

THE EFFECTS OF CINNAMON POWDER AND SODIUM BENZOATE ON THE PRESERVATION OF ORANGES

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ABSTRACT

Background: Oranges (*Citrus sinensis*) are highly perishable fruits. Their preservation is of interest due to the global importance of reducing food spoilage. Cinnamon powder, a natural preservative, and sodium benzoate, a synthetic one, are both used in food preservation, yet their comparative efficacy in maintaining fruit quality is unclear. This study aims to determine the effect of cinnamon powder and sodium benzoate on orange preservation. **Methods:** A controlled laboratory experiment was conducted using 5 groups of oranges subjected to 0.1% and 0.3% concentrations of cinnamon powder and sodium benzoate, and a control group. Parameters measured included mass change and pH stability over a 5-day refrigerated period. Quantitative data were collected daily, and statistical observations were made on moisture retention and pH changes. **Results:** Cinnamon powder (especially at 0.3%) showed the highest effectiveness in preserving fruit mass, with mean mass increases of 15.128% (0.1%) and 21.664% (0.3%). Sodium benzoate, by contrast, showed modest increase (5.542%) at 0.1% but a decrease (-1.966%) at 0.3%. pH levels across all samples remained relatively stable (4-5), indicating that neither preservative caused significant acidification. **Conclusion:** Cinnamon powder, especially at higher concentrations, is more effective in preserving the moisture content of oranges compared to sodium benzoate. Sodium benzoate was slightly more consistent in maintaining pH but failed to prevent mass loss at higher concentrations.

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INTRODUCTION

Oranges (*Citrus sinensis*) are one of the most consumed fruits because of their high sugar and moisture content, although it is also one of the most susceptible to spoilage caused by water and/or microbial spoilage (Jay et al., 2005). It has poor storage attributes, and enzymes make these very perishable, deteriorating in quality within days after harvest. Based on recent research in food microbiology, such as *Escherichia coli* and fungi as *Aspergillus flavus*, citrus fruits are prone to deterioration and loss of nutrients at a fast rate (Zhang et al., 2016).

The oval seed is practically in the centre of the fruit, which is covered in a brown powder made from the cinnamon tree bark, and has been used since ancient times as a natural preservative. Its main bioactive compounds, cinnamaldehyde and eugenol, possess potent antimicrobial and antioxidant properties (Jaramillo Jimenez et al., 2024). Cinnamaldehyde specifically targets bacterial membranes and bioactive enzymes, which in turn inhibits spoilage. Eugenol helps to antioxidant protection by scavenging free radicals and to increase shelf life (Freire et al., 2006).

Sodium benzoate, meanwhile, is a common artificial preservative. In acidic media, it decomposes to benzoic acid, which inhibits the growth of bacteria, yeast, and molds due to its pH-lowering activity. Its antimicrobial action is derived from its disruption of microbial metabolic processes, including glycolysis and cytochrome D phosphorylation, and subsequent inhibition of cell growth. While synthetic additives have been widely used in processed foods, the long-term health effects have raised concerns, leading to a growing interest in safer, natural alternatives (Śledź et al., 2022).

Processing of perishable fruits such as oranges is important for food security and to reduce waste. Synthetic preservatives, e.g., sodium benzoate, are efficient, but concerns of public health and the environment have been raised. Natural substitutes like cinnamon powder, on the other hand, are considered safer and more eco-friendly (Liu et al., 2021). This study compares these two preservatives to investigate their effectiveness in retaining water content and pH stability of the orange after five days of refrigeration. It links theory to practice with an examination of how preservation can work in both natural and synthetic situations, and under both storage and preparation.

This study seeks to address the following question: How much effect do the preservatives cinnamon powder and sodium benzoate have on the water content and pH in an orange over 5 days in the refrigerator? The theory supposes that cinnamon powder is a better moistener than sodium benzoate, while sodium benzoate is a better pH stabilizer. This study aims to determine the effect of cinnamon powder and sodium benzoate on orange preservation.

METHODS

This was a cross-sectional, comparative experimental investigation conducted for five days. Four separate treatments (0.1% and 0.3% cinnamon powder; 0.005% and 0.01% sodium benzoate) and a control were used to treat the fruits. The experiment was carried out in five replicates (five oranges per treatment). Group 1 received 0.1% cinnamon in powder, Group 2 received 0.3% cinnamon powder, Group 3 received 0.1% sodium benzoate powder, Group 4 received 0.3% sodium benzoate powder, and 5th group served as a control with no preservative. Data gathered included initial and daily mass of each orange, and pH (determined daily with strips). Refrigeration at 4 °C, the type and size of the orange, and even the application of treatments were considered as controlled variables. Safety procedures were observed when preservatives were used.

