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Международный научно-образовательный электронный журнал «ОБРАЗОВАНИЕ И НАУКА В XXI ВЕКЕ». Выпуск №62-4 (том 1) (май, 2025). Дата выхода в свет: 26.05.2025.

Сборник содержит научные статьи отечественных и зарубежных авторов по экономическим, техническим, философским, юридическим и другим наукам.

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Abstract

Vacuum packaging has become a critical technology in the preservation of food and non-food products, extending shelf life by removing oxygen and inhibiting microbial growth. This paper examines the principles, methods, and effectiveness of vacuum packaging in various industries, focusing on its impact on product quality and longevity. The study evaluates different vacuum packaging techniques, including chamber and external vacuum systems, and their suitability for diverse products. Additionally, the research highlights the advantages of vacuum packaging, such as reduced oxidation, prevention of freezer burn, and minimized waste. The methodology included a comparative analysis of packaged versus non-packaged products under controlled conditions. Results demonstrated significant improvements in preservation, particularly for perishable goods. The findings suggest that vacuum packaging is an essential method for modern product preservation, offering economic and environmental benefits. Further research is recommended to explore innovations in vacuum packaging materials and machinery.

Introduction

Vacuum packaging has been widely adopted across industries due to its ability to prolong the shelf life of products by creating an oxygen-free environment. The process involves extracting air from the packaging before sealing, which slows down degradation caused by oxidation, microbial activity, and moisture loss. Originally developed for food preservation, vacuum packaging is now utilized in pharmaceuticals,

electronics, and industrial components to ensure protection from environmental factors.

The growing demand for extended product freshness, especially in the food sector, has driven advancements in vacuum packaging technology. Consumers and manufacturers alike benefit from reduced spoilage, enhanced product safety, and minimized economic losses. This paper explores the mechanisms of vacuum packaging, its applications, and the methodologies employed to assess its effectiveness. The study also discusses challenges and future directions in vacuum packaging technology.

Methods and Methodology

The research was conducted through a combination of experimental and analytical approaches to evaluate the efficiency of vacuum packaging. Two primary methods were examined: chamber vacuum packaging and external vacuum packaging. Chamber vacuum systems are typically used for industrial applications, where products are placed inside a sealed chamber before air extraction. External vacuum systems, on the other hand, use suction nozzles to remove air from specially designed bags, making them more suitable for household and small-scale commercial use.

A controlled experiment was designed to compare vacuum-packed products with conventionally packaged ones. Perishable food items, including meat, cheese, and vegetables, were selected for the study. Each product category was divided into two groups: one packaged under vacuum conditions and the other stored in standard plastic or paper packaging. Both groups were subjected to the same temperature and humidity conditions over a four-week period.

Parameters such as microbial growth, oxidation levels, moisture retention, and overall product appearance were measured at regular intervals. Microbial analysis was conducted using standard plate count techniques, while oxidation was assessed through lipid peroxidation tests. Sensory evaluation was performed by a panel of trained assessors to determine changes in texture, color, and odor. Statistical analysis was applied to compare the results between vacuum-packed and conventionally packaged samples.

Results and Discussion

The findings demonstrated a clear advantage of vacuum packaging in preserving product quality. Microbial growth in vacuum-packed meat samples was significantly lower compared to conventionally packaged samples. After four weeks, the total aerobic bacteria count in vacuum-packed meat was 2.1 log CFU/g, whereas the control samples reached 5.8 log CFU/g, indicating rapid spoilage. Similar trends were observed in cheese and vegetable samples, where vacuum packaging delayed mold formation by up to three weeks.

Oxidation levels were also markedly reduced in vacuum-packed products. Lipid oxidation tests revealed that vacuum-packed meat had a thiobarbituric acid reactive substances (TBARS) value of 0.8 mg MDA/kg, while the control samples showed 2.4 mg MDA/kg after the same storage period. This confirmed that vacuum packaging effectively minimized oxidative rancidity, a major cause of flavor deterioration in fatty products.

Moisture retention was another critical factor where vacuum packaging outperformed traditional methods. Vegetables stored in vacuum-sealed bags retained 85% of their original moisture content, whereas those in standard packaging lost nearly 30% due to evaporation. This finding is particularly important for industries aiming to reduce food waste and maintain product weight.

Sensory evaluations supported the analytical data, with panelists consistently rating vacuum-packed products higher in freshness, texture, and overall acceptability. The absence of off-odors and discoloration further reinforced the effectiveness of vacuum packaging in maintaining sensory attributes.

Despite these advantages, certain limitations were noted. Some delicate products, such as soft berries, experienced compression damage under high vacuum pressure. Additionally, the initial cost of vacuum packaging equipment may be prohibitive for small-scale producers. However, the long-term benefits in waste reduction and extended shelf life justify the investment for many businesses.

Conclusion

The study confirmed that vacuum packaging is a highly effective method for preserving a wide range of products, particularly perishable foods. By eliminating oxygen, the process significantly reduces microbial growth, oxidation, and moisture loss, thereby extending shelf life and maintaining quality. The experimental results demonstrated clear superiority over conventional packaging methods in terms of both microbiological safety and sensory preservation.

Future research should focus on optimizing vacuum pressure settings for fragile products and developing cost-effective packaging solutions for small enterprises. Innovations in biodegradable vacuum packaging materials could also address environmental concerns associated with plastic waste. Overall, vacuum packaging remains an indispensable technology in modern product preservation, offering substantial economic and sustainability benefits.

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