Mango peels disinfection: its impact on microbiological safety, phytochemical composition and antioxidant activity

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Introduction

It is estimated that **15-25 million tonnes of mango peels and stones** are produced annually. The incineration or deposition of these by-products in landfills represents a **severe environmental problem**.

Previous studies showed that mango peels had a high potential to develop **food ingredients or natural additives** with high fiber and phenolic compounds content.

Usually, mango peel processing into food ingredients/additives starts with a **disinfectant washing**. **Sodium hypochlorite (SH)** and **peracetic acid (PAA)** are the most used disinfectants for washing food products. However, until now, the effects of washing with SH or PAA on mango peels' composition and properties have been unknown. This study aims to fill this lack of knowledge.

Methodology

Two Box-Behnken Designs were performed, one for **SH** and the other for **PAA**.

Three independent factors with 3-levels each were considered:
- Food product to disinfectant solution ratio **(X_A):** 1:1, 1:5, 1:10 (kg:L)
- SH or PAA concentration **(X_B):** 0, 100 and 200 or 0, 40 and 80 mg/L
- Disinfection time **(X_C):** 1, 10, 19 min

The impact of these factors on **total mesophilic aerobic bacteria**, total yeasts and moulds, dry matter, ash content, **total phenolic compounds** (Folin–Ciocalteu assay)**, total carotenoids,** and **antioxidant capacity** (DPPH and ABTS assays), was evaluated.

The **SH and PAA optimal disinfection conditions** were determined, considering each parameter individually or performing a multi-criterion optimization

Other batch of mango peels was washed according to SH and PAA optimal disinfection conditions. Besides parameters mentioned before, *Enterobacteriaceae* and *Bacillus cereus* were evaluated.

Results and discussion

Significant statistical models were found for all parameters evaluated, excluding total yeast and moulds (not detected), ash content, and ABTS assay (in PAA Design). **Marçal et al. (2022)** presented and discussed all these models.

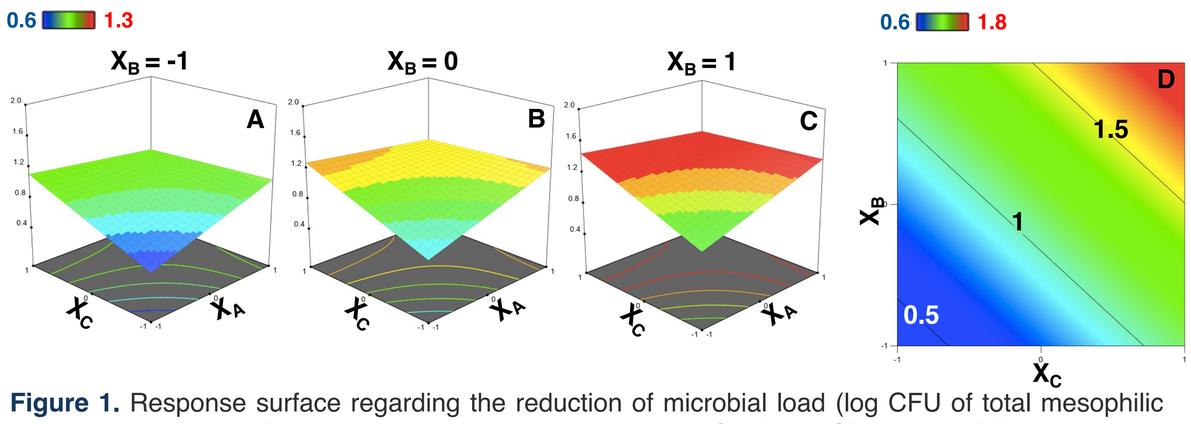

Figure 1. Response surface regarding the reduction of microbial load (log CFU of total mesophilic aerobic bacteria/g FW) in mango peels washed according to SH (A, B, C) and PAA (D) experimental design.

Microbiological quality: In both experimental designs, it was observed that X_B and X_C had a statistically significant positive impact on microbial load reduction (Figures 1 and 2). However, in the SH experimental design, when the proper levels of X_A were applied, shorter disinfection times were required to achieve the highest microbial load reductions.

Dry matter: A negative correlation between X_C and mango peels' dry matter was observed in both experimental designs.

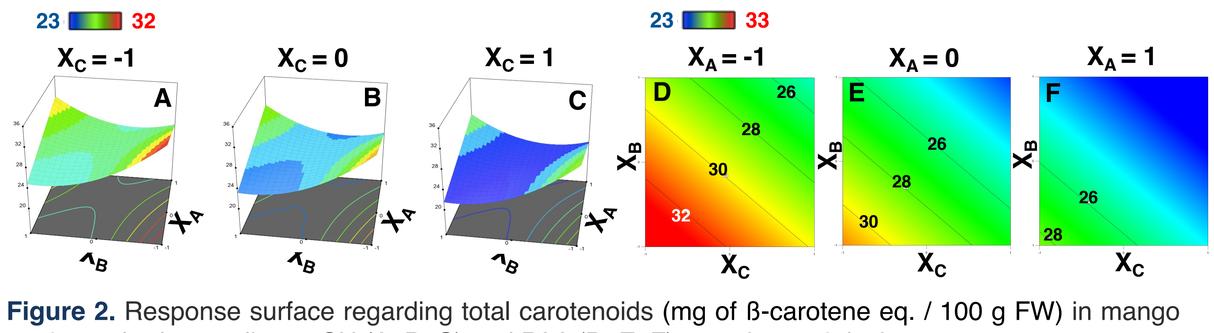

Figure 2. Response surface regarding total carotenoids (mg of ß-carotene eq. / 100 g FW) in mango peels washed according to SH (A, B, C) and PAA (D, E, F) experimental design.

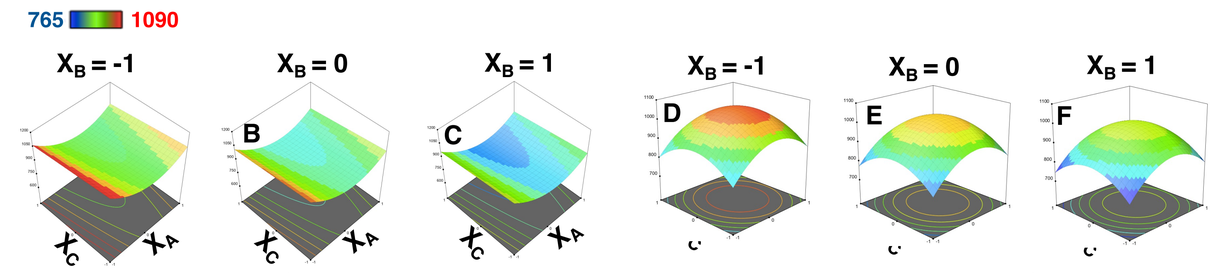

Figure 3. Response surface regarding the capacity to scavenge the DPPH-free radicals (mg of Trolox equivalents / 100 g FW) in mango peels washed according to SH (A, B, C) and PAA (D, E, F) experimental design.

Total phenolic compounds: X_B (in SH experimental design), X_A, and X_C (in PAA experimental design) positively impacted this response. However, total phenolic compounds were determined through Folin–Ciocalteu method where other compounds with reducing capacity can influence. Hence, more studies are needed to understand the effect of washing conditions on mango peels' phenolic compounds.

Total carotenoids: In both experimental designs, the increase of X_C caused a proportional loss of carotenoids. Furthermore, in PAA experimental design, X_A and X_B also negatively impacted this response (Figure 2).

Antioxidant activity: Overall, high disinfectant concentrations decreased mango peels' antioxidant activity (Figure 3).

Figure 4. Optimal washing conditions were determined through multi-criterion optimization, considering all models with statistical significance.

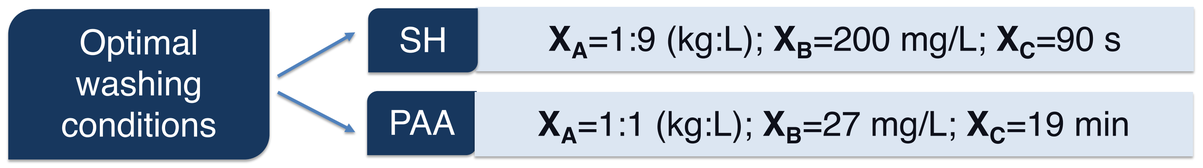

Table 1. Characterization of mango peels washed according to SH and PAA optimal conditions

		Control	SH optimal conditions	PAA optimal conditions
Microbiological quality	**Total mesophilic aerobic bacteria** (log CFU / g FW)	6.2±1.1[a]	4.4±0.3[b]	4.4±0.1[b]
	Total yeasts and molds (log CFU / g FW)	4.2±0.1[a]	3.4±0.5[b]	3.0±0.1[b]
	Enterobacteriaceae (log CFU / g FW)	4.1±0.0[a]	2.7±0.3[b]	2.5±0.2[b]
Phytochemical composition	**Dry matter** (g / 100 g DW)	18.9±0.12[a]	17.91±0.54[a]	16.7±0.1[b]
	Total phenolic compounds (mg gallic acid eq. / 100 g FW)	314.8±27.8[a]	389.3±66.7[a]	365.0±22.9[a]
	Total carotenoids (mg of ß-carotene eq. / 100 g FW)	23.3±1.1[a]	21.7±4.1[a]	20.5±5.2[a]
Antioxidant activity	**DPPH assay** (mg of Trolox eq. / 100 g FW)	897.8±172.5[a]	853.2±63.6[a]	808.1±66.0[a]
	ABTS assay (mg of ascorbic acid eq. / 100 g FW)	281.2±21.9[a]	318.8±44.3[a]	272.8±19.7[a]

Controls: no washed mango peels. Each value was expressed as mean ± standard deviation (n = 6). Different letters in the same row indicate statistically significant differences ($p < 0.05$).

The SH and PAA optimal disinfection conditions **improved the mango peels' microbiological quality** and **preserved their phytochemical composition and antioxidant activity**.

Conclusion

Statistical models developed in this study are **valuable tools** to define the best washing conditions considering the **desired properties for the final product.**

Acknowledgments

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Reference

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