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Effects of Soaking and Boiling on Arabinose Levels in Peach Gum Determined by HPLC-RID

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Abstract

This study investigated the effects of boiling and pre-soaking on L-arabinose content in peach gum using high-performance liquid chromatography with refractive index detection (HPLC-RID) under household-style preparation conditions designed to simulate common domestic cooking practices. The experiment consisted of three modules: Module A (raw peach gum vs. peach gum boiled for 30 minutes), Module B (extended boiling for 45, 60, and 90 minutes), and Module C (pre-soaking for 1, 2, and 3 hours followed by boiling for 5, 10, 15, and 30 minutes). Data were analyzed using the Mann-Whitney U test, Kruskal-Wallis test, and Dunn-Bonferroni post-hoc comparisons.

The raw sample contained 2.88 ± 0.02 %w/w arabinose, while peach gum boiled for 30 minutes contained 0.66 ± 0.00 %w/w, and the boiling-water extract contained 1.04 ± 0.01 %w/w. The difference between the raw and 30-minute boiled peach gum was not statistically significant ($p = 0.10$). However, prolonged boiling significantly reduced arabinose content (Kruskal-Wallis $p = 0.0133$), with a significant pairwise difference between 45-minute and 90-minute boiling (adjusted $p = 0.0114$). Pre-soaking improved arabinose retention, and the highest arabinose level was observed after 3 hours soaking followed by 10 minutes boiling (2.22 ± 0.02 %w/w).

These findings indicate that gentle processing, particularly pre-soaking followed by short boiling, preserves arabinose in peach gum more effectively than prolonged boiling.

Keywords: Peach Gum, L-arabinose, HPLC-RID, Pre-soaking, Thermal Processing

Introduction

Peach gum is an edible natural gum exudate obtained from peach trees and is commonly used in dessert preparations. Its major components are polysaccharides, particularly arabinogalactan-type polysaccharides, in which arabinose is a prominent monosaccharide component (Qian et al., 2011; Simas et al., 2008; Zeng et al., 2022). Previous studies have reported that L-arabinose may delay sucrose absorption and has potential applications in health foods and blood glucose control (Seri et al., 1996; Pol et al., 2020; Pasmans et al., 2022). Therefore, the retention of arabinose after food preparation is of nutritional and functional importance.

In practical consumption, peach gum is usually prepared by soaking and boiling. These processing steps may alter polysaccharide structure and/or promote the migration of water-soluble components into the boiling medium, which may affect the final arabinose content available for consumption (Wei et al., 2019; Zeng et al., 2022). However, quantitative data on the effects of soaking time and boiling time on arabinose content remain limited, especially under household-style preparation conditions.

High-performance liquid chromatography with refractive index detection (HPLC-RID) is a suitable analytical approach for the determination of sugars in plant-derived materials and food-related samples, including arabinose (Weiß & Alt, 2017). Therefore, this study aimed to evaluate the effects of boiling and pre-soaking before boiling on arabinose levels in peach gum using HPLC-RID, in order to identify suitable preparation conditions for preserving arabinose and to provide baseline information for future functional food product development.

Research Methodology

This study was a laboratory-based experimental investigation. Peach gum was used as the raw material, and samples were prepared under boiling conditions at 100 °C using 600 mL of water per experimental set. Arabinose content was analyzed

using HPLC-RID and reported as percent by weight (%w/w) in the form of mean ± standard deviation (Mean ± SD). Each experimental group was analyzed in triplicate (n = 3).

The experiment was divided into three modules:

1. Module A: Comparison of raw peach gum, peach gum boiled for 30 minutes, and the boiling-water extract obtained from the 30-minutes boiling condition

2. Module B: Evaluation of extended boiling times (45, 60, and 90 minutes), with the 30-minute boiled group included as a reference in the time-trend graph

3. Module C: Evaluation of pre-soaking for 1, 2, and 3 hours, followed by boiling for 5, 10, 15, and 30 minutes

Statistical analyses included:

1. Mann-Whitney U test for comparison of two independent groups (raw vs. 30-minute boiled peach gum in Module A)

2. Kruskal-Wallis test for comparisons among multiple groups of the module B and C

3. Dunn-Bonferroni post-hoc test for pairwise comparisons when the overall difference was statistically significant

The level of statistical significance was set at $\alpha = 0.05$.

Results

1. Module A: Raw vs. 30-minute Boiled Peach Gum

The raw peach gum sample contained 2.88 ± 0.02 %w/w arabinose. After boiling at 100 °C for 30 minutes in 600 mL water, arabinose in the boiled peach gum decreased to 0.66 ± 0.00 %w/w. Arabinose was also detected in the boiling-water extract at 1.04 ± 0.01 %w/w. The statistical comparison between raw and 30-minute boiled peach gum (excluding the boiling-water extract) showed no statistically significant difference by the Mann-Whitney U test ($p = 0.10$).

Table 1 Arabinose concentration (%w/w) in raw and 30-minute heated peach gum samples

Module A samples	Heating preparation	Arabinose concentration (%w/w, Mean ± SD)
Raw peach gum (ground into fine powder)	-	2.88 ± 0.02
Boiled peach gum	100 °C for 30 minutes in 600 mL water	0.66 ± 0.00
Boiling-water extract	100 °C for 30 minutes	1.04 ± 0.01

2. Module B: Effect of Extended Boiling Time

Prolonged boiling significantly affected arabinose content in peach gum (Kruskal-Wallis p = 0.0133). The 30-minutes boiled group from Module A (0.66 ± 0.00 %w/w) was included as a reference for time-trend and statistical analyses. The arabinose concentrations in the extended boiling groups were 0.68 ± 0.00 %w/w (boiling for 45 minutes), 0.52 ± 0.00 %w/w (boiling for 60 minutes) and 0.45 ± 0.01 %w/w (boiling for 90 minutes) respectively as demonstrated in the table 2. A significant pairwise difference of mean arabinose's concentration was observed between the samples that boiled for 45 and 90 minutes (Dunn-Bonferroni adjusted p = 0.0114). The mean concentrations of arabinose of the peach gum samples which are boiled at various durations are demonstrated on the figure 1.

Table 2 Arabinose concentration (%w/w) in peach gum under extended boiling durations

Module B samples	Heating duration	Arabinose concentration (%w/w, Mean ± SD)	p-value
Boiled peach gum	100 °C for 45 minutes in 600 mL water	0.68 ± 0.00	0.0133
Boiled peach gum	100 °C for 60 minutes in 600 mL water	0.52 ± 0.00	
Boiled peach gum	100 °C for 90 minutes in 600 mL water	0.45 ± 0.01	

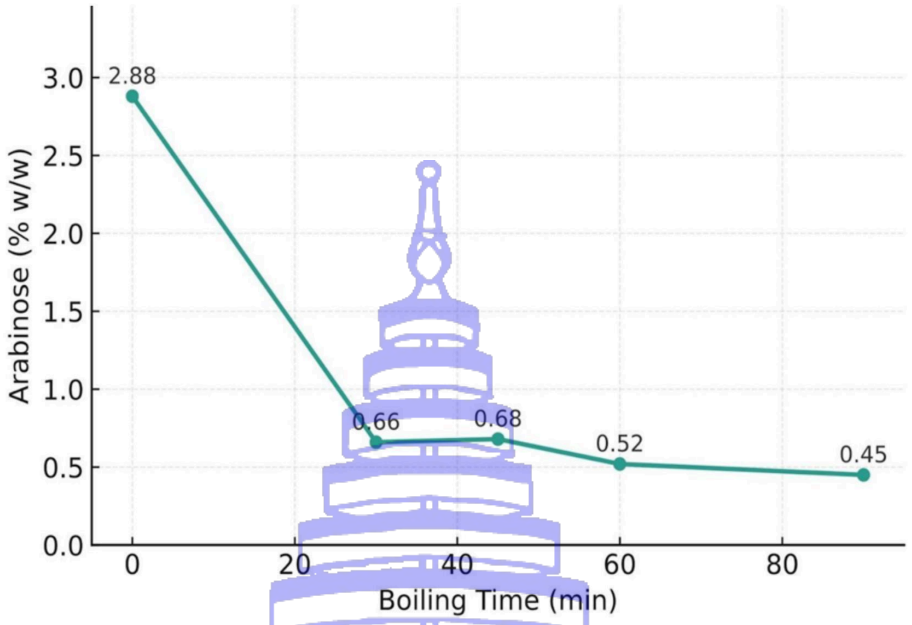

Figure 1 Time-course of arabinose content (%w/w) in peach gum boiled at 100 °C

3. Module C: Effect of Pre-Soaking Followed by Boiling

Pre-soaking before boiling improved arabinose retention compared with prolonged boiling conditions.

1) 1-hour Pre-soaking

Arabinose concentrations after boiling were:

5 minutes: 0.78 ± 0.00 %w/w

10 minutes: 0.83 ± 0.00 %w/w

15 minutes: 1.18 ± 0.00 %w/w

30 minutes: 0.93 ± 0.00 %w/w

The overall difference among boiling times was statistically significant (Kruskal-Wallis $p = 0.0131$). In pairwise comparisons, only the 15-minute and 5-minute boiling conditions showed a statistically significant difference (Dunn-Bonferroni adjusted $p = 0.0111$), while the other pairwise comparisons were not statistically significant ($p > 0.05$).

Table 4 Arabinose concentration in 1-hour pre-soaked peach gum after boiling at 100 °C

Module C samples	Boiling duration	Arabinose concentration (%w/w, Mean ± SD)	p-value

Soaked peach gum (1-hour in water)	100 °C for 5 minutes in 600 mL water	0.78 ± 0.00	0.0131
Soaked peach gum (1-hour in water)	100 °C for 10 minutes in 600 mL water	0.83 ± 0.00	
Soaked peach gum (1-hour in water)	100 °C for 15 minutes in 600 mL water	1.18 ± 0.00	
Soaked peach gum (1-hour in water)	100 °C for 30 minutes in 600 mL water	0.93 ± 0.00	

2) 2-hour Pre-soaking

Arabinose concentrations after boiling were:

5 minutes: 0.95 ± 0.00 %w/w

10 minutes: 1.21 ± 0.00 %w/w

15 minutes: 1.11 ± 0.01 %w/w

30 minutes: 0.84 ± 0.00 %w/w

The overall difference among boiling times was statistically significant (Kruskal-Wallis p = 0.0138). In pairwise comparisons, a statistically significant difference was observed between the 10-minute and 30-minute boiling conditions (Dunn-Bonferroni adjusted p = 0.0118).

Table 5 Arabinose concentration in 2-hour pre-soaked peach gum after boiling at 100 °C

Module C samples	**Boiling duration**	**Arabinose concentration (%w/w, Mean ± SD)**	**p-value**
Marinated peach gum in water (2-hour soaking)	100 °C for 5 minutes in 600 mL water	0.95 ± 0.00	0.0138
Marinated peach gum in water (2-hour soaking)	100 °C for 10 minutes in 600 mL water	1.21 ± 0.00	
Marinated peach gum in water (2-hour soaking)	100 °C for 15 minutes in 600 mL water	1.11 ± 0.01	

Marinated peach gum in water (2-hour soaking)	100 °C for 30 minutes in 600 mL water	0.84 ± 0.00

3) 3-hour Pre-soaking

Arabinose concentrations after boiling were:

5 minutes: 1.19 ± 0.00 %w/w

10 minutes: 2.22 ± 0.02 %w/w

15 minutes: 1.51 ± 0.01 %w/w

30 minutes: 0.31 ± 0.01 %w/w

The overall difference among boiling times was statistically significant (Kruskal-Wallis p = 0.0148). In pairwise comparisons, a statistically significant difference was observed between the 10-minute and 30-minutes boiling conditions (Dunn-Bonferroni adjusted p = 0.0127).

Table 6 Arabinose concentration in 3-hour pre-soaked peach gum after boiling at 100 °C

Module C samples	Boiling duration	Arabinose concentration (%w/w, Mean ± SD)	p-value
Marinated peach gum in water (3-hour soaking)	100 °C for 5 minutes in 600 mL water	1.19 ± 0.00	0.0148
Marinated peach gum in water (3-hour soaking)	100 °C for 10 minutes in 600 mL water	2.22 ± 0.02	
Marinated peach gum in water (3-hour soaking)	100 °C for 15 minutes in 600 mL water	1.51 ± 0.01	

Table 6 (continued)

Module C samples	Boiling duration	Arabinose concentration (%w/w, Mean ± SD)	p-value
Marinated peach gum in water (3-hour soaking)	100 °C for 30 minutes in 600 mL water	0.84 ± 0.00	

Marinated peach gum in water (3-hour soaking)	100 °C for 30 minutes in 600 mL water	0.31 ± 0.01

Among all experimental conditions, 3 hours pre-soaking followed by 10 minutes boiling yielded the highest arabinose level (2.22 ± 0.02 %w/w), which was closest to the raw sample value (2.88 ± 0.02 %w/w).

