tissue, removal of contents, scalding - short-term thermal treatment of the tripe's inner and exterior surfaces with hot water, clearing out the mucous membrane, chilling under running water. The tripe was ground down in a grinder with a 2-3mm hole diameter [13].

2.3 Experimental part

For the study, six samples (including one control) were prepared, each containing 100 g of meat. To prepare DMSO solutions, 10 ml of distilled water and 1 ml, 0.8 ml, 0.5 ml, 0.3 ml, and 0.1 ml of DMSO for each solution were used, solutions with different concentrations of 1,18 mol/l, 0,93 mol/l, 0,571 mol/l, 0,39 mol/l, 0,01 mol/l were prepared accordingly. The meat samples were thoroughly mixed once using a glass rod to ensure homogeneity before and

after mixing with the DMSO solution. The samples were stored for 7 days at room temperature under aerobic conditions and then compared with the previous and subsequent pH and C indicators. (To reduce errors, the same experiment was performed four times.)

3. pH and TIC MEASUREMENTS in MEAT SAMPLES

The pH and TIC of the samples were measured, with significant differences noted for all samples in comparison to the control samples. pH₁ was initially 7.05 and TIC₁ was 1.54 mol/l for the first sample (control), but at the end of the experiment, these values changed to 7,96 and 8,2 mol/l accordingly. For the last sample (sample N6), both degrees also differentiated as predicted: on the last day of the experiment, pH₆

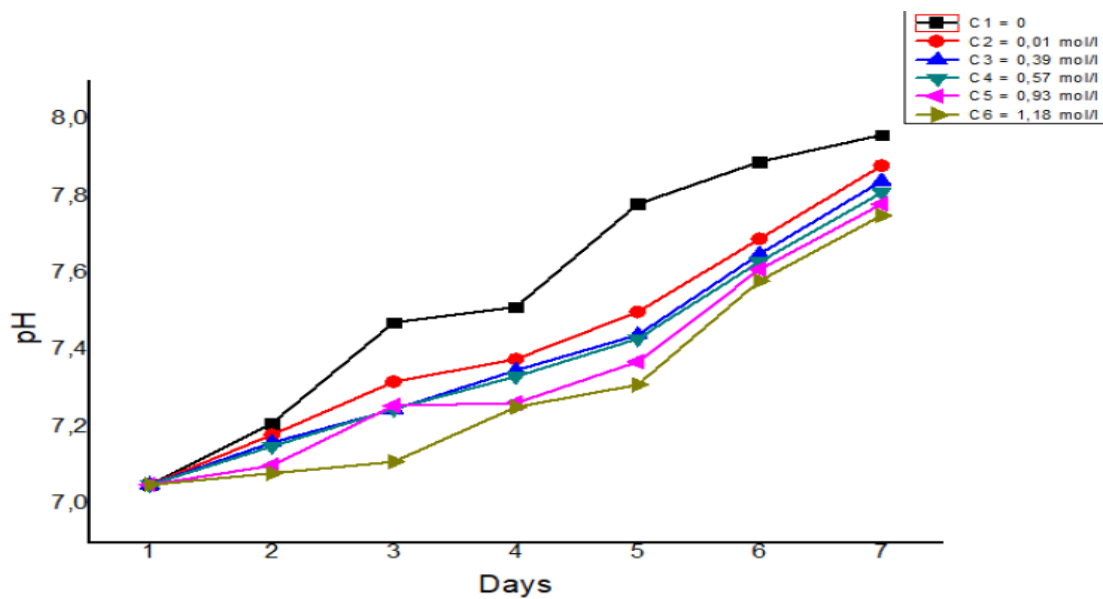
and TIC₆ degrees were 7.75 and 5.38 mol/l, respectively.

