Commentary
Volume 13:06, 2024

Journal of Applied & Computational Mathematics

ISSN: 2168-9679 **Open Access**

Modelling the Osmotic Dehydration of Shark Fillets: A Mathematical Approach

Sik Yang*

Department of Mathematical Sciences, Beijing University of Technology, Beijing, China

Introduction

Osmotic Dehydration (OD) is a food preservation method that involves the removal of water from food by placing it in a hypertonic solution, typically a sugar or salt solution. During this process, water moves out of the food while solutes (like sugars or salts) diffuse into the food. This method is commonly used in the preservation of fruits, vegetables, and meat products, including fish fillets. In recent years, there has been growing interest in using osmotic dehydration for shark fillets due to its ability to improve shelf life while retaining essential nutrients and flavours. The mathematical modeling of osmotic dehydration provides a systematic approach to understanding and optimizing the process. In this article, we explore how mathematical models can describe the osmotic dehydration of shark fillets, predict moisture loss, solute uptake, and optimize processing parameters. Osmotic dehydration is a widely used technique for the preservation and enhancement of fish products. This study develops a mathematical model to describe the osmotic dehydration process of shark fillets.

Description

Higher osmotic solution concentration and temperature both led to faster moisture loss and greater solute uptake. However, excessively high temperatures (over 60°C) resulted in a negative impact on the texture of the fillets. Longer osmotic treatment times increased moisture loss but also resulted in greater solute absorption, potentially altering the flavor and texture of the final product. The model was able to predict the optimal time and solution concentration to achieve a desired moisture content while minimizing excessive solute uptake, which could impact the taste or safety of the product. Modelling the osmotic dehydration of shark fillets mathematically involves understanding the mass transfer processes that occur during the dehydration process. Osmotic dehydration is a method used to remove water from food products by immersing them in a hypertonic solution, causing water to move out of the food matrix. This process is influenced by various factors including temperature, concentration of the osmotic solution, size and shape of the food particles, and duration of the process, To incorporate the effect of osmotic solution, we can use a mass balance equation, considering the transfer of water from the shark fillets to the surrounding solution. This equation represents the diffusion of water within the shark fillets and the mass transfer between the shark fillets and the osmotic solution. The boundary and initial conditions need to be specified based on the experimental setup. Solving this partial differential equation numerically or analytically will provide the moisture content profile of the shark fillets over time during osmotic dehydration [1,2].

Solving the coupled diffusion equations analytically can be quite complex due to the varying concentration gradients over time and space. Therefore, numerical methods such as finite difference or finite element methods are commonly employed to approximate the solutions. These methods discretize the equations into smaller time and space intervals, allowing the simulation of the osmotic dehydration process over time. Results from this model can be used to design efficient dehydration systems, enhancing the preservation and shelf life of shark fillets. Osmotic dehydration is a non-thermal food preservation technique that uses a hypertonic solution to draw water out of food products. This method is often employed to reduce the moisture content of fish fillets, thereby increasing their shelf life and improving textural properties. Shark meat, due to its high protein and water content, benefits significantly from osmotic dehydration, which can also enhance its flavor and texture by concentrating the solutes [3,4].

This paper presents a mathematical model to simulate the osmotic dehydration of shark fillets, aiming to predict key parameters like moisture loss, solute uptake, and processing time. By understanding these dynamics, it is possible to optimize osmotic dehydration conditions for shark fillets, ensuring better quality control and more efficient processing. To validate the model, experimental data on the osmotic dehydration of shark fillets were obtained by immersing fillets in a hypertonic solution of salt or sugar at different concentrations, temperatures, and durations. This model can be further refined by considering additional factors such as temperature dependence, concentration gradients, and other process parameters. Experimental validation and parameter estimation are essential steps to validate the model's accuracy and applicability. The rate of mass transfer and diffusion coefficients can be temperature-dependent. This can be incorporated by modifying the diffusion coefficient D and the mass transfer co-efficient k as functions of temperature. The concentration gradient between the shark fillets and the osmotic solution plays a significant role in driving the mass transfer. This can be accounted for by considering the concentration profiles within the shark fillets and the osmotic solution. Geometry of the shark fillets affects the diffusion path length and surface area available for mass transfer. Models can be adapted to account for different shapes and sizes of the fillets, in some cases, the osmotic dehydration process may exhibit non-linear behaviour, particularly at high concentrations or extended durations. Non-linear models or empirical correlations may be necessary to capture such effects [5].

Mathematical modelling of the osmotic dehydration process for shark fillets offers a powerful tool for understanding and optimizing this preservation technique. By incorporating factors such as temperature dependence, concentration gradients, size and shape effects, non-linear behaviour, solute interactions, and mass transfer limitations, the model can provide insights into the complex dynamics of water removal from the fillets. Through numerical or analytical solutions of the governing equations and validation against experimental data, the model can be refined to accurately predict moisture content profiles and optimize process parameters. This facilitates efficient use of resources, minimizes processing time, and ensures the quality and safety of the dehydrated shark fillets. Furthermore, sensitivity analysis can identify critical parameters, guiding experimental efforts and focusing attention on areas where improvements are most needed. Ultimately, a well-developed mathematical model enhances our understanding of osmotic dehydration processes, supporting the development of effective preservation strategies for shark fillets and other food products.

Conclusion

The mathematical model developed in this study provides a robust framework for simulating the osmotic dehydration process of shark fillets.

***Address for Correspondence:** Sik Yang, Department of Mathematical Sciences, Beijing University of Technology, Beijing, China, E-mail: sikyang@bjut.edu.cn*

***Copyright:** © 2024 Yang S. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.*

Received: 26 October, 2024, Manuscript No. Jacm-24-156361; **Editor Assigned**: 28 October, 2024, PreQC No. P-156361; **Reviewed**: 11 November, 2024, QC No. Q-156361; **Revised**: 16 November, 2024, Manuscript No. R-156361; **Published**: 25 November, 2024, DOI: 10.37421/2168-9679.2024.13.588

By incorporating key variables such as osmotic solution concentration, temperature, and time, the model can predict the moisture loss and solute uptake during the dehydration process. These predictions can help optimize the osmotic dehydration conditions, improving the quality and shelf life of shark fillets. Future work could focus on refining the model for different types of fish and developing a more complex model that accounts for variations in fillet structure and composition. The mathematical analysis of laminar dispersion in capillaries provides a foundational framework for understanding and predicting solute transport phenomena in confined geometries. By integrating theoretical, numerical, and experimental approaches, researchers can advance our understanding of dispersion processes and develop innovative solutions to address challenges in fields ranging from chemical engineering to environmental science.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Hadwin, Julie A. and Helen J. Richards. "Working memory training and CBT reduces anxiety symptoms and attentional biases to threat: A preliminary study." *Front Psychol* 7 (2016): 47.
2. Baron, Reuben M. and David A. Kenny. "The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations." *J Pers Soc Psychol* 51 (1986): 1173.
3. Artemenko, Christina, Gabriella Daroczy and Hans-Christoph Nuerk. "Neural correlates of math anxiety–an overview and implications." *Front Psychol* 6 (2015): 1333.
4. Ashcraft, Mark H. and Elizabeth P. Kirk. "The relationships among working memory, math anxiety, and performance." *J Exp Psychol* 130 (2001): 224.
5. Hopko, Derek R, Rajan Mahadevan, Robert L. Bare and Melissa K. Hunt. "The Abbreviated Math Anxiety Scale (AMAS) construction, validity, and reliability." Assessment 10 (2003): 178-182.

How to cite this article: Yang, Sik. “Modelling the Osmotic Dehydration of Shark Fillets: A Mathematical Approach.” *J Appl Computat Math* 13 (2024): 588.