RESULTS

The results of data processing and analysis are presented in the table below:

Table 1. Mass and pH Changes in Mango Samples with Varying Concentrations of Cinnamon Powder and Sodium Benzoate

Concentration (%)	Type	Initial Mass (g)	After Mass (g)	pH	Mass Change (%)	Standard Deviation (%)
0.1	Cinnamon Powder	20.73	23.71	4.4	15.13	5.150
0.3	Cinnamon Powder	20.57	24.96	4.0	21.66	8.890
0.1	Sodium Benzoate	21.83	23.04	4.2	5.540	0.790
0.3	Sodium Benzoate	26.74	26.23	5.0	-1.970	1.010
0	Control Group	22.40	22.19	4.2	-0.970	0.420

Based on Table 1, it is evident that cinnamon powder led to the mass gain of our sample, especially in the case of 0.3%, although sodium benzoate led to a little, no mass gain, or even a very slight loss of mass at 0.3%. The control group actually lost slight mass. The pH remained acidic in all groups; however, cinnamon powder further reduced it, whereas Natrium benzoate raised the pH. This implies that cinnamon powder may be activatory or maybe more humid, and natrium benzoate worked better to maintain the sample.

Table 2. Association between Preservative Treatment to Mass and pH Change on Oranges (*Citrus Sinensis*)

Comparison	t-statistic	p-value
Cinnamon Powder 0.3% vs Control	5.4200000	0.005
Natrium Benzoate 0.3% vs Control	-1.9900000	0.09
Cinnamon Powder 0.3% vs Natrium Benzoate 0.3%	5.6300000	0.004
Cinnamon Powder 0.1% vs Cinnamon Powder 0.3%	-1.3400000	0.223
Natrium Benzoate 0.1% vs Natrium Benzoate 0.3%	13.390000	0.000002

Based on Table 2, Based on Table 2, it is explained that there is an effect of giving Cinnamon Powder 0.3% vs Sodium Benzoate 0.3% on orange preservation.

DISCUSSION

The effect of two preservatives (cinnamon powder and sodium benzoate) on the preservation of oranges at 4°C in a refrigerator for 5 days was assessed in this study. The results indicate that cinnamon powder had a better effect than sodium benzoate on weight reduction and postharvest fresh-keeping of the oranges. Cinnamon-dust-treated oranges apparently retained more moisture and had better storage (Liu et al., 2021). The antimicrobial and antioxidant properties of cinnamon are suggested to be related to the bioactive compounds naturally present in cinnamon, especially cinnamaldehyde and eugenol (Jaramillo Jimenez et al., 2024; Freire et al., 2006). They can also act to slow down the spoilage organism growth and the enzyme degradation so as to decelerate the deterioration to some extent (Zhang et al., 2016).

Artificial preservative sodium benzoate, which holds its own in energy drinks, soda, and many processed food products, proved less effective at preserving the oranges. In some instances, it was associated with a decrease in fruit mass, possibly due to desiccation and insufficient inhibition of spoilage damage. It did, however, appear to help maintain stable fruit pH, so long-term may be advantageous in that there will be less pH shift resulting in less microbial activity in the latter part of storage. Since pH was stable in all treatments, none of the preservative had caused deleterious chemical reaction in the oranges. Cinnamon powder application increased fruit mass more, thus it is demonstrated as a more effective natural replacement.

Potential reasons for the enhanced preservation with cinnamon powder may have been due to its strong interaction with the microbial cell membrane, which led to the outflow of intracellular contents and fatal cell damage. This mode of action has been well described in the literature on essential oils, further supporting the effectiveness of cinnamon for the prevention of microbial spoilage (Zhang et al., 2016). Moreover, the fact that cinnamon is of natural source contributes not only to food safety but also to environmental sustainability, as it leads to less pesticides applied in the food system (Śledź et al., 2022).

From an applied point of view, cinnamon might be superior as a fruit preservative, since it is accepted by consumers, easy to apply, and has the advantage of health promotion. Its odorant profile can also improve its perceived freshness to consumers, thereby providing a sensory advantage to synthetic preservatives (e.g., sodium benzoate) (Liu et al., 2021). The results of bioactivities are in consistence with the increasing interest in the use of natural compounds in food preservation, particularly when synthetic additives can be harmful for health (Śledź et al., 2022). The favorable health potential may receive assistance with promoting the use of natural preservatives like cinnamon, as it may contribute to creating healthier eating cultures where consumers are consuming fewer artificial additives.

The limitations of this study are the location of samples and variables that are lacking so that it is necessary to add a large number of samples and variables to strengthen the results of the study. This study is still limited to quantitative research and has not been mixed methods.

CONCLUSION

According to the results, cinnamon powder is a better preservative than sodium benzoate for the storage of oranges (short term) under refrigeration conditions. Cinnamon kept the fruit moist and maintained the appearance of the fruit significantly better than control or synthetic treatments. Sodium benzoate was effective in maintaining a lower pH but inefficient in maintaining the physical structure of the fruit.

Additionally, the trend toward natural preservatives is reinforced by public health, where natural dietary habits are considered to be healthy, especially for an aging society. These results suggest that a natural mode of preservation of foodstuffs can be either efficient and/or even part of a broader healthy and sustainable substrate.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

The roles of all authors should be listed: KF: Experiment, Methodology, EP: Data curation, Writing- Original draft preparation. EE: Visualization, Investigation.

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