4-RESULT AND DISCUSSION

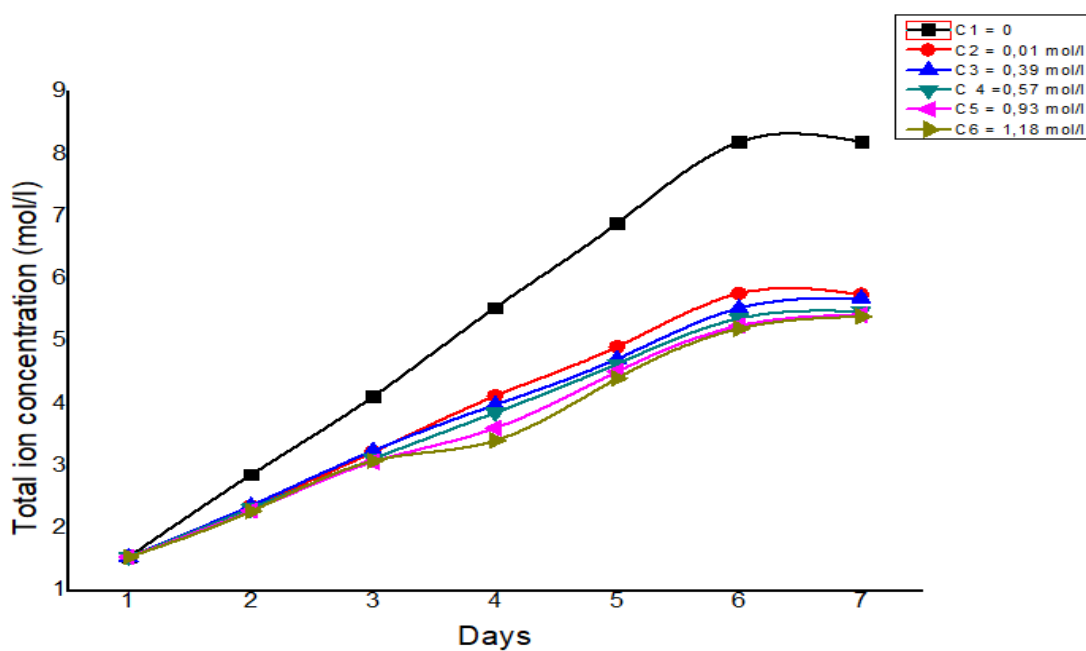
According to the measurements, it was determined that at the end of the investigation, samples treated with 1.18 mol/l DMSO solution performed better in terms of both pH and TIC indicators (**Figure 1. a and b**). As a result, the pH was 0.21 units less and the TIC was 2.82 mol/l less in comparison to the control sample (Table 1). Because DMSO has a minimal acidic characteristic [16], it tends to reduce the pH of the samples partially which does not allow for a reduction in shelf life. In general, as the DMSO concentration increased, the suggested indications improved, the degradation process weakened, and the shelf life increased.

Table 1: Variation of pH and C parameters of secondary-meat products depending on DMSO solutions for 7 days

Samples N	DMSO Solutions [mol/l]	Mean pH	Mean TIC [mol/l]
1	1,18	7,75	5,38
2	0,93	7,78	5,43
3	0,57	7,81	5,49
4	0,39	7,84	5,60
5	0,01	7,88	5,73
6	Final Control	7,96	8,2
7	Initial Control	7,05	1,54



a)



b)

Figure: 2 Dependence of pH (a) and C (b) prepared 6 meat samples on DMSO concentration

5-CONFLICT of INTEREST

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

6-ETHICS

There are no ethical issues with the publication of this manuscript

7-REFERENCES

- [1] Anne D. Lambert¹, James P. Smith¹. And Karen L. DOODS. Shelf Life Extension and Microbiological Safety of Fresh Meat

- Review, 8(4), 267–297, 1991.
[https://doi.org/10.1016/S0740-0020\[05\]80002-4](https://doi.org/10.1016/S0740-0020[05]80002-4)
- [2] J. H. Chen, Y. Ren, J. Seow, T. Liu, W. S. Bang, and H. G. Yuk. *Intervention Technologies for Ensuring Microbiological Safety of Meat: Current and Future Trends*, 14(2), 712-749, 2012.
<https://doi.org/10.1111/j.1541-4337.2011.00177.x>
- [3] S. Ahmad, A. Anzar, A. K. Srivastava, P. K. Srivastava. *Effect of Curing, Antioxidant Treatment, and Smoking of Buffalo Meat on pH, Total Plate Count, Sensory Characteristics, and Shelf Life During Refrigerated Storage*, 14(3), 139-150, 2007. <https://doi.org/10.1081/JFP-200048028>
- [4] Elisabeth Borch, Marie-Louise Kant-Muemansb, Ylva Blixt. Bacterial spoilage of meat products and cured meat, 18(2), 103-120, 1996.
[https://doi.org/10.1016/0168-1605\[96\]01135-X](https://doi.org/10.1016/0168-1605[96]01135-X)
- [5] Ashie, I. N. A., Smith, J. P., Simpson, B. K., & Haard, N. F. *Spoilage and shelf-life extension of fresh fish and shellfish. Critical Reviews in Food Science and Nutrition*, 3(1-2), 87–121, 1996.
<https://doi.org/10.1080/10408399609527720>
- [6] Allen, C., Russell, S., & Fletcher, D. *The relationship of broiler breast meat color and pH to shelf-life and odor development. Poultry Science*, 76(7), 1042–1046, 1997.
<https://doi.org/10.1093/ps/76.7.1042>
- [7] J. Nketsia-Tabiri, A. Adu-Gyamfi, F. Apea Bah. *Irradiation of Prepared Meals for Microbiological Safety and Shelf Life extension*, 19-24, 385, 2009
DOI: [10.4314/gjas.v39i1.2122](https://doi.org/10.4314/gjas.v39i1.2122)
- [8] Holmer, S. F., McKeith, R. O., Boler, D. D., Dilger, A. C., Eggert, J. M., Petry, D. B., Killefer, J. *The effect of pH on shelf-life of pork during aging and simulated retail display. Meat Science*, 82(1), 86–93, 2009.
<https://doi.org/10.1016/j.meatsci.2008.12.008>
- [9] Cariso, Alberto R. *An investigation of factors contributing to the extended storage life of meat products for the tropics: a thesis presented in partial fulfillment of the requirements for the degree of Master of Technology in Meat Technology at Massey University*, 147, 1987.
<http://hdl.handle.net/10179/14246>
- [10] Notman, R., Noro, M., O'Malley, B., & Anwar, J. Molecular Basis for Dimethylsulfoxide [DMSO] Action on Lipid Membranes. *Journal of the American Chemical Society*, 128(43), 2006.
<https://doi.org/10.1021/ja063363t>
- [11] Collucci, M., Maione, F., Bonito, M., Piscopo, A., Digiannario, A., & Pieretti, S. New insights of dimethyl sulphoxide effects (DMSO) on experimental in vivo models of nociception and inflammation. *Pharmacological Research*, 57(6), 419–425, (2008)
<https://doi.org/10.1016/j.phrs.2008.04.004>
- [12] Santos, N. C., Figueira-Coelho, J., Martins-Silva, J., & Saldanha, C. Multidisciplinary utilization of dimethyl sulfoxide:

pharmacological, cellular, and molecular aspects. *Biochemical Pharmacology*, 65(7), 1035–1041, 2003. [https://doi.org/10.1016/S0006-2952\[03\]00002-9](https://doi.org/10.1016/S0006-2952[03]00002-9)

- [13] Yusif Shukurlu, Ayshen Salmanova, Madina Shrifova, *Biotechnological Aspects of the Modification of Secondary Collagen-Containing Raw Materials -Tripe for the Production of Cost-Effective Functional Meat Products*, 9, 2022 <https://doi.org/10.1590/fst.85521>
- [14] Ahmad, S., & Srivastava, P. K. *Quality and shelf life evaluation of fermented sausages of buffalo meat with different levels of heart and fat. Meat Science*, 75(4), 603–609, 2007. <https://doi.org/10.1016/j.meatsci.2006.09.008>
- [15] H. Korkeala, O. Maiki-Petaiys, T. Alanko. Determination of pH in Meat, 18(2), 121–132, 1986. [https://doi.org/10.1016/0309-1740\(86\)90088-4](https://doi.org/10.1016/0309-1740(86)90088-4)
- [16] MacGregor, W. S., *THE CHEMICAL AND PHYSICAL PROPERTIES OF DMSO*. *Annals of the New York Academy of Sciences*, 141 (1 Biological Ac), 3–12, 1967. [10.1111/j.1749-6632.1967.tb34860.x](https://doi.org/10.1111/j.1749-6632.1967.tb34860.x)