



**EFFECTS OF SOAKING AND BOILING ON ARABINOSE  
LEVELS IN PEACH GUM DETERMINED BY HPLC-RID**

**SARANYA PRASERTRUNGRUANG**

**MASTER OF SCIENCE  
IN  
ANTI-AGING AND REGENERATIVE SCIENCE**

**SCHOOL OF ANTI-AGING AND REGENERATIVE MEDICINE  
MAE FAH LUANG UNIVERSITY**

**2025**

**©COPYRIGHT BY MAE FAH LUANG UNIVERSITY**

**EFFECTS OF SOAKING AND BOILING ON ARABINOSE  
LEVELS IN PEACH GUM DETERMINED BY HPLC-RID**

**SARANYA PRASERTRUNGRUANG**

**THIS INDEPENDENT STUDY IS A PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF SCIENCE  
IN  
ANTI-AGING AND REGENERATIVE SCIENCE**

**SCHOOL OF ANTI-AGING AND REGENERATIVE MEDICINE  
MAE FAH LUANG UNIVERSITY**

**2025**

**©COPYRIGHT BY MAE FAH LUANG UNIVERSITY**



**INDEPENDENT STUDY APPROVAL  
MAE FAH LUANG UNIVERSITY  
FOR**

**MASTER OF SCIENCE IN ANTI-AGING AND REGENERATIVE SCIENCE**

**Independent Study Title:** Effects of Soaking and Boiling on Arabinose Levels in  
Peach Gum Determined by HPLC-RID

**Author:** Saranya Praserttrunguang

**Examination Committee:**

Ariya Sarikaphuti, Ph. D.	Chairperson
Vitoon Jularattanaporn, Ph. D.	Member
Assistant Professor Tawee Saiwichai, Ph. D.	Member

**Advisor:**

*Vitoon J.*  
..... Advisor  
(Vitoon Jularattanaporn, Ph. D.)

**Dean:**

*Jarasphol Rintra*  
.....  
(Jarasphol Rintra, M. D.)

## ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my advisor, Dr. Vitoon Jularattanaporn, M.D., Ph.D., for his invaluable guidance, thoughtful advice, and constant encouragement throughout this study. His dedication, patience, and attention to detail have greatly inspired and supported my academic growth

My appreciation also goes to Dr. Ariya Sarikaphuti, Chairperson of the Examination Committee, and Asst. Prof. Dr. Tawee Saiwichai, External Examiner, for their constructive suggestions and valuable comments that helped improve this work.

I am grateful to the Sugars and Derivatives Analytical Laboratory (SuDAL), Kasetsart University, for providing laboratory facilities and technical assistance that made this research possible.

My heartfelt thanks go to my parents and family for their unconditional love, understanding, and endless support. Their faith and encouragement have been the greatest strength throughout my journey.

To my friends and classmates, thank you for your support and companionship during both the challenging and joyful moments. Finally, I would like to thank myself for the determination and perseverance that led to the completion of this study. This achievement reflects the value of effort, faith, and gratitude in every step of learning.

Saranya Prasertrungruang

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

**Author** Saranya Praserttrungruang

**Degree** Master of Science (Anti-Aging and Regenerative Science)

**Advisor** Vitoon Jularattanaporn, Ph. D.

## ABSTRACT

This study investigated the effect of household-style heat treatment on the arabinose content of Peach Gum (*Prunus persica* exudate). Unboiled samples were compared with samples boiled for 30, 45, 60, and 90 minutes, and an additional experiment evaluated whether pre-soaking could shorten boiling time while preserving arabinose. Raw peach gum sourced from Biosacc Co., Ltd. (China) was cleaned, size-standardized, and tested under controlled laboratory conditions. Boiling was performed in household drinking water at a fixed ratio of 1 g peach gum to 20 mL water, while deionized water was used exclusively for HPLC analysis. Quantification was carried out using High-Performance Liquid Chromatography (HPLC) with an Agilent Hi-Plex Ca column and a Refractive Index Detector (RID)

Results demonstrated that arabinose remained detectable after boiling across all conditions, with the most pronounced reduction occurring within the first 30 minutes. Arabinose levels ranged from 2.88% w/w in raw samples to 0.45% w/w after 90 minutes of boiling, followed by a stable plateau. Pre-soaking for three hours combined with a 10–15-minute boil preserved arabinose more effectively while minimizing heat exposure.

These findings indicate that household-style preparation can retain arabinose in peach gum and support its potential application as a functional food ingredient with health-promoting value.

**Keywords:** Peach Gum, Arabinose, *Prunus Persica* Exudate, Household-style Boiling, Pre-soaking, Heat Treatment, Water-soluble Polysaccharide, Arabinogalactan, HPLC, Refractive Index Detector (RID), Agilent Hi-plex Ca column, Functional Food, Nutraceutical, Carbohydrate Analysis, Natural Gum, Dietary Fiber, Hydrocolloid, Bioactive Compound, Traditional Preparation, Thermal Stability

# TABLE OF CONTENTS

<b>CHAPTER</b>	<b>Page</b>
<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Background and Importance of the Study	1
1.2 Research Objectives	3
1.3 The Importance of the Study	4
1.4 Research Hypothesis	4
1.5 Scope of the Study	5
1.6 Research Assumptions	6
1.7 Conceptual Framework	7
1.8 Limitations of the Study	8
1.9 Expected Benefits of the Study	9
1.10 Definition of Terms	11
<b>2 LITERATURE REVIEW</b>	<b>14</b>
2.1 Peach Gum	14
2.2 Characteristics of Peach Gum	15
2.3 Key Compounds in Peach Gum	16
2.4 Preparation and Processing of Fresh Peach Gum for Various Applications	23
2.5 Pharmacological Properties of Peach Gum	27
2.6 Applications of Peach Gum in Various Fields	30
2.7 Mechanisms and Functional Relevance of Peach Gum (Prunus persica) (Experimental Evidence)	35
2.8 Detection of L-arabinose in Peach Gum Using High-performance Liquid Chromatography (HPLC)	39
<b>3 RESEARCH METHODOLOGY</b>	<b>41</b>
3.1 Study Design	41
3.2 Materials and Equipment	49
3.3 Experimental Site	51

## TABLE OF CONTENTS

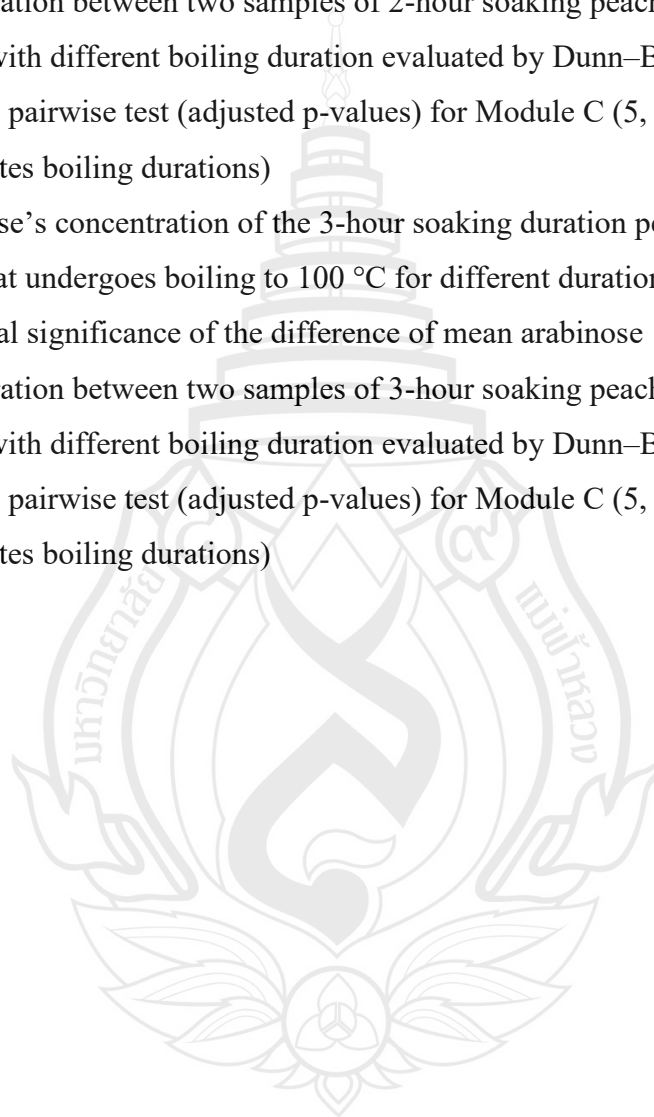
<b>CHAPTER</b>	<b>Page</b>
3.4 Experimental Procedure	52
3.5 Statistical Testing and Data Analysis	63
<b>4 RESEARCH RESULT</b>	<b>68</b>
4.1 The Arabinose's Concentration of the Raw and 30-minute Heating Duration Samples (Module A)	68
4.2 The Concentration of Arabinose of the Boiled Peach Gum Samples Treated with Extended Heat Duration (Module B)	69
4.3 The Arabinose's Concentration of Soaked Peach Gum Samples that Undergoes Boiling (Module C)	71
<b>5 CONCLUSION AND DISCUSSION</b>	<b>77</b>
5.1 Summary of the Experimental Results	77
5.2 Discussion of the Experimental Results	78
5.3 Recommendations and Future Research	80
<b>REFERENCES</b>	<b>83</b>
<b>APPENDICES</b>	<b>89</b>
APPENDIX A ETHICS COMMITTEE EXEMPTION DOCUMENT	89
APPENDIX B REPORT	90

## LIST OF TABLES

<b>Table</b>	<b>Page</b>
1.1 Conceptual framework of experimental modules for arabinose determination in peach gum	8
2.1 Key Compounds in Peach Gum	17
2.2 Summary of peach gum applications in various industries	34
2.3 Summary of L-arabinose: Mechanisms of action, health relevance, dosage/ form, and experimental evidence	37
3.1 Experimental design and conditions of each module	45
4.1 Arabinose's concentrations (% w/w) of the raw and 30-minute heating samples	68
4.2 Arabinose's concentrations (% w/w) of the extended heating duration samples	69
4.3 Statistical significance of the difference of mean arabinose concentration between two samples evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module B (30–90 min boiling)	71
4.4 Arabinose's concentration of the 1-hour soaking duration peach gum in water that undergoes boiling to 100 °C for different durations	72
4.5 Statistical significance of the difference of mean arabinose concentration between two samples of 1-hour soaking peach gum treated with different boiling duration evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module C (5, 10, 15 and 30-minutes boiling durations)	72
4.6 Arabinose's concentration of the 2-hour soaking duration peach gum in water that undergoes boiling to 100 °C for different durations	73

## LIST OF TABLES

<b>Table</b>	<b>Page</b>
4.7 Statistical significance of the difference of mean arabinose concentration between two samples of 2-hour soaking peach gum treated with different boiling duration evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module C (5, 10, 15 and 30-minutes boiling durations)	74
4.8 Arabinose’s concentration of the 3-hour soaking duration peach gum in water that undergoes boiling to 100 °C for different durations	74
4.9 Statistical significance of the difference of mean arabinose concentration between two samples of 3-hour soaking peach gum treated with different boiling duration evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module C (5, 10, 15 and 30-minutes boiling durations)	75



## LIST OF FIGURES

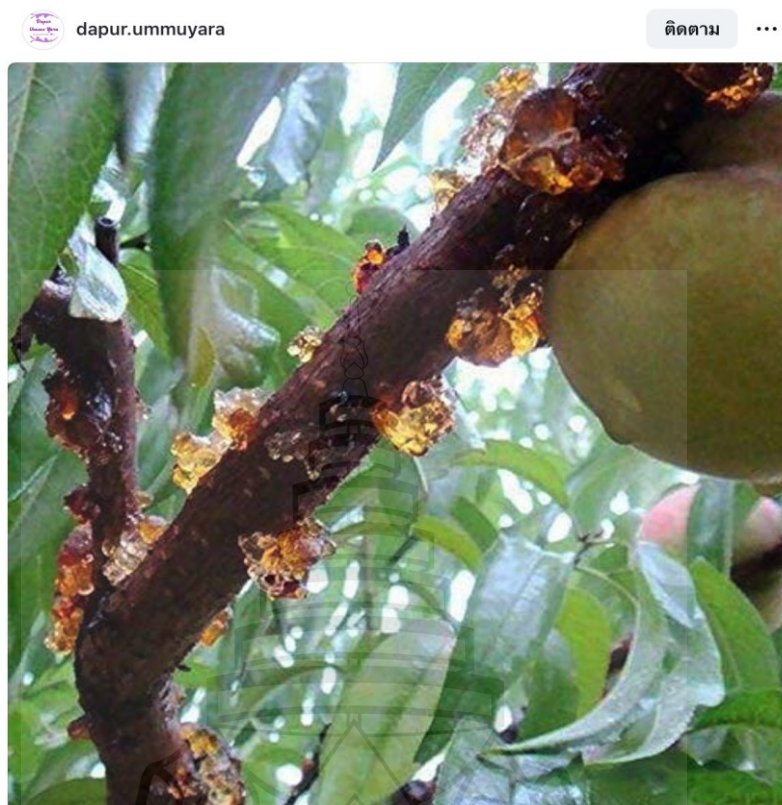
Figure	Page
1.1 Natural exudate of peach gum ( <i>Prunus persica</i> ) on peach tree bark	2
1.2 Conceptual framework of experimental Modules for arabinose determination in peach gum	7
2.1 Peach gum (resin) exuded from the bark of a peach tree	15
2.2 Dried peach gum lumps (raw material) before soaking/processing	16
2.3 D- and L-arabinose (Fischer projections)	19
2.4 Examples of commercially packaged raw peach gum sold as dried resin pieces (yellow and red varieties)	23
2.5 Raw peach gum soaked in household drinking water to allow swelling prior to manual impurity removal	24
2.6 Household-style boiling of peach gum in drinking water at approximately 100°C during preparation	25
3.1 Raw peach gum (particle size approximately 0.6–0.8 cm). Left: retail package from Biosacc Co., Ltd., China. Right: raw beads in their natural form, weighed to 30 g prior to the experiment	43
3.2 Raw peach gum ground to a fine, homogeneous powder prior to HPLC analysis	43
3.3 Peach gum matrix after boiling, drained with a standard strainer and homogenized before analysis	44
3.4 Codes of sample vials prepared for high-performance liquid chromatography analysis of peach gum samples boiled without pre-soaking under various time durations	47
3.5 Codes of sample vials prepared for High-Performance Liquid Chromatography analysis to quantify the arabinose content under different soaking and boiling conditions	47
4.1 Time-course of arabinose content (% w/w) in peach gum boiled at 100 °C	70
4.2 Arabinose content (% w/w) in pre-soaked peach gum (1–3 h) after short boiling (5–30 min) under Module C conditions	76