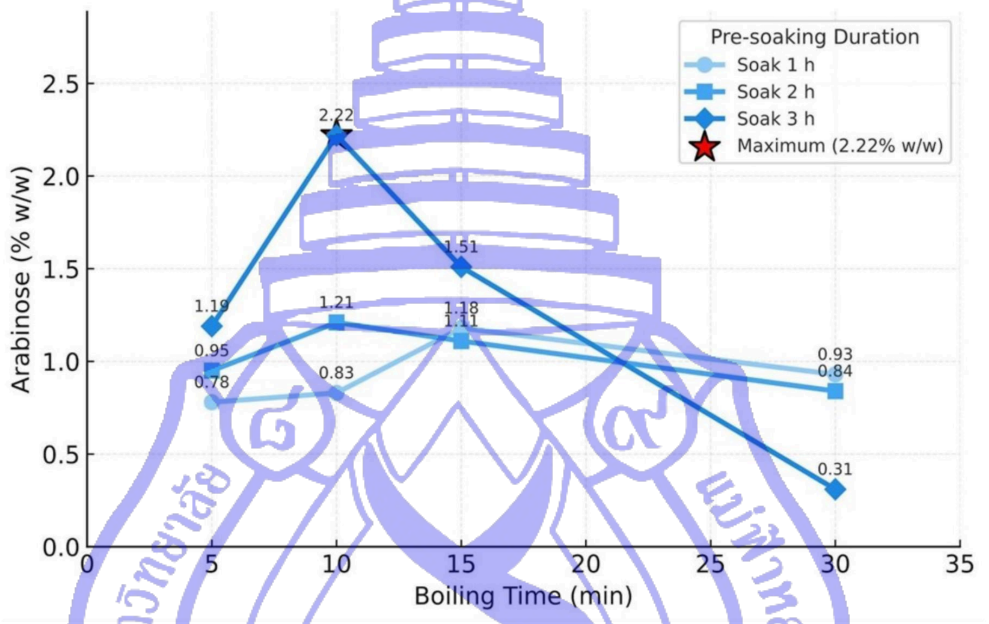

Figure 2 Arabinose content (%w/w) in pre-soaked peach gum (1–3 hours) after short boiling (5–30 minutes) under Module C conditions

Discussion and Suggestion

The results clearly demonstrate that thermal processing affects arabinose retention in peach gum. Although arabinose remained detectable under all boiling conditions, prolonged boiling resulted in a progressive decrease in arabinose content. This effect was especially evident in the comparison between 45 minutes and 90 minutes boiling, which showed a statistically significant difference. These findings support the assumption that prolonged exposure to high temperature may accelerate partial polysaccharide degradation and/or promote diffusion of water-soluble components from peach gum into the boiling medium, which is consistent with

previous reports describing the physicochemical sensitivity of peach gum polysaccharides to preparation conditions (Wei et al., 2019; Zeng et al., 2022).

In contrast, pre-soaking before boiling markedly improved arabinose retention. The condition of 3 hours soaking followed by 10 minutes boiling produced the highest arabinose concentration (2.22 ± 0.02 % w/w) and was the closest to the raw sample among all tested conditions. This finding is practically important because it suggests that allowing peach gum to hydrate before applying short heat treatment can reduce arabinose loss while maintaining suitability for consumption. From a structural perspective, controlled hydration may help promote swelling and softening of polysaccharide-rich matrices before heating, thereby reducing excessive thermal damage during boiling (Qian et al., 2011; Wei et al., 2019).

The detection of arabinose in the boiling-water extract (1.04 ± 0.01 % w/w) also indicates that some soluble components migrate from peach gum into the liquid phase during boiling. Therefore, in practical product development, it may be beneficial to use both the peach gum and the boiling liquid together to minimize the loss of valuable components during preparation. This point is especially relevant for household-style functional food or beverage applications in which the cooking liquid is often consumed together with the solid ingredient.

From a household preparation perspective, boiling for 30 minutes is still acceptable when convenience is prioritized, as arabinose remains detectable. However, if maximizing arabinose retention is the goal, pre-soaking for 3 hours followed by boiling for 10 minutes is the most suitable condition based on the present findings. Given that L-arabinose has been associated with modulation of sucrose digestion and postprandial glucose response (Seri et al., 1996; Pol et al., 2020; Pasmans et al., 2022), preserving arabinose during preparation may support the functional value of peach gum-based products. This interpretation is also consistent with previous evidence reporting hypoglycaemic and hypolipidaemic properties of peach gum polysaccharides, which further supports the potential health relevance of preserving key carbohydrate components during preparation (Wu et al., 2017). In a broader metabolic context, improved carbohydrate handling may also relate to downstream effects on energy balance and insulin sensitivity, as discussed in the literature on short-chain fatty acids and metabolic regulation (Canfora et al., 2015).

Suggestions for Future Research

Future studies should consider the following:

1. Instrumental texture analysis and consumer acceptance testing under pre-soaking followed by short-boiling conditions.

2. Evaluation of antioxidant activity and other functional properties of heat-processed peach gum products.

3. Pilot-scale or human studies to assess blood glucose and lipid responses after consumption of processed peach gum.

4. Development of functional food or beverage formulations optimized for high arabinose retention during household-style preparation.

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