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background and Importance of the Study

Peach gum (天然桃胶, Tian Ran Tao Jiao) is a natural polysaccharide exudate obtained from the *Prunus persica* tree and has been traditionally used in Chinese cuisine and related practices (Zeng et al., 2022). In its raw form, peach gum appears as transparent resin-like beads; after soaking and boiling, it becomes soft and chewy, making it a distinctive functional food ingredient (see Figure 1.1). Structurally, peach gum contains arabinogalactan-type polysaccharides, with constituent monosaccharides such as L-arabinose, D-galactose, D-glucuronic acid, and D-xylose (Simas et al., 2008; Wei et al., 2019). As a fermentable carbohydrate, L-arabinose can support gut microbial metabolism and is linked to short-chain fatty acid (SCFA) production (e.g., propionate and butyrate), which is associated with glycemic regulation, inflammation control, and metabolic health (Canfora et al., 2015; Louis & Flint, 2017; Ríos-Covián et al., 2016). In addition, L-arabinose has been reported to inhibit sucrase activity and delay glucose absorption from sucrose-containing foods, resulting in a more gradual postprandial glucose and insulin response (Pasmans et al., 2022; Pol et al., 2020; Pol & Mars, 2021).



**Source** Dapur.ummuyara (2020)

**Figure 1.1** Natural exudate of peach gum (*Prunus persica*) on peach tree bark

Given these potential benefits, peach gum may be considered as an alternative to tapioca pearls commonly used in bubble tea. In product development, peach gum's naturally chewy texture and polysaccharide-rich composition may support its use in milk tea or other beverages traditionally served with pearls (Zeng et al., 2022). Moreover, peach gum-derived oligosaccharides have been reported to exhibit antioxidant and antibacterial activities (Yao et al., 2013), and peach gum intake has been associated with improvements in metabolic syndrome-related outcomes alongside changes in microbial SCFA production in an animal model (Noer et al., 2023). In addition, the rheological behavior of peach gum-based systems has been investigated in food-relevant matrices, supporting its potential for texture-oriented applications (Chen et al., 2024).

However, heat processing (e.g., boiling) may alter polysaccharide structure and physicochemical properties, which could influence the stability and availability of

constituent sugars such as arabinose and potentially affect downstream fermentation-related outcomes, including SCFA production (Wei et al., 2022). Scientific evidence on how household-style thermal processing affects arabinose stability and release in peach gum remains limited, with no standardized data available on the extent of arabinose retention after boiling. Therefore, investigating the impact of thermal processing on arabinose retention in peach gum is essential for evaluating its feasibility as a functional food ingredient. This study aims to determine whether arabinose remains after heat treatment and to assess its potential health benefits and applications in food innovation.

## 1.2 Research Objectives

The primary objective of the major plan is to find the best preparation method to preserve the arabinose component during the household processing of peach gum. The investigators conduct multiple studies to evaluate the amount of arabinose by High-Performance Liquid Chromatography (HPLC) technique in peach gum samples that have undergone household-style boiling only, with a focus on boiling duration and pre-soaking time prior to boiling.

The secondary objective (planned for future research) is to explore the biological properties of peach gum, including its potential alpha-glucosidase inhibitory activity, its ability to inhibit gastrointestinal cancer cell proliferation, and its adsorption capacity for bioactive compounds from other natural sources, in a controlled laboratory setting. This secondary objective is separate from the primary objective of the current Independent Study and will not be investigated or reported in this Independent Study. It is included here only to outline the intended future research direction that will be pursued in subsequent studies.

For this research, as a part of the master's degree Independent Study, the study is designed to determine the effect of heat on the amount of arabinose during household-style boiling compared to the raw sample of peach gum.

### 1.3 The Importance of the Study

Arabinose in peach gum primarily occurs as a constituent sugar within arabinogalactan-type polysaccharides (Simas et al., 2008; Wei et al., 2019). These polysaccharides have been reported to be largely indigestible during simulated oral–gastrointestinal–intestinal digestion and can be utilized during fecal fermentation, contributing to gut microbiota modulation and SCFA production (Wei et al., 2022). SCFAs such as propionate and butyrate are widely recognized as microbial metabolites linked to energy metabolism, glycemic regulation, and inflammation-related pathways (Canfora et al., 2015; Louis & Flint, 2017; Ríos-Covián et al., 2016).

However, household-style heat processing (e.g., boiling) may modify polysaccharide structure and physicochemical properties, which could influence the availability of constituent sugars such as arabinose and thereby affect fermentation-related outcomes. Evidence specifically describing how boiling affects arabinose retention and release in peach gum remains limited, and standardized data on arabinose remaining after boiling are not yet well established. Therefore, this study is important for three reasons. First, it addresses a knowledge gap by providing evidence on how boiling influences arabinose retention in peach gum. Second, it supports functional food development by evaluating whether peach gum can retain fermentation-related potential after household-style processing. Finally, it provides a foundation for subsequent studies that may investigate biological functions, clinical applications, and broader food industry uses of peach gum.

### 1.4 Research Hypothesis

Boiling peach gum under household-style conditions is expected to release arabinose without complete degradation, remaining detectable via HPLC. The arabinose content might increase due to partial polysaccharide breakdown or decrease due to heat-induced sugar degradation. If retained, peach gum could maintain its nutritional potential and serve as a healthier alternative to tapioca pearls in beverages.

## 1.5 Scope of the Study

This research focuses on the quantification of arabinose in peach gum under household-style preparation, with

1. Boiling duration as the main experimental variable while keeping temperature constant at 100 °C, and
2. Soaking duration at three different timings include 1-hour, 2-hours and 3-hours before heating.

1.5.1 Analyte of Interest: Arabinose is the primary compound analyzed.

1.5.2 Experimental comparison & variables

1. Boiling Duration: Raw vs boiled at 100 °C for 30, 45, 60, and 90 minutes.
2. Pre-Soaking Effect: Soaking raw peach gum at room temperature for 1, 2, and 3 hours, then boiling for shorter times (5, 10, 15, or 30 minutes) to evaluate whether soaking allows shorter boiling time while maintaining arabinose levels.

1.5.3 Water Used: Boiling is performed using regular household water to replicate realistic cooking conditions. Distilled/deionized water is used exclusively for HPLC mobile phase and calibration standards to ensure analytical accuracy.

1.5.4 Analytical Method: High-Performance Liquid Chromatography (HPLC) with Refractive Index Detection (RID) is employed to quantify arabinose.

1.5.5 Setting & Timeframe: All experiments are performed at the Sugars and Derivatives Analytical Laboratory (SuDAL), Kasetsart University, within one month.

1.5.6 Exclusions: The study is limited to chemical analysis only and excludes biological testing, sensory evaluation, texture analysis, and industrial-scale applications.

1.5.7 Primary Research Question:

When peach gum is subjected to household-style boiling at a constant temperature of 100 °C for different durations (30, 45, 60, 90 minutes) and when pre-soaking (1-3 hours) is applied to reduce boiling time (5, 10, 15, 30 minutes), does arabinose remain detectable by HPLC? If so, how does its quantity compare to that of raw (unboiled) peach gum?

## 1.6 Research Assumptions

To ensure valid, reproducible results and fair comparison between conditions, the following assumptions are made:

1.6.1 Constant temperature: All boiling steps are conducted at a rolling boil (~100 °C) with no intentional change in heat level throughout each time point.

1.6.2 Realistic water matrix: Household water is used for soaking and boiling to simulate real cooking conditions, and is assumed not to introduce interfering peaks at the arabinose retention time in HPLC analysis.

1.6.3 HPLC solvent purity: Distilled/deionized water is used exclusively for the HPLC mobile phase, dilutions, and calibration standards to guarantee analytical accuracy.

1.6.4 Sample sourcing & replicates: All peach gum pieces are obtained from the same supplier lot, randomly selected, and independently prepared for each replicate (n = 3 per condition).

1.6.5 Controlled soaking and boiling durations:

1.6.5.1 Soaking is performed at room temperature for exactly 1, 2, and 3 hours with no additives.

1.6.5.2 After soaking, samples are boiled at 100 °C for reduced durations (5, 10, 15, and 30 minutes) to assess whether soaking time can shorten boiling time while preserving arabinose content.

1.6.5.3 Separate groups are boiled without prior soaking for 30, 45, 60, and 90 minutes to evaluate time-dependent arabinose changes under constant heat.

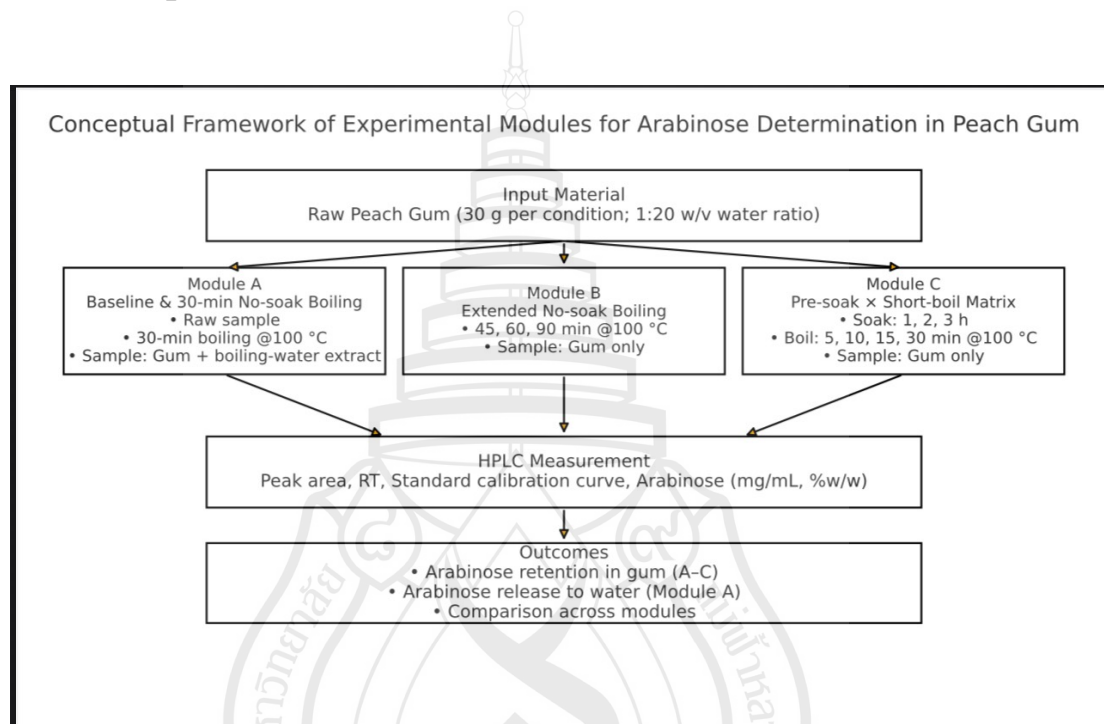
1.6.6 Fixed solid-to-water ratio: The ratio of peach gum to water is maintained at 1:20 (w/v) during both soaking and boiling.

1.6.7 Consistency of preparation: The same type of cooking vessel, water volume, and agitation method are used for all conditions, and peach gum pieces are of similar size, to ensure that differences observed are due only to boiling time or soaking.

1.6.8 Definition of “arabinose remains”: Arabinose is considered present if a quantifiable peak is detected under the validated HPLC method (total arabinose, without L/D-isomer differentiation).

1.6.9 Post-processing stability: After boiling, samples are cooled in a clean environment and stored in closed containers under conditions that prevent microbial growth or enzymatic changes prior to HPLC analysis.

## 1.7 Conceptual Framework



**Note** Developed by the researcher. Module A compares raw peach gum versus 30-min no-soak boiling and includes both gum and boiling-water extract; Module B evaluates extended no-soak boiling (45–90 min) using gum only; Module C evaluates pre-soaking (1–3 h) followed by short boiling (5–30 min) using gum only. HPLC outputs include peak area, retention time, calibration curve, and arabinose concentration (mg/mL, %w/w).

**Figure 1.2** Conceptual framework of experimental Modules for arabinose determination in peach gum

**Table 1.1** Conceptual framework of experimental modules for arabinose determination in peach gum

<b>Input material</b>	<b>Raw Peach Gum(30 g per condition; 1:20w/v water ratio)</b>
Module A	Baseline & 30-min No-Soak Boiling Raw Sample 30-min boiling @100°C Sample; Gum+boiling-water extract
Module B	Extended No-soak Boiling 45,60,90 min @100°C Sample: Gum only
Module C	Pre-soak X short-boil Matrix Soak: 1,2,3, h Boil: 5,10,15,30 min @100°C Sample: Gum only
HPLC	Peak area,RT,Standard calibration curve,
Measurement	Arabinose(mg/mL,%w/w)
Outcomes	Arabinose retention in gum (A-C) Arabinose release to water (Module A) Comparison across modules

## 1.8 Limitations of the Study

This study has several limitations that should be considered when interpreting the results:

1.8.1 Sample Source: All peach gum was obtained from a single supplier batch, which may not reflect variability among different geographic sources or harvest seasons.

1.8.2 Water Type: Boiling was performed using household water to simulate real-life cooking, which may introduce minor mineral variation; results may differ slightly if distilled water is used.

1.8.3 Fixed Temperature & Duration: Boiling was limited to 100 °C under atmospheric pressure and to the specific durations tested (5-90 minutes). The findings may not apply to other cooking methods (e.g., pressure cooking, steaming) or different temperature ranges.

1.8.4 Analytical Limitation: The HPLC method used in this study quantifies total arabinose and does not include chiral separation; therefore, L- and D-arabinose cannot be distinguished.

1.8.5 Chemical Analysis Only: The study focuses on chemical quantification and does not include biological activity, sensory properties, texture analysis, or clinical outcomes.

1.8.6 Short Study Period: Experiments were conducted within one month, which may not capture batch-to-batch variability or seasonal effects.

1.8.7 Pre-Soaking and Boiling Simulation: Soaking and boiling conditions were standardized to reflect household-style preparation; results may not be generalizable to industrial-scale processing or different cooking equipment.

## **1.9 Expected Benefits of the Study**

This study aims to provide scientific data supporting the potential use of peach gum as a functional food ingredient and as a texture-oriented alternative in pearl-style beverage products.

### **1.9.1 Contribution to Functional Food Development**

1.9.1.1 Alternative ingredient for pearl-style products: Peach gum may serve as an alternative to conventional starch-based pearls in bubble tea and other carbohydrate-based foods, particularly where a chewy texture is desired.

1.9.1.2 Evidence of retention after heating: By comparing raw peach gum with samples boiled under multiple conditions, this study determines whether arabinose remains detectable after household-style processing.

1.9.1.3 Relevance to fermentation-related potential: If arabinose remains detectable after boiling, peach gum may retain components relevant to microbial

fermentation and SCFA-related outcomes (Canfora et al., 2015; Louis & Flint, 2017; Ríos-Covián et al., 2016).

### 1.9.2 Advancement in Food Chemistry and Processing

1.9.2.1 Understanding Heat and Time Effects: This research generates new knowledge on how different boiling durations (30-90 min) and pre-soaking with reduced boiling times (5-30 min) influence arabinose retention. This information is crucial for designing food products with optimal nutritional and functional properties.

1.9.2.2 Processing Guidelines: Findings may support the creation of preliminary guidelines for standardized soaking and boiling conditions in household and small-scale production, helping to maximize arabinose preservation and product consistency.

### 1.9.3 Expansion of peach gum Utilization

1.9.3.1 Enhanced Market Potential: Scientific confirmation of peach gum's nutritional and functional benefits could expand its use beyond traditional applications, encouraging its inclusion in beverages, desserts, and functional food products.

1.9.3.2 Sustainable Ingredient: As a plant-derived ingredient, peach gum may offer an environmentally friendly and health-conscious alternative to starch-based pearls and may help reduce reliance on refined starch-based ingredients in pearl-style beverage products.

### 1.9.4 Foundation for Future Research

1.9.4.1 Encouraging Further Studies: This study may inspire more advanced research on biological effects, gut microbiota modulation, metabolic outcomes, and clinical trials involving arabinose-containing foods.

1.9.4.2 Innovation in Food Technology: The results may lead to new product development, such as functional beverages or dietary supplements containing peach gum, with evidence-based health claims supported by robust analytical data.

## 1.10 Definition of Terms

### 1.10.1 Arabinose

Arabinose is a pentose monosaccharide, meaning a sugar composed of five carbon atoms. It is commonly found in plants and serves as a key component of polysaccharides such as arabinogalactan and hemicellulose, which play an essential role in the structure of plant cell walls.

In this study, arabinose is the primary target for analysis and is quantified in raw and boiled peach gum using High-Performance Liquid Chromatography (HPLC).

### 1.10.2 Arabinogalactan Polysaccharide (AGP)

Arabinogalactan is a complex polysaccharide composed of arabinose and Galactose. It is a major structural component of peach gum, and when broken down by enzymes or heat, arabinose may be released.

### 1.10.3 Peach gum (PG)

Peach gum is a natural resin exudate from the peach tree (*Prunus persica*). It appears as translucent to amber-colored granules and, when soaked and boiled, takes on a gelatinous and chewy texture, resembling tapioca pearls used in bubble tea.

Main components of peach gum include:

1. Arabinogalactan polysaccharide, a source of arabinose
2. Glucuronic acid, which contributes to viscosity
3. Other minor monosaccharides in small amounts

This study focuses on analyzing arabinose content in peach gum before and after boiling.

1.10.4 High-Performance Liquid Chromatography (HPLC) HPLC is an analytical chemistry technique used to separate, detect, and quantify compounds in liquid samples. In this study, HPLC serves as the primary method to analyze arabinose content in raw and boiled peach gum. Since the method used does not include chiral separation, HPLC in this study detects only total arabinose and does not differentiate between L-arabinose and D-arabinose.

#### 1.10.5 Short-Chain Fatty Acids (SCFAs)

SCFAs are microbial fermentation products derived from polysaccharides and dietary fibers and are recognized as important metabolites linked to gut health and host metabolism (Ríos-Covián et al., 2016). Key SCFAs include:

1.10.5.1 Propionate has been linked to host energy metabolism and may influence appetite- and glucose-related pathways, including gut hormone responses (Canfora et al., 2015; Chambers et al., 2015; Ríos-Covián et al., 2016).

1.10.5.2 Butyrate: Butyrate is commonly described as a major energy source for colonic epithelial cells and has been linked to inflammation-related pathways in the gut (Louis & Flint, 2017; Ríos-Covián et al., 2016).

1.10.5.3 Although this study does not directly measure SCFAs, SCFA formation is relevant to microbial utilization of fermentable components in peach gum, supporting the rationale for arabinose determination (Wei et al., 2022).

#### 1.10.6 Thermal Processing (Boiling Process)

Refers to boiling peach gum in household water at 100 °C under atmospheric pressure, using time intervals of 30, 45, 60, and 90 minutes (without pre-soaking) and 5, 10, 15, and 30 minutes (after pre-soaking), to simulate real-life cooking conditions and assess the effect on arabinose retention.

#### 1.10.7 Distilled Water

Distilled water is purified water that has undergone distillation to remove minerals ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Na}^{+}$ ), ions, and organic contaminants that could interfere with HPLC analysis. In this study, distilled/deionized water is used exclusively for HPLC mobile phase and standard preparation, not for boiling, to ensure analytical accuracy and prevent peak interference.

#### 1.10.8 Sugars and Derivatives Analytical Laboratory (SuDAL)

SuDAL is a research laboratory at Kasetsart University specializing in monosaccharide and polysaccharide analysis, HPLC applications, and structural sugar composition studies. All sample analyses in this study were conducted at SuDAL to ensure accuracy and reproducibility.

1.10.9 Pre-Soaking: Soaking raw peach gum at room temperature for 1, 2, or 3 hours prior to boiling to assess whether soaking reduces the required boiling time while preserving arabinose.

1.10.10 Arabinose Retention: The presence of a quantifiable arabinose peak in HPLC analysis after boiling, expressed relative to raw (unboiled) peach gum samples.

1.10.11 Solid-to-Water Ratio (1:20): The fixed proportion of peach gum to water used during soaking and boiling, measured as weight-to-volume (w/v), to ensure experimental consistency.



## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Peach Gum

Peach gum is a plant gum (exudate resin) that solidifies on peach trees and can be observed as hardened, amber-like lumps on the bark/branches (Figure 2.1; MICHELIN Guide Digital-Singapore, 2018).

Peach gum polysaccharides (PGPs) are commonly described as arabinogalactans mainly composed of arabinose and galactose, and they may be utilized by gut microbiota, supporting their potential as prebiotic substrates and for short-chain fatty acid (SCFA) production (Wei et al., 2022).

Given the popularity of bubble tea, where “boba pearls” are primarily made from tapioca starch and are consumed as part of a milk tea formulation, postprandial glycaemic and insulinaemic responses can be relevant depending on the product formulation; therefore, developing alternative pearls with improved nutritional functionality remains of interest (Kaur et al., 2022).

In addition, peach gum–derived oligosaccharides have shown antioxidant and antibacterial activities *in vitro*, supporting further exploration of functional food applications (Yao et al., 2013).

However, processing and hydrolysis are known to affect peach gum polysaccharides, which may consequently influence fermentability and the availability of constituent sugars relevant to this study (e.g., arabinose) (Zeng et al., 2022).



Peach gum is the resin from peach and Chinese wild peach trees.

**Source** Michelin Guide Digital-Singapore (2018)

**Figure 2.1** Peach gum (resin) exuded from the bark of a peach tree

#### Formation and Production of Peach Gum

Peach gum is formed through gummosis, a process in which peach trees exude gummy/resinous materials in response to stress or injury, such as physical damage, environmental stress, or microbial infection (Zeng et al., 2022).

During gummosis, secreted materials gradually harden upon exposure to air, forming amber- to brown-colored gum lumps on the bark over time (Zeng et al., 2022; Simas et al., 2008).

## 2.2 Characteristics of Peach Gum

**Physical properties:** Peach gum appears as semi-transparent resin lumps with amber-yellow to reddish-brown hues (Figure 2.2). It is hard and brittle when dry; when

soaked, it hydrates and swells, forming a gel-like/viscous consistency (Zeng et al., 2022).

**Chemical composition:** Peach gum consists of complex polysaccharides, commonly reported as arabinogalactan-rich polysaccharides with constituent monosaccharides such as D-galactose, L-arabinose, D-xylose, and D-glucuronic acid (Simas et al., 2008; Zeng et al., 2022; Wei et al., 2022).

**Water interaction / hydrocolloid behavior:** Due to its polysaccharide nature, peach gum can act as a hydrocolloid, absorbing water and contributing to viscosity, supporting potential use as a thickening/stabilizing ingredient in food systems (Zeng et al., 2022; Chen et al., 2024).



**Source** Photograph by the author, 2025.

**Figure 2.2** Dried peach gum lumps (raw material) before soaking/processing

### 2.3 Key Compounds in Peach Gum

The key bioactive compounds found in peach gum play significant roles in its health benefits and functional properties. Importance of Each Compound in Peach Gum as shown in table 2.1

**Table 2.1** Key Compounds in Peach Gum

<b>Compound</b>	<b>Functions &amp; Roles</b>
L-arabinose	When present as free L-arabinose (e.g., in formulations), evidence in humans shows it can attenuate postprandial glucose/insulin responses via inhibition of sucrose digestion (Pol et al., 2020; Pasmans et al., 2022; Pol & Mars, 2021).
D-Galactose	Major constituent sugar reported in peach gum polysaccharides (Simas et al., 2008; Zeng et al., 2022).
D-Glucuronic acid	Reported uronic-acid component of peach gum polysaccharides (Simas et al., 2008; Zeng et al., 2022).
D-Xylose	Minor constituent sugar reported in peach gum polysaccharides (Simas et al., 2008; Zeng et al., 2022).

### 2.3.1 Key Compounds and Biological Properties of Peach Gum

Peach gum (*Prunus persica*) is a natural plant exudate primarily composed of arabinogalactan-rich polysaccharides, with arabinose- and galactose-containing structures (Simas et al., 2008; Zeng et al., 2022). In vitro digestion and fecal fermentation studies indicate that peach gum polysaccharides can be utilized by gut microbiota, supporting their potential as prebiotic substrates and for short-chain fatty acid (SCFA) production (Wei et al., 2022).

### 2.3.2 Molecular Structure of Arabinogalactan

2.3.2.1 Peach gum polysaccharides are commonly described as branched arabinogalactan-type polysaccharides, consisting of a galactose-rich backbone with arabinose-rich side chains, alongside minor sugars such as xylose and uronic acids including glucuronic acid (Simas et al., 2008; Zeng et al., 2022; Dai et al., 2024). This branched architecture is consistent with hydrocolloid behavior and fermentability in gut-relevant conditions (Zeng et al., 2022; Wei et al., 2022).

2.3.2.2 Release of L-arabinose residues: arabinose residues in peach gum are primarily present as part of polysaccharide chains rather than as free

monosaccharides. They can be liberated through hydrolysis processes, including enzymatic cleavage used in structural studies and hydrolytic approaches discussed in reviews of peach gum polysaccharides (Kardošová et al., 1978; Zeng et al., 2022).

### 2.3.3 Chemical Composition of Peach Gum

#### 2.3.3.1 Major Carbohydrates

Peach gum polysaccharides (PGPs) are composed of multiple monosaccharides. In one study analyzing peach gum polysaccharide (PG), the monosaccharide composition (mg/g) was reported as follows:

1. L-arabinose – 362.71 mg/g
2. D-Galactose – 348.69 mg/g
3. D-Xylose – 70.63 mg/g
4. D-Mannose – 21.96 mg/g
5. L-Rhamnose – 7.82 mg/g
6. D-Ribose – 0.91 mg/g
7. D-Glucose – 0.81 mg/g
8. Guluronic acid (Gul A) – 0.40 mg/g

These carbohydrate constituents contribute to the functional properties of peach gum polysaccharides in aqueous systems, including hydration, viscosity development, and potential applications as hydrocolloids in food-related formulations (Yang et al., 2023).

#### 2.3.3.2 Uronic Acids and Proteins

Uronic acids are also present in peach gum polysaccharide (PG). In the same analysis, the uronic-acid components (mg/g) were reported as:

1. D-Glucuronic acid (Glu A) – 65.91 mg/g
2. D-Galacturonic acid (Gal A) – 0.66 mg/g

In addition, the protein content of the analyzed PG sample was reported as 0.18% (w/w, dry basis), indicating a minor protein fraction associated with the polysaccharide material (Yang et al., 2023).

### 2.3.4 arabinose and Its Relationship with Arabinogalactan in Peach Gum

#### 2.3.4.1 arabinose in peach gum and release from polysaccharides

In peach gum, arabinose is mainly present as a constituent sugar (residue) within arabinogalactan-rich polysaccharides rather than as a free monosaccharide

(Simas et al., 2008; Zeng et al., 2022; Dai et al., 2024). The release of arabinose residues into free arabinose requires hydrolysis, which may occur through enzymatic cleavage (e.g., arabinofuranosidase-related activities) or other hydrolytic conditions (Kardošová et al., 1978; Zeng et al., 2022).

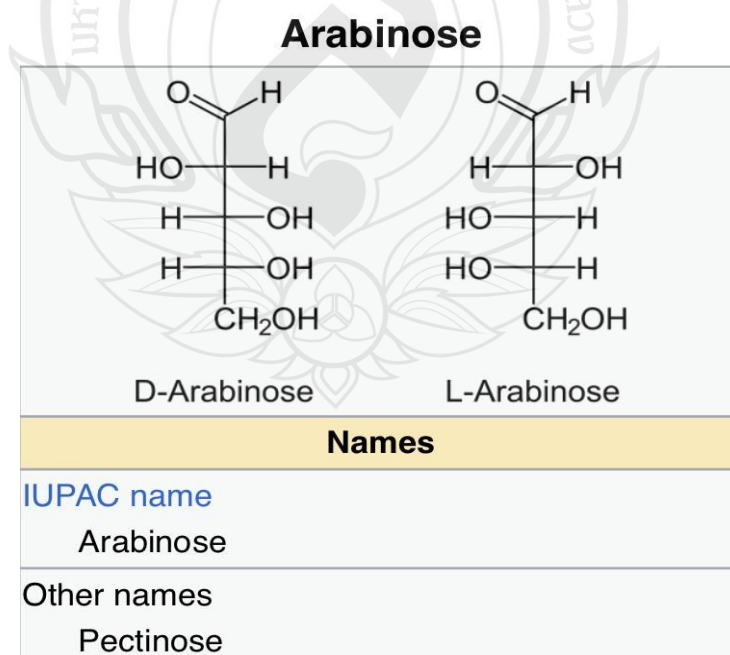
Peach gum polysaccharides can be utilized by gut microbiota in fecal fermentation models, supporting their role as prebiotic substrates and their link to SCFA-related outcomes (Wei et al., 2022). In contrast, free L-arabinose (Figure 2.3) is discussed primarily in relation to sucrose digestion and postprandial glycaemic/insulinaemic responses (Pol et al., 2020; Pasmans et al., 2022; Pol & Mars, 2021).

#### Key points

1. Prebiotic substrate (PGPs): peach gum polysaccharides can be fermented by gut microbiota (Wei et al., 2022).

2. Release mechanism: arabinose residues can be liberated from polysaccharides through hydrolysis (Kardošová et al., 1978; Zeng et al., 2022).

Metabolic relevance (free L-arabinose): evidence supports effects on sucrose digestion/postprandial responses when L-arabinose is present in free form (Pol et al., 2020; Pasmans et al., 2022; Pol & Mars, 2021).



Source “Arabinose” (2025)

**Figure 2.3** D- and L-arabinose (Fischer projections)

#### 2.3.4.2 Short-Chain Fatty Acids (SCFAs).

When complex carbohydrates are fermented by gut microbiota, SCFAs such as propionate and butyrate can be produced and are linked to metabolic and gut health (Ríos-Covián et al., 2016; Louis & Flint, 2017). Peach gum polysaccharides have been reported to affect gut microbiota in fermentation models and in animal models with SCFA-related outcomes (Wei et al., 2022; Noer et al., 2023).

#### 2.3.4.3 Propionate: Metabolic relevance

Propionate is a major short-chain fatty acid (SCFA) produced by colonic microbial fermentation of non-digestible carbohydrates (Ríos-Covián et al., 2016). Human evidence indicates that targeted delivery of propionate to the colon can increase satiety-related gut hormones (PYY and GLP-1) and reduce energy intake, with relevance to body weight maintenance/adiposity outcomes (Chambers et al., 2015). In broader SCFA literature, SCFAs (including propionate) are discussed in relation to regulation of body weight and insulin sensitivity, and SCFA profiles are linked to gut and systemic health in diet–microbiome contexts (Canfora et al., 2015; Ríos-Covián et al., 2016).

#### Key evidence-linked points

1. Satiety/appetite (human evidence): Increased colonic propionate delivery is associated with higher PYY and GLP-1 and lower energy intake, with implications for body weight maintenance/adiposity (Chambers et al., 2015).
2. Insulin sensitivity (review-level): SCFAs, including propionate, are discussed in relation to body weight control and insulin sensitivity (Canfora et al., 2015).
3. Inflammation/immune relevance (review-level): SCFAs are linked with diet and human health, including discussion in inflammatory contexts (Ríos-Covián et al., 2016).
4. Hepatic lipid metabolism (animal model): Propionate has been reported to repress hepatic lipogenesis and reduce hepatic triglyceride concentration in diet-induced obesity models (Weitkunat et al., 2016).
5. Hepatic steatosis/insulin sensitivity (animal model): SCFAs have been shown to protect against high-fat diet-induced obesity via metabolic switching

mechanisms, with relevance to insulin sensitivity and hepatic steatosis (den Besten et al., 2015).

2.3.4.4 Butyrate: Gut Health and Metabolic relevance . Butyrate is a major short-chain fatty acid (SCFA) produced by colonic microbial fermentation of non-digestible carbohydrates. It is widely discussed as an important metabolite for intestinal epithelial energy supply and colonic homeostasis, with additional roles in barrier function and immune regulation (Hamer et al., 2008; Parada Venegas et al., 2019). Evidence specific to peach gum polysaccharides shows fermentability in fecal fermentation models and links to SCFA-related outcomes, supporting their relevance as prebiotic substrates (Wei et al., 2022; Noer et al., 2023).

Key points:

1. Major SCFA from fermentation: Butyrate is a main end-product of microbial fermentation of dietary fiber/non-digestible carbohydrates (Hamer et al., 2008).
2. Energy source for intestinal epithelium: Butyrate is described as an important fuel for intestinal epithelial cells and contributes to colonic homeostasis (Hamer et al., 2008; Parada Venegas et al., 2019).
3. Barrier function (review-level): SCFAs (including butyrate) are discussed as strengthening gut barrier function; fecal SCFAs are reported as reduced in active IBD in review summaries (Parada Venegas et al., 2019).
4. Immune regulation (review-level): Butyrate is discussed as having immunomodulatory functions and relevance to intestinal inflammation, including mechanistic discussion via GPCRs (Parada Venegas et al., 2019).
5. Inflammation & carcinogenesis (review-level): Review literature summarizes butyrate effects in models related to inhibition of inflammation and carcinogenesis, while emphasizing that human in vivo data remain limited (Hamer et al., 2008).
6. Formation by microbiota: The formation of propionate and butyrate by the human colonic microbiota is described at pathway/producer level in microbiology literature (Louis & Flint, 2017).

7. Peach gum—fermentable substrate (in vitro): Peach gum polysaccharides undergo in vitro digestion and fecal fermentation and are reported to impact gut microbiota and SCFA-related outputs (Wei et al., 2022).

8. Peach gum—SCFAs in animal model: In a streptozotocin-induced rat model, peach gum was reported with outcomes that include microbial SCFA production (Noer et al., 2023).

9. Peach gum—gut inflammation model: Peach gum polysaccharide has been studied in a DSS-induced colitis context, supporting gut-health relevance at the disease-model level (Wei et al., 2023).

10. Metabolic relevance (review-level): SCFAs (including butyrate) are discussed in relation to body weight regulation and insulin sensitivity in review literature (Canfora et al., 2015).

11. Satiety relevance (review-level): Butyrate is described as potentially promoting satiety in review discussion, with caution that human in vivo data are limited (Hamer et al., 2008).

12. Processing rationale: Because peach gum polysaccharide structure can be altered by processing/hydrolysis (reviewed broadly), it is reasonable to discuss that boiling-related changes may influence fermentability and downstream SCFA profiles as a rationale, not a confirmed outcome (Zeng et al., 2022; Wei et al., 2022).

#### Conclusion

Overall, peach gum is an arabinogalactan-rich plant exudate whose polysaccharides can serve as fermentable substrates in gut fermentation models, supporting relevance to SCFA-related outcomes (Wei et al., 2022). Evidence from animal work also reports associations between peach gum intake and microbial SCFA production in metabolic disorder models (Noer et al., 2023). In this study context, processing (e.g., boiling) is discussed as a factor that may alter polysaccharide characteristics and thereby potentially influence fermentability; therefore, focusing on arabinose-related changes under boiling conditions remains justified (Zeng et al., 2022).

## 2.4 Preparation and Processing of Fresh Peach Gum for Various Applications

Peach gum is a natural plant exudate from peach trees that hardens after secretion, forming resin-like lumps that may vary in color. Commercial “raw” peach gum is commonly sold as dried resin pieces, and examples of different product colors/grades are shown in Figure 2.4.

For culinary use, dried peach gum is typically soaked in clean water to soften, followed by manual removal of visible impurities (e.g., small dark specks) before cooking (MICHELIN Guide Digital-Singapore, 2018). After this preparation, peach gum may be applied in food preparations, while peach gum polysaccharides are also discussed in the literature for broader application potential (e.g., functional ingredients/material uses) (Zeng et al., 2022).



Source Photograph by the author.

**Figure 2.4** Examples of commercially packaged raw peach gum sold as dried resin pieces (yellow and red varieties)

### 2.4.1 Cleaning and Sorting

After harvesting, dried peach gum was soaked in household drinking water to soften and swell, which facilitated manual removal of visible impurities (e.g., bark/wood debris). The softened gum was then rinsed with fresh drinking water prior to boiling (MICHELIN Guide Digital-Singapore, 2018).



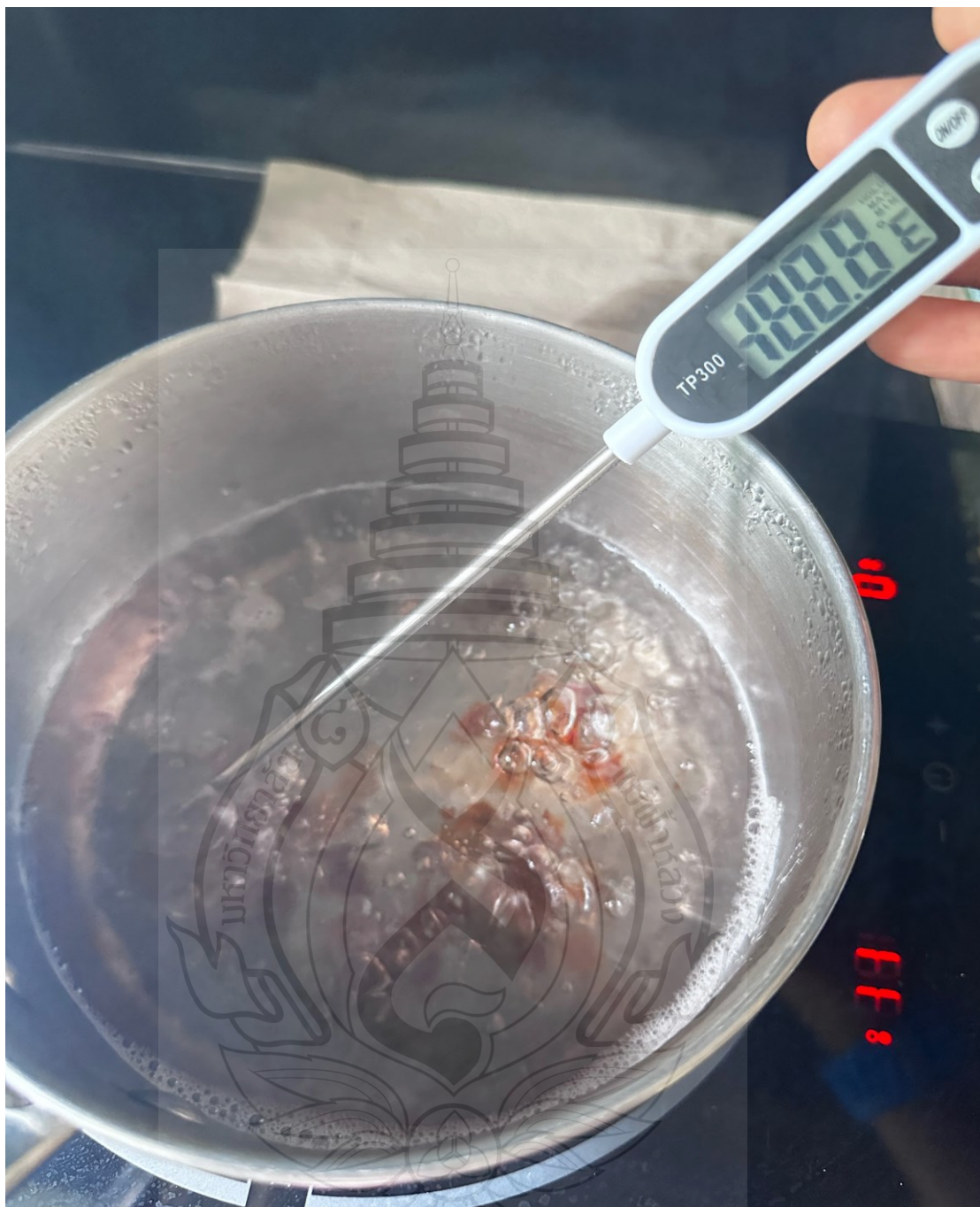
**Source** Photograph by the author.

**Figure 2.5** Raw peach gum soaked in household drinking water to allow swelling prior to manual impurity removal

#### 2.4.2 Processing Peach Gum into Usable Forms

Peach gum can be processed into different forms depending on the intended application, ranging from household culinary preparation to polysaccharide extraction and laboratory characterization.

2.4.2.1 Boiling for Household Consumption. One common household preparation method is boiling peach gum in water to soften the resin and make it suitable for culinary uses (Figure 2.6). In this study, soaking and boiling were performed using household drinking water to mimic consumer preparation; however, deionized (DI) water was used during laboratory sample preparation prior to HPLC analysis.



Source Photograph by the author.

**Figure 2.6** Household-style boiling of peach gum in drinking water at approximately 100°C during preparation

#### 2.4.2.2 Drying and Powder Processing.

For storage and formulation purposes, peach gum is commonly handled and distributed as dried resin pieces, which can later be rehydrated (soaked) prior to use

(MICHELIN Guide Digital-Singapore, 2018). Drying primarily serves to reduce moisture and improve shelf stability during storage. For product development, dried peach gum may be milled into a powder to improve handling, dosing, and dispersion in formulations where peach gum polysaccharides are used as hydrocolloid/functional carbohydrate ingredients (Zeng et al., 2022).

**2.4.2.3 Extraction of Polysaccharides from Peach Gum.** Peach gum polysaccharides are typically obtained through aqueous extraction followed by ethanol precipitation to recover polysaccharide-rich fractions. In a representative protocol, dried peach gum is extracted with water under heat (e.g.,  $\sim 95^{\circ}\text{C}$  for  $\sim 2$  h), the extract is clarified (e.g., by centrifugation), and polysaccharides are recovered by adding excess ethanol (e.g., several volumes) to precipitate the crude polysaccharide fraction. Subsequent steps such as deproteinization (e.g., Sevag method), dialysis, and freeze-drying may be applied to obtain a cleaner crude polysaccharide preparation suitable for downstream analysis or functional evaluation (Zhou et al., 2024).

In addition to hot-water extraction, some studies employ alkaline extraction (e.g., dilute NaOH) with neutralization and ethanol precipitation as part of polysaccharide preparation prior to downstream fractionation and fermentation-related evaluation (Wei et al., 2022).

For process development, preparation conditions (e.g., extraction time, ethanol concentration, and water-to-material ratio) have been optimized in research settings, and HPLC and FT-IR have been used as part of the evaluation of preparation/quality-related outcomes (Zhang et al., 2019).

#### **2.4.2.4 Purification/Fractionation and Analytical Characterization**

After crude extraction, peach gum polysaccharides may be further purified or fractionated depending on study objectives. Common clean-up steps include deproteinization and dialysis to reduce non-polysaccharide components in crude extracts (Zhou et al., 2024).

For fractionation by molecular size, ultrafiltration has been used to separate peach gum polysaccharide fractions with different molecular weight distributions. For example, ultrafiltration membranes with defined molecular weight cut-offs have been applied to obtain multiple fractions for comparative digestion/fermentation experiments (Wei et al., 2022).

Similarly, partially degraded peach gum polysaccharides have been isolated and reported as specific fractions (e.g., by ultrafiltration) for subsequent structural and bioactivity-related investigations (Wei et al., 2019).

For analytical characterization and quality evaluation (not “purification”), polysaccharide studies commonly report:

1. Molecular weight / size distribution (e.g., SEC-based methods such as SEC-MALLS) (Wei et al., 2022);
2. Monosaccharide composition after hydrolysis (reported in multiple peach gum polysaccharide studies; analytical specifics depend on the study) (Wei et al., 2022).
3. Process/quality-oriented analytical readouts where HPLC may be used as part of method evaluation (Zhang et al., 2019).

#### 2.4.2.5 Enzymatic Hydrolysis for Structural Studies (Not “Bioavailability Improvement”)

Enzymatic hydrolysis has been reported in the context of structural studies of peach gum polysaccharides. Specifically, enzyme preparations from *Aspergillus flavus* have been used to hydrolyze peach gum polysaccharide for structural investigation. The study reported hydrolysis products where D-galactose was a main product, and L-arabinose was detected in trace amounts, among other sugars/oligosaccharides—supporting the use of enzymatic cleavage as an approach to probe polysaccharide structure and constituent residues (Kardošová et al., 1978).

## 2.5 Pharmacological Properties of Peach Gum

### 2.5.1 Absorption of L-arabinose and Its Role in Blood Sugar Regulation

L-arabinose is discussed primarily as a functional pentose ingredient that can attenuate postprandial glycaemic responses when co-ingested with sucrose, mainly through effects on sucrose digestion in the small intestine (Pol et al., 2020; Pasmans et al., 2022; Pol & Mars, 2021).

In a double-blind randomized crossover trial, co-ingestion of L-arabinose with sucrose resulted in a lower rate of glucose appearance derived from sucrose (reported

as ~67% lower at 15 min and ~57% lower at 30 min), with the slowing effect described up to 150 min; endogenous glucose production was not different between conditions, and the insulin response was described as less pronounced (Pasmans et al., 2022).

#### 2.5.2 Metabolism and Elimination of L-arabinose

In human studies, L-arabinose is typically discussed in terms of its functional effect on sucrose digestion and postprandial responses, rather than as a major energy substrate (Pol & Mars, 2021; Pasmans et al., 2022).

Therefore, in this section it is safer and more accurate to state that the key physiological relevance in this thesis context is its role in modulating glucose appearance from sucrose, while SCFA outcomes should be discussed primarily under fermentable carbohydrates/polysaccharides (e.g., peach gum polysaccharides) rather than claiming SCFA production directly from free L-arabinose without a dedicated source.

#### 2.5.3 Impact of L-arabinose on Glucose Digestion and Absorption

Mechanistically, L-arabinose has been reported as a selective sucrase inhibitor with an uncompetitive inhibition mechanism in experimental work, supporting its use as an ingredient to blunt glycaemic responses from sucrose-containing foods (Seri et al., 1996; Pol & Mars, 2021).

Consistent with this, the human crossover trial reported that L-arabinose co-ingestion with sucrose slowed glucose appearance derived from sucrose (including the 15–30 min reductions) while endogenous glucose production was unchanged, indicating the effect is attributable to altered absorption kinetics from sucrose rather than suppression of hepatic glucose output (Pasmans et al., 2022).

#### 2.5.4 Effects of peach gum (polysaccharides) and SCFA-related pathways on lipid metabolism

Beyond glycaemic outcomes, lipid-related effects have been reported for peach gum interventions in animal models. In a streptozotocin-induced metabolic syndrome rat model, peach gum powder (PGP) significantly improved the lipid profile, including an increase in HDL-C and a reduction in triglycerides, alongside increases in caecal SCFAs (Noer et al., 2023). Therefore, in this chapter, lipid-metabolism relevance is discussed primarily in the context of (i) evidence from peach gum/peach gum

polysaccharide interventions and (ii) the broader SCFA literature describing links between SCFAs and metabolic regulation.

#### Key points

1. Animal evidence (peach gum): Peach gum powder improved HDL-C and reduced triglycerides in a MetS-induced rat model (Noer et al., 2023).
2. SCFA co-occurrence in the same model: The same study reported increased caecal SCFAs with peach gum powder intervention, supporting an SCFA-linked rationale (Noer et al., 2023).
3. Propionate/butyrate relevance (peach gum context): Peach gum polysaccharides are discussed as fermentable substrates linked to SCFA-related outputs in gut fermentation/animal contexts (Wei et al., 2022; Noer et al., 2023).
4. SCFAs and metabolic regulation (review-level): SCFAs are reviewed in relation to body weight control and insulin sensitivity (Canfora et al., 2015).
5. Diet–microbiome context (review-level): SCFAs are linked with diet and human health in gut–systemic contexts, supporting discussion of metabolic relevance (Ríos-Covián et al., 2016).
6. Hepatic lipid metabolism (animal model): Propionate has been reported to repress hepatic lipogenesis and improve insulin sensitivity in high-fat diet–induced obesity models (Weitkunat et al., 2016).
7. Lipogenesis-to-oxidation switch (animal model): SCFAs have been reported to protect against high-fat diet–induced obesity via a PPAR $\gamma$ -dependent metabolic switch from lipogenesis to fat oxidation (den Besten et al., 2015).
8. Butyrate and intestinal function (review-level): Butyrate is reviewed as an important metabolite for colonic function and intestinal homeostasis (Hamer et al., 2008).
9. Barrier/immune relevance (review-level): SCFAs (including butyrate) are reviewed in relation to gut epithelial and immune regulation, relevant to inflammatory contexts (Parada Venegas et al., 2019).
10. Interpretation boundary: Reported lipid changes in this section are supported directly by peach gum intervention evidence (Noer et al., 2023), while mechanistic pathways involving SCFAs and hepatic lipid metabolism are discussed as

supporting context based on SCFA-focused literature (Canfora et al., 2015; den Besten et al., 2015; Weitkunat et al., 2016; Ríos-Covián et al., 2016).

## 2.6 Applications of Peach Gum in Various Fields

Studies and review literature describe peach gum polysaccharides as functional carbohydrate/hydrocolloid materials with applications spanning food systems, health-related research (preclinical), cosmetic-related research models, and material/environmental uses (Zeng et al., 2022).

### 2.6.1 Applications in the Food Industry (revised with in-text citations)

Peach gum is an arabinogalactan-rich plant exudate whose polysaccharides have been discussed as hydrocolloid ingredients relevant to food formulations, including viscosity/texture modification and stabilization in model food systems (Zeng et al., 2022).

#### 1. Thickening and texture modification (hydrocolloid behavior).

Physicochemical studies report that peach gum polysaccharides can increase viscosity in aqueous systems and show concentration-dependent rheological behavior, supporting their potential use as texture/structure modifiers in food-related formulations (Qian et al., 2011; Wei, Ma, et al., 2019).

#### 2. Stabilization and structuring in emulsion-type systems (model relevance).

In an oil-in-water emulsion model, peach gum-based structures (with soybean protein isolate) were investigated for rheology modification and lipid-digestion-related outcomes, supporting relevance to emulsion-type systems used in food formulation research (Chen et al., 2024).

Note: Evidence here is from model systems; therefore wording should remain “has been investigated/has been studied” rather than claiming confirmed performance in specific commercial products (Chen et al., 2024).

#### 3. Edible coatings / surface films for shelf-life quality.

Peach gum polysaccharides have been applied as edible-coating materials; a study on cherry tomatoes reported peach gum polysaccharide-based coatings with outcomes related to storage/shelf-life quality of fresh produce (Li et al., 2017).

### 2.6.2 Health Applications

Peach gum polysaccharides have been investigated for health-related effects mainly in experimental settings (in vitro studies, in vivo animal models, and gut digestion/fermentation models). In a streptozotocin-induced rat model, peach gum intake was reported to improve outcomes relevant to metabolic syndrome components and was also discussed in relation to microbial short-chain fatty acid (SCFA) production; therefore, current evidence should be interpreted as preclinical/animal-model findings rather than confirmed human outcomes (Noer et al., 2023). Hypoglycaemic and hypolipidaemic properties of peach gum polysaccharides have also been reported in an animal model study (Wu et al., 2017).

In digestion–fermentation research, peach gum polysaccharides with different molecular-weight fractions were reported to undergo in vitro digestion and fecal fermentation, with impacts on gut microbiota and fermentation-related outputs, supporting their discussion as fermentable carbohydrate substrates in gut-relevant models (Wei et al., 2022).

Beyond metabolic contexts, peach gum polysaccharides have also been studied in disease-model settings. For example, a peach gum polysaccharide was structurally characterized and investigated in a DSS-induced acute colitis model, supporting interest in gut-health–related applications at the experimental level (Wei et al., 2023). In another study, peach gum polysaccharides were investigated for hepatoprotective effects in an alcoholic liver injury context, with outcomes discussed in relation to oxidative stress and lipid metabolism (Zhou et al., 2024).

Regarding anti-tumor/anti-proliferative potential, peach gum–derived polysaccharide fractions (including partially degraded polysaccharides and alkali-extracted arabinogalactan preparations) have been investigated for anti-proliferative/anti-tumor activity in experimental studies; however, claims should be stated as “has been investigated/reported in experimental studies” rather than as established clinical effects (Wei et al., 2019; Dai et al., 2024).

#### 2.6.2.1 Applications in the Cosmetic Industry

Peach gum polysaccharides have gained interest as cosmetic-related ingredients primarily due to experimental evidence in UVB-related photoaging contexts. A mechanistic study reported that peach gum polysaccharide could attenuate

UVB-induced photoaging-related changes by modulating matrix metalloproteinases and oxidative factors, supporting its discussion as a natural candidate for anti-photoaging/skin-protection research (Yang et al., 2023).

Given the current evidence base, cosmetic claims should be written as “has been investigated” and should avoid overgeneralizing to guaranteed clinical benefits in humans unless supported by human trials.

### 2.6.3 Medical Applications

Peach gum polysaccharides have been investigated mainly in preclinical settings (animal models and in vitro/model systems); therefore, “medical application” claims should be framed as experimental evidence rather than confirmed human clinical effects (Wu et al., 2017; Noer et al., 2023; Zeng et al., 2022).

#### 2.6.3.1 Blood Sugar Control and Diabetes-Related Outcomes (preclinical evidence)

In an animal-model study, peach gum polysaccharides were reported to improve glycaemic-related markers in KKAY mice after repeated oral administration, including reductions in fasting blood glucose and HbA1c (Wu et al., 2017). Because these findings come from an animal model, they should be interpreted as supportive evidence for further study rather than proof of clinical efficacy in humans (Wu et al., 2017).

#### 2.6.3.2 Lipid-Related Outcomes and Weight-Management Relevance (preclinical evidence)

The same preclinical study also reported lipid-related improvements (e.g., triglycerides and LDL-C) following peach gum polysaccharide administration in KKAY mice, supporting discussion of hypolipidaemic potential at the animal-model level (Wu et al., 2017). Additionally, peach gum has been reported in another animal model (streptozotocin-induced rats) with outcomes discussed in relation to metabolic syndrome components and microbial SCFA production, which supports continued investigation in metabolic-health contexts (Noer et al., 2023).

#### 2.6.3.3 Anti-tumor / Anti-proliferative Potential (experimental studies)

Peach gum-derived polysaccharide fractions have been investigated for anti-proliferative or anti-tumor activities in experimental studies, including partially degraded polysaccharides and alkali-extracted peach gum arabinogalactan preparations

(Wei et al., 2019; Dai et al., 2024). At this stage, these findings should be reported as experimental observations, and detailed immune-mechanism claims (e.g., macrophage activation, TNF- $\alpha$ , IL-2, IFN- $\gamma$ , or specific % inhibition values) should not be included unless directly documented in the cited primary papers (Wei et al., 2019; Dai et al., 2024).

#### 2.6.3.4 Applications in Rehabilitative Medicine and Elderly Care.

Dysphagia (swallowing difficulties) in older adults is clinically relevant because it is associated with risks such as undernutrition and aspiration-related complications, and it is commonly managed by thickening liquids using commercial thickeners to improve swallowing safety (Garin et al., 2014). Because viscosity can vary across different beverage types even when the same thickener is used, viscosity/consistency should not be assumed to match thickened water in all drinks (Garin et al., 2014). Peach gum polysaccharides are hydrocolloid-type materials and may therefore be explored as potential thickening/texture-modifying ingredients; however, dysphagia-oriented use would require direct rheological testing in relevant beverage matrices (Zeng et al., 2022).

#### 2.6.4 Biotechnology Industry

Peach gum polysaccharides have been investigated as renewable biopolymer materials for biotechnological applications (mainly in laboratory-scale material/adsorption studies); therefore, statements should be framed as “investigated/reported in experimental studies” rather than established industrial performance (Zeng et al., 2022).

##### 1. Surface films / coatings (food–biomaterial interface).

In experimental food-preservation settings, peach gum polysaccharides have been applied as edible-coating materials. A study on cherry tomatoes reported peach gum polysaccharide–based coatings with outcomes related to extended shelf life and maintenance of storage-quality parameters (Li et al., 2017).

##### 2. Environmental/ water-treatment biomaterials (adsorbent-type applications).

Peach gum polysaccharides have also been modified/functionalized and investigated as adsorbent materials for pollutant removal. For example, multi-amine functionalization of peach gum polysaccharide has been reported for adsorption of

hexavalent chromium (Cr(VI)) in water-treatment-oriented experiments (Tan et al., 2018).

In addition, a magnetic gel prepared from peach gum polysaccharide has been investigated for adsorption of heavy-metal ions such as Pb<sup>2+</sup> and Cd<sup>2+</sup> under experimental conditions (Huang et al., 2018).

**Table 2.2** Summary of peach gum applications in various industries

Industry	Utilization	Experimental Evidence	References
1. Food Industry	- Hydrocolloid/texture modifier; emulsion-model rheology studies; edible coating	- Evidence is mainly from physicochemical/rheology studies and food-model experiments (e.g., hydrocolloid behavior, emulsion systems) rather than confirmed commercial product performance. -Edible-coating evidence is reported in a model produce study (e.g., cherry tomatoes).	Zeng et al. (2022), Wei, Ma, et al. (2019), Chen et al. (2024) and Li et al. (2017)
2. Health/medical relevance (preclinical)	- Metabolic- and gut-health-related outcomes (animal/model systems)	-Evidence is largely preclinical (animal models, in vitro studies, and digestion/fermentation models); findings should not be interpreted as confirmed clinical effects in humans.	Wu et al. (2017), Noer et al. (2023), Wei et al. (2022), Wei et al. (2023) and Zhou et al. (2024)

**Table 2.2** (continued)

Industry	Utilization	Experimental Evidence	References
3. Cosmetics Industry	- UVB/ photoaging mechanism study	- Evidence is mainly mechanistic/preclinical (e.g., UVB-related photoaging model study); claims should be framed as investigated/ reported in the cited study.	Yang et al. (2023)
4. Biotechnology/ environmental	- Heavy-metal ion adsorption (e.g., Pb <sup>2+</sup> /Cd <sup>2+</sup> ); Cr(VI) removal / adsorption; biomaterial potential	- Evidence is from experimental adsorption/ material studies using functionalized peach gum polysaccharides; reported performance depends on experimental conditions and is not a guarantee of field-scale efficacy.	Huang et al. (2018), Tan et al. (2018) and Zeng et al. (2022)

## 2.7 Mechanisms and Functional Relevance of Peach Gum (*Prunus persica*) (Experimental Evidence)

Current mechanistic evidence for peach gum relates mainly to experimental settings (in vitro studies, animal models, and digestion/fermentation models). Therefore, statements in this section should be interpreted as reported/investigated mechanisms rather than confirmed clinical effects in humans (Wu et al., 2017; Wei et al., 2022; Zeng et al., 2022).

### 2.7.1 Glycaemic-Related Effects (Experimental Evidence)

#### 1. Peach gum polysaccharides (PGPs): animal-model findings.

In a preclinical study, peach gum polysaccharides were reported to improve glycaemic-related outcomes in a diabetic mouse model after repeated administration.

These results support further investigation but do not confirm clinical efficacy in humans (Wu et al., 2017).

2. Free L-arabinose: sucrase inhibition and reduced postprandial responses (not the same as “PGPs”).

Evidence for L-arabinose as a sucrose/sucrase-related modulator should be attributed to studies where L-arabinose is present in free form (e.g., added into foods/drinks), rather than being assumed to occur directly from intact peach gum polysaccharides (Pol et al., 2020; Pasmans et al., 2022; Pol & Mars, 2021).

An earlier animal study reported that L-arabinose selectively inhibits intestinal sucrase in an uncompetitive manner and suppresses glycaemic response after sucrose ingestion (Seri et al., 1996).

#### 2.7.2 Lipid-Related Outcomes (Preclinical Evidence)

Hypolipidaemic-related outcomes for peach gum polysaccharides have been reported in an animal model study, supporting discussion at the preclinical level only (Wu et al., 2017).

In another animal model, peach gum intake was reported with outcomes discussed in relation to metabolic syndrome components and microbial SCFA production, which may support continued investigation in metabolic-health contexts (Noer et al., 2023).

#### 2.7.3 Anti-tumor / Anti-proliferative Potential (Experimental Studies)

Peach gum-derived polysaccharide fractions have been investigated for anti-proliferative/anti-tumor activity in experimental studies (e.g., partially degraded polysaccharides; alkali-extracted arabinogalactan preparations). These findings should be framed as experimental observations rather than established medical effects (Wei et al., 2019; Dai et al., 2024).

2.7.4 UVB-related Photoaging / Skin-Related Mechanistic Study (Experimental Evidence)

A mechanistic/preclinical study investigated peach gum polysaccharide in a UVB-induced skin photoaging context, with discussion linked to matrix metalloproteinase (MMP)-related pathways and oxidative factors. Claims should be stated as “investigated/reported in the cited study.” (Yang et al., 2023)

### 2.7.5 Viscosity Modification Relevance for Dysphagia (Conceptual / Requires Direct Testing)

Dysphagia management commonly involves thickened beverages, and viscosity can differ across beverage matrices even when thickened to the same target level (Garin et al., 2014).

Because peach gum polysaccharides are hydrocolloid-type materials, they may be explored as thickening/texture-modifying ingredients; however, dysphagia-oriented claims would require direct rheological testing in relevant beverage matrices before any clinical implication is stated (Zeng et al., 2022).

**Table 2.3** Summary of L-arabinose: Mechanisms of action, health relevance, dosage/form, and experimental evidence

No.	Mechanism of action (L-arabinose)	Health relevance	Dosage / form reported	Experimental evidence	References
1	Selective intestinal sucrase inhibition (uncompetitive), slowing sucrose hydrolysis	- Supports attenuation of postprandial glycaemic response after sucrose ingestion (context: sucrose-containing intake)	Co-administered with sucrose (dose/form as reported in the study)	Animal study evidence reported uncompetitive inhibition of sucrase and suppression of glycaemic response following sucrose ingestion; should be interpreted as preclinical evidence	Seri et al. (1996)

**Table 2.3** (continued)

No.	Mechanism of action (L-arabinose)	Health relevance	Dosage / form reported	Experimental evidence	References
2	Supports reduced/ flattened postprandial glucose excursions from sucrose under controlled conditions	- Supports reduced/ flattened postprandial glucose excursions from sucrose under controlled conditions	L-arabinose co-ingested with sucrose (dose/form as reported in the trial)	Double-blind, randomized crossover human trial reported delayed glucose absorption derived from sucrose; findings are specific to the tested formulation and conditions	Pasmans et al. (2022)
3	Replacing sucrose with L-arabinose in foods/drinks to modify postprandial responses	- Supports formulation strategies aiming to reduce glycaemic and insulinaemic responses associated with sucrose	Sucrose replacement with L- arabinose in drink and cereal-food formats (proportions as reported)	Human study reported blood glucose and plasma insulin responses when sucrose was replaced with L-arabinose in selected product formats; evidence should be framed as tested in the study context	Pol et al. (2020)

**Table 2.3** (continued)

No.	Mechanism of action (L-arabinose)	Health relevance	Dosage / form reported	Experimental evidence	References
4	Evidence synthesis (mechanisms and applications of pentoses/ rare sugars including L-arabinose)	- Provides review-level context for mechanisms and use-cases (not primary efficacy proof)	Not dose- focused (review)	Narrative review summarizing mechanisms and reported effects across studies; use for background framing rather than as primary effect evidence	Pol and Mars (2021)

## 2.8 Detection of L-arabinose in Peach Gum Using High-performance Liquid Chromatography (HPLC)

Quantification of L-arabinose in peach gum is analytically relevant because arabinose is typically present as a constituent residue within peach gum polysaccharides, and processing/hydrolysis conditions may influence the measurable sugar profile. Therefore, an instrumental method that can reliably separate and quantify monosaccharides is required for this study context (Zeng et al., 2022).

### 2.8.1 Accuracy, precision, and suitability for monosaccharide quantification

High-performance liquid chromatography (HPLC), commonly coupled with refractive index detection (RID) for carbohydrate analysis, allows reliable separation and quantification of individual sugars. In validated HPLC–RID approaches, multiple sugars (including arabinose and galactose) can be resolved with good reproducibility and precision using aqueous mobile phases and appropriate carbohydrate columns (Weiß & Alt, 2017).

### 2.8.2 Simultaneous analysis of multiple sugars in complex matrices

Unlike single-analyte enzymatic assays, chromatographic methods such as HPLC enable the simultaneous detection and quantification of several sugars within the same run. This is useful when assessing L-arabinose alongside other relevant monosaccharides in a complex sample matrix (Weiß & Alt, 2017).

### 2.8.3 Relevance to research and product-quality evaluation contexts

Quantitative HPLC data can support research-grade comparison of samples processed under different conditions and can also be used as an analytical basis for quality evaluation where carbohydrate composition is a key specification (Zeng et al., 2022; Weiß & Alt, 2017).



## CHAPTER 3

### RESEARCH METHODOLOGY

#### 3.1 Study Design

##### 3.1.1 Experiment Design

A laboratory-based comparative experiment was conducted and structured into three modules as follows:

##### 3.1.1.1 Module A: Raw Compared with 30-Minute Boil (No Soak)

Purpose: To establish a baseline comparison between unboiled (raw) peach gum and peach gum boiled for 30 minutes.

Groups:

1. Raw peach gum (unboiled)
2. Peach gum boiled at 100 °C for 30 minutes

Sample Preparation Ratio: 1 g of peach gum per 20 mL of potable water.

Sample Collection: For both groups, the gum was collected for analysis. For the 30-minute boiled condition, the boiling water was also collected. The gum and water were analyzed separately to determine arabinose concentration, with gum reported as percent weight-per-weight (% w/w) and water reported as percent weight-per-volume (% w/v).

Use of Results: Results from Module A were used exclusively to compare raw and 30-minute boiled samples to determine whether heat treatment affects arabinose content. The boiling-water measurement in this module served only as a qualitative indicator of arabinose leaching and was not used for multi-timepoint comparisons.

##### 3.1.1.2 Module B: Time-Course Boiling (No Soak)

Purpose: To investigate the time-dependent release and retention of arabinose during boiling under increasing heat-treatment durations.

Boiling Durations: 30, 45, 60, and 90 minutes at 100 °C.

Sample Collection:

1. 30-minute group: Both the peach gum and the boiling water were collected and analyzed. The dataset is identical to the 30-minute condition in Module A but is included here to enable complete time-course visualization.

2. 45-, 60-, and 90-minute groups: Only the peach gum was collected and analyzed for arabinose content.

Use of Results: Data from Module B were used to construct time-course plots and to observe trends in arabinose concentration across progressively longer boiling durations.

3.1.1.3 Module C: Pre-Soaking Followed by Short Boiling (Household-Friendly Approach)

Purpose: To evaluate whether pre-soaking peach gum can reduce the required boiling time while maintaining or enhancing arabinose content, thus providing a preparation method that is more practical for household use.

Pre-Soaking Conditions: Peach gum was soaked for 1, 2, and 3 hours in room-temperature drinking water.

Boiling Durations: 5, 10, 15, and 30 minutes at 100 °C.

Sample Preparation Ratio: 1 g of peach gum per 20 mL of water.

Sample Collection: Only the peach gum was collected and analyzed for arabinose content. Boiling water was not collected in this module.

Use of Results: Data from Module C were used to determine whether pre-soaking allows the use of shorter boiling durations without substantial loss of arabinose. The findings also inform recommendations for a household-friendly preparation technique.



Source Photograph by Author

**Figure 3.1** Raw peach gum (particle size approximately 0.6–0.8 cm). Left: retail package from Biosacc Co., Ltd., China. Right: raw beads in their natural form, weighed to 30 g prior to the experiment



Source Photograph by Author

**Figure 3.2** Raw peach gum ground to a fine, homogeneous powder prior to HPLC analysis

#### Sample Handling and Replication

**Single Lot Usage:** All samples were prepared using peach gum obtained from the same lot to minimize inter-sample variability and ensure consistency across all experimental conditions.

**Replicates:** Each condition was performed in triplicate

( $n = 3$ ) to support analytical reliability and reproducibility.

**Fixed Ratio:** A constant preparation ratio of 1 g of peach gum to 20 mL of drinking water was maintained. The same type of vessel and heat source was used across all conditions to reduce technical variability.

**Independent Vessels per Timepoint:** For each boiling duration (30, 45, 60, and 90 minutes), samples were prepared in separate vessels rather than withdrawing aliquots from a single pot over time. This approach ensured that each timepoint functioned as an independent experimental unit and avoided potential inter-timepoint influence (carry-over).

The same principle was applied to the pre-soaking followed by short-boiling combinations (e.g., 1, 2, or 3 hours of soaking combined with boiling for 5, 10, 15, or 30 minutes), with each soak–boil condition prepared in its own separate vessel.

**Timing Control:** Boiling durations were recorded from the point at which the water reached a constant rolling boil. Heat input was kept constant throughout each experiment, and the mixture was stirred gently to promote uniform heating.

**Post-Boil Handling:** At the designated timepoint, boiling was stopped and the samples were promptly quenched.

Boiling water (in modules where it was analyzed) was clarified or filtered as required, allowed to cool to room temperature, and then prepared for High-Performance Liquid Chromatography (HPLC) analysis.

**Gum matrix:** The boiled gum was removed using a stainless-steel household strainer, drained, and homogenized prior to analysis.

**Documentation:** Detailed records—including start and stop times, temperatures, and pot or run identification numbers—were maintained to support reproducibility and traceability of the experimental workflow



**Figure 3.3** Peach gum matrix after boiling, drained with a standard strainer and homogenized before analysis

### Analytical Method

High-Performance Liquid Chromatography (HPLC) was employed as the primary analytical technique for quantifying arabinose in the peach gum samples. Quantification was performed using an external calibration approach constructed from L-arabinose standard solutions. Both the peach gum matrix and, where applicable, the remaining boiling water were analyzed to determine the total arabinose profile associated with each treatment condition.

### Randomization and Blinding

To minimize analytical bias and instrument drift, randomization and blinding procedures were implemented throughout the analysis. Within each batch, the injection order of samples was randomized. All sample vials were coded prior to analysis (as illustrated in Figures 3.4 and 3.5), and the coding scheme concealed the experimental condition from the analyst during HPLC runs. This ensured that data acquisition and interpretation were performed under blinded conditions.

**Table 3.1** Experimental design and conditions of each module

Module	Condition	Soaking Time	Boiling Time @100°C	Sample Collected
A	Raw peach gum	–	–	Peach gum only
A	No soak	–	30 min	Peach gum followed by boiling water (water analyzed separately)
B	No soak	–	45 min	Peach gum only
B	No soak	–	60 min	Peach gum only
B	No soak	–	90 min	Peach gum only
C	Pre-soak	1 h	5 min	Peach gum only
C	Pre-soak	1 h	10 min	Peach gum only
C	Pre-soak	1 h	15 min	Peach gum only
C	Pre-soak	1 h	30 min	Peach gum only
C	Pre-soak	2 h	5 min	Peach gum only

**Table 3.1** (continued)

Module	Condition	Soaking Time	Boiling Time @100°C	Sample Collected
C	Pre-soak	2 h	10 min	Peach gum only
C	Pre-soak	2 h	15 min	Peach gum only
C	Pre-soak	2 h	30 min	Peach gum only
C	Pre-soak	3 h	5 min	Peach gum only
C	Pre-soak	3 h	10 min	Peach gum only
C	Pre-soak	3 h	15 min	Peach gum only
C	Pre-soak	3 h	30 min	Peach gum only

**Note 1.** The ratio of peach gum to water was maintained consistently at 1 g per 20 mL (weight/volume; w/v) across all experimental conditions.

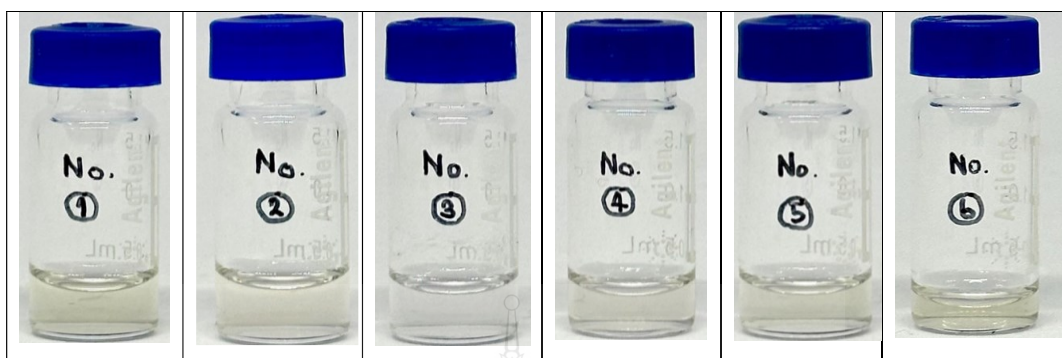
2. Each experimental condition was conducted in triplicate (n = 3) to ensure reproducibility and reduce random variability.

3. High-Performance Liquid Chromatography (HPLC) was employed as the principal analytical technique for the quantification of arabinose in all samples.

4. For the 30-minute boiling without pre-soaking condition, the remaining boiling water was additionally collected and analyzed separately to determine the amount of arabinose released into the liquid phase.

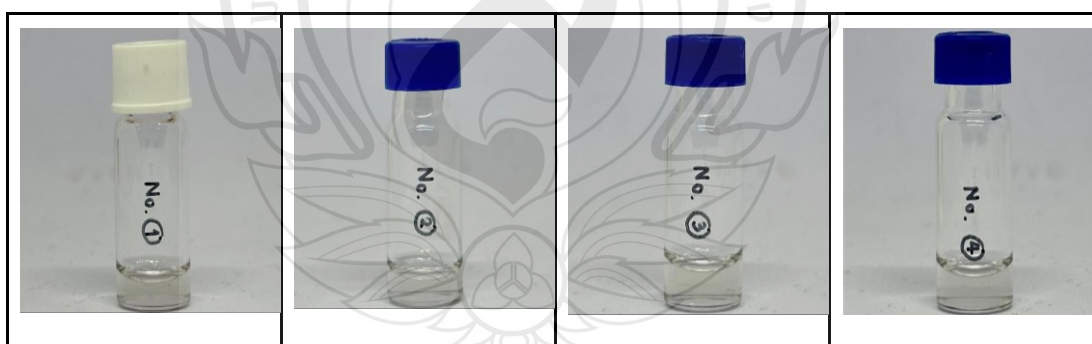
5. The results for the 30-minute no-soak condition (gum and boiling water) were shared between Module A and Module B; no separate 30-minute batch was prepared specifically for Module

All boiling durations were measured only after the water reached a constant rolling boil to ensure consistent and uniform thermal exposure across all conditions.

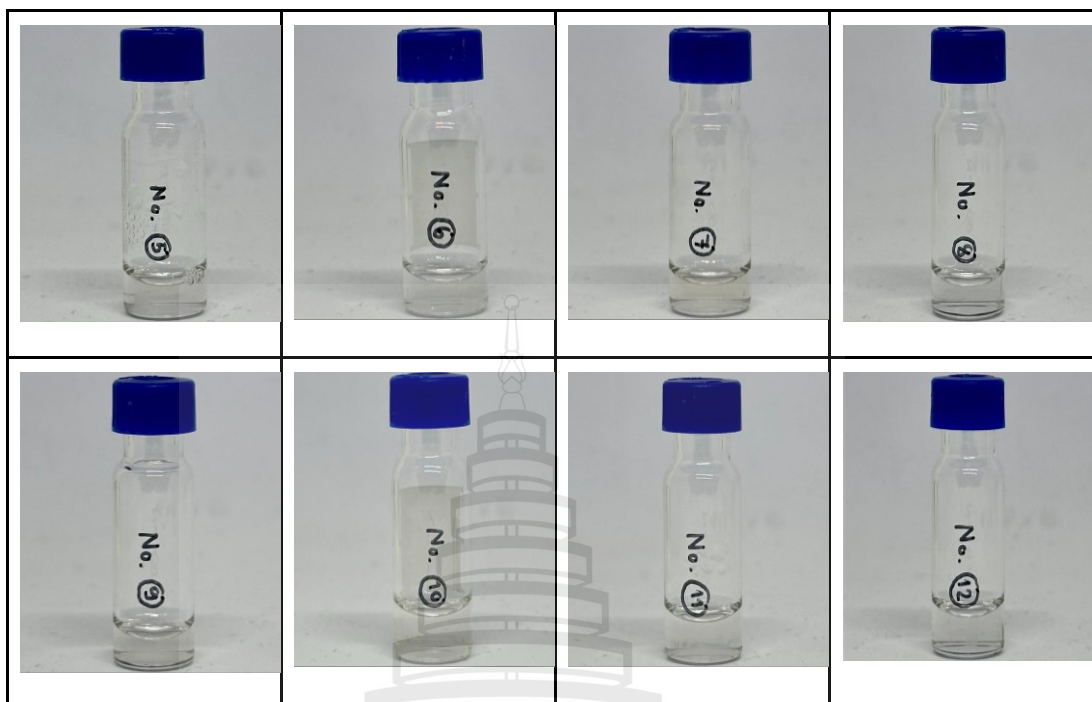


- Note**
1. Boiled peach gum (natural form), 100 °C, 30 minutes, 1000 mL water
  2. Boiled peach gum (natural form), 100 °C, 45 minutes, 1000 mL water
  3. Boiled peach gum (natural form), 100 °C, 60 minutes, 1000 mL water
  4. Boiled peach gum (natural form), 100 °C, 90 minutes, 1000 mL water
  5. Raw peach gum (natural form), unboiled
  6. Boiling-water extract collected after peach gum boiling at 100 °C for 30 minutes

**Figure 3.4** Codes of sample vials prepared for high-performance liquid chromatography analysis of peach gum samples boiled without pre-soaking under various time durations.



**Figure 3.5** Codes of sample vials prepared for High-Performance Liquid Chromatography analysis to quantify the arabinose content under different soaking and boiling conditions



- Note**
1. Peach gum (PG) soaked for 1 hour and boiled at 100 °C for 5 minutes
  2. Peach gum (PG) soaked for 1 hour and boiled at 100 °C for 10 minutes
  3. Peach gum (PG) soaked for 1 hour and boiled at 100 °C for 15 minutes
  4. Peach gum (PG) soaked for 1 hour and boiled at 100 °C for 30 minutes
  5. Peach gum (PG) soaked for 2 hours and boiled at 100 °C for 5 minutes
  6. Peach gum (PG) soaked for 2 hours and boiled at 100 °C for 10 minutes
  7. Peach gum (PG) soaked for 2 hours and boiled at 100 °C for 15 minutes
  8. Peach gum (PG) soaked for 2 hours and boiled at 100 °C for 30 minutes
  9. Peach gum (PG) soaked for 3 hours and boiled at 100 °C for 5 minutes
  10. Peach gum (PG) soaked for 3 hours and boiled at 100 °C for 10 minutes
  11. Peach gum (PG) soaked for 3 hours and boiled at 100 °C for 15 minutes
  12. Peach gum (PG) soaked for 3 hours and boiled at 100 °C for 30 minutes

**Figure 3.5** (continued)

## 3.2 Materials and Equipment

### 3.2.1 Materials

#### 3.2.1.1 Raw Peach Gum

Source: Biosacc Co., Ltd., China (available at: <http://www.biosacc.com>)

Seller : AVA Plant Co.,Ltd. Address: 119 Bangna-Trad 42 Debaratana rd.  
Bangna-Tai Bangna Bangkok Thailand 10260

Tax No.: 0105555000307(Head office) Tel. 0844331354 Info@avaplant.com  
<http://www.abaplant.com>

Total quantity used: Approximately 1,530 g, calculated from 17 experimental conditions performed in triplicate, with 30 g of peach gum used per condition. No additional 30-minute boiling batch was prepared for Module B; instead, the 30-minute dataset obtained in Module A was reused for Module B analyses.

Lot selection: All peach gum specimens were obtained from the same product lot to minimize inter-sample variability and ensure consistency across all experimental conditions.

#### 3.2.1.2 Prepared Samples

Raw peach gum was processed under multiple controlled conditions across three experimental modules:

No-Soak Condition — Module A (Baseline Comparison): This module compared unboiled raw peach gum with peach gum boiled at 100 °C for 30 minutes to establish the baseline effect of heat treatment.

No-Soak Condition — Module B (Time-Course Analysis):  
Peach gum samples were boiled at 100 °C for 30, 45, 60, and 90 minutes.

The 30-minute boiling data were identical to those generated in Module A and were included in Module B solely for time-course visualization and comparison.

Pre-Soak Condition — Module C (Pre-Soaking Followed by Short-Duration Boiling): Raw peach gum was soaked in drinking water at room temperature for 1, 2, and 3 hours and subsequently boiled at 100 °C for 5, 10, 15, or 30 minutes.

Ratio: All experimental conditions adhered to a fixed proportion of 30 g of peach gum per 600 mL of water (equivalent to a 1:20 weight-to-volume ratio), resulting in a total water requirement of approximately 30.6 liters for the entire experiment.

Sample collection:

1. Module A (30-minute, no-soak): Both peach-gum solids and the remaining boiling water were collected and analyzed separately.

2. Module B (45, 60, and 90 minutes): Only the peach-gum solids were collected and analyzed; boiling water for the 30-minute condition was already assessed in Module A.

3. Module C: Only the peach-gum solids were collected; boiling water was not collected for analysis in this module.

### 3.2.2 Equipment

The following equipment was used throughout the experiment to ensure accuracy, consistency, and adherence to validated analytical procedures:

1. High-Performance Liquid Chromatography (HPLC) system equipped with an Agilent Hi-Plex Calcium (Ca) column and a Refractive Index Detector (RID).

2. Analytical balance with a precision of 0.1 millig (four-digit readability).

3. Beakers (50 mL) and measuring cylinders (100 mL) for sample handling and volume measurement.

4. Volumetric flasks (100 mL) for preparing standard solutions and sample dilutions.

5. Glass test tubes (20 mL) with secure caps for sample storage prior to extraction or filtration.

6. Micropipettes (20–200 microliters and 100–1000 microliters) equipped with sterile disposable tips for accurate liquid transfer.

7. Membrane filters with a pore size of 0.45 micrometers, or syringe filters, used to clarify samples prior to HPLC injection.

8. Digital thermometer with a measurement range up to 100 °C Celsius for monitoring and maintaining consistent temperature conditions.

9. Stopwatch or digital timer for precise recording of boiling and soaking durations.

10. Household stainless-steel cooking pot and an induction cooktop with a fixed power setting to maintain a consistent rolling boil for all heat-treatment conditions.

### 3.2.3 Chemicals

The following chemicals and solvents were used throughout the experiment to ensure analytical accuracy and consistency:

1. Drinking water. Used for soaking and boiling the peach gum samples during all heat-treatment procedures.

2. Deionized water. Used for sample dilution and served as the mobile phase in the High-Performance Liquid Chromatography (HPLC) system. The deionized water was filtered and degassed prior to use to ensure suitability for chromatographic analysis.

3. L-arabinose standard solution. Prepared at predetermined concentrations and used to construct the external calibration curve for quantitative analysis of arabinose in all samples.

4. Mobile-phase solvent. Deionized water was used as the sole mobile phase in accordance with the requirements for the Agilent Hi-Plex Calcium (Ca) column. No organic solvents were utilized during sample analysis, except when necessary for column maintenance or cleaning (for example, HPLC-grade acetonitrile).

## 3.3 Experimental Site

All experimental procedures were carried out at the Sugars and Derivatives Analytical Laboratory (SuDAL), Faculty of Agro-Industry, Kasetsart University. This laboratory is a certified analytical facility specializing in the quantification of sugars and related compounds. It employs validated methodologies, including High-Performance Liquid Chromatography (HPLC), to ensure analytical precision, reproducibility, and data reliability.

The laboratory is equipped with an advanced HPLC system and controlled-environment facilities suitable for detailed carbohydrate analysis, making it an appropriate setting for the quantitative evaluation of arabinose in peach gum samples.

Location: Room 3411, 4th Floor, Agro-Industry Building 3, Faculty of Agro-Industry, Kasetsart University

Website: [www.csdlabservices.com](http://www.csdlabservices.com)

Telephone: 095-517-6493

Experiment period: October to November 2025 (all experimental modules—Modules A, B, and C—were conducted within this continuous period)

### **3.4 Experimental Procedure**

#### **3.4.1 Sample Preparation**

Peach gum samples were prepared according to three experimental modules in order to evaluate the effects of heat treatment and pre-soaking on arabinose content. In all experiments, the ratio of peach gum to water was standardized at 1:20 (weight/volume), using 30 g of peach gum and 600 mL of drinking water per batch. Each experimental condition was performed in triplicate ( $n = 3$ ) to ensure reproducibility and reduce variability.

##### **3.4.1.1 No-Soak (Direct Boil) Condition**

This module was designed to assess the impact of boiling duration on arabinose content without any pre-soaking.

Thirty g of peach gum were boiled in 600 mL of drinking water at 100 °Cs Celsius for 30, 45, 60, and 90 minutes.

After the designated boiling duration, each batch was allowed to cool to room temperature.

1. For the 30-minute boiling group, both the boiled gum and the remaining boiling water were collected and analyzed separately to quantify arabinose content in the solid matrix and the cooking liquid.

2. For the 45-, 60-, and 90-minute groups, only the boiled gum was collected and analyzed; the boiling water was not included in the analysis for these timepoints.

#### 3.4.1.2 Pre-Soak Followed by Short Boil

For each soaking duration, thirty g of peach gum were soaked in 600 mL of drinking water at room temperature, followed by boiling according to the specified conditions:

1. Group 1: Soaked for 1 hour, then divided into four subgroups and boiled at 100 °C for 5, 10, 15, and 30 minutes.
2. Group 2: Soaked for 2 hours (using a fresh batch of 30 g peach gum and 600 mL water), then boiled for the same four durations.
3. Group 3: Soaked for 3 hours (using a new 30-gram batch and 600 mL water), followed by boiling under the same four time conditions.

After boiling, all samples were allowed to cool to room temperature. Only the gum matrix was collected for analysis; boiling water was not analyzed for this module.

#### 3.4.1.3 Raw (Unboiled) Control

This module served as the baseline reference for arabinose content.

Peach gum from the same production lot was milled into a fine, homogeneous powder.

The powdered sample was analyzed without any soaking or heat treatment, representing the baseline arabinose content in untreated peach gum.

Extraction and analysis followed the validated High-Performance Liquid Chromatography (HPLC) procedure under room-temperature conditions.

#### 3.4.2 Sample Processing for High-Performance Liquid Chromatography (HPLC)

(Applicable to all modules: No-Soak, Pre-Soak followed by Short Boil, and Raw Control)

Sample processing followed the standard protocol used at the Sugars and Derivatives Analytical Laboratory (SuDAL), referred to as the “2.00 g and 8.00 g extraction protocol.” This procedure ensured consistent extraction efficiency and analytical reliability across all sample types.

3.4.2.1 Weighing and Extraction. Accurately weigh 2.00 g of homogenized peach gum (either raw or boiled) into a 50-milliliter polypropylene tube.

Add 8.00 g (approximately 8.00 mL) of deionized water to the tube, then cap securely to prevent evaporation or contamination.

3.4.2.2 Shaking. Place the tube in a temperature-controlled orbital shaker set at 30 degrees Celsius and 300 revolutions per minute (rpm). Shake continuously for 24 hours to allow complete extraction of soluble components, including arabinose.

#### 3.4.3 Centrifugation

Centrifuge the mixture at 10,000 rpm, at 4 degrees Celsius, for 20 minutes to obtain a clear supernatant.

Record the obtained supernatant volume ( $V_{\text{supernatant}}$ , in mL) for use in downstream calculations.

#### 3.4.4 Filtration

Pass the clarified supernatant through a 0.45-micrometer syringe filter into clean HPLC vials to remove particulate matter that may interfere with chromatographic separation.

Apply additional dilution when necessary, and document the total dilution factor (DF) precisely.

#### 3.4.5 HPLC Analysis

Analyze each sample using High-Performance Liquid Chromatography (HPLC) equipped with an Agilent Hi-Plex Calcium (Ca) column and a Refractive Index Detector (RID).

Chromatographic conditions were as follows:

Mobile phase: Deionized water, isocratic mode

Flow rate: 0.6 mL per minute

Column temperature: 65 degrees Celsius

Injection volume: 10 microliters

L-arabinose external calibration standards were used to generate a calibration curve for quantification.

#### 3.4.6 Reporting Units

Peach gum (solid matrix): Results were reported as percentage weight per weight (% w/w), expressed as millig of arabinose per 100 millig of gum.

Boiling water (when analyzed): Results were reported as millig per milliliter (mg/mL), and optionally converted to g per 100 mL (% w/v) for comparison with food-chemistry standards.

#### Calculation Notes

Let:

$C_{\text{meas}}$  = measured arabinose concentration obtained from calibration (mg/mL) after application of dilutions.

$V_{\text{supernatant}}$  = recorded volume of the supernatant (mL)

DF = total dilution factor applied

2,000 mg = equivalent mass of the 2.00 g sample used in extraction

#### 3.4.6.1 Total Arabinose Mass (mg)

Total Arabinose (mg) =  $C_{\text{meas}} \times V_{\text{supernatant}} \times \text{DF}$

#### 3.4.6.2 Arabinose Content in Peach Gum (% w/w)

% w/w =  $(C_{\text{meas}} \times V_{\text{supernatant}} \times \text{DF} \div 2000 \text{ mg}) \times 100$

#### 3.4.6.3 Boiling Water (Direct Injection without Extraction)

##### 1. Concentration (mg/mL)

1) Concentration (mg/mL) =  $C_{\text{meas}}$

##### 2. Conversion to % w/v (g/100 mL)

2) g per 100 mL (% w/v) =  $0.1 \times C_{\text{meas}}$

#### 3.4.7 HPLC Startup Procedure

Prior to sample injection, the High-Performance Liquid Chromatography (HPLC) system was prepared and calibrated in accordance with the laboratory's standard operating procedure. The following steps were performed to ensure that the system was fully stabilized and ready for analytical operation:

3.4.7.1 Power activation. The computer, printer, and voltage stabilizer were switched on to initiate the system's electronic components.

3.4.7.2 Instrument startup. The HPLC instrument and the Refractive Index Detector (RID) were powered on. All components were allowed to initialize completely.

3.4.7.3 System status verification. The control panel and system software were inspected to confirm that no error messages, fault alerts, or calibration warnings were present.

3.4.7.4 Calibration mode activation. The instrument was set to Calibration Mode through the control panel to allow internal stabilization and baseline alignment.

3.4.7.5 System warm-up. The system was allowed to warm up for 5–10 minutes to ensure thermal stability of both the HPLC and the RID detector.

3.4.7.6 Once the status indicator displayed “System Calibrated”, the HPLC system was considered fully operational and ready for sample injection.

#### 3.4.8 System Setup Before Operation

Before sample injection, the High-Performance Liquid Chromatography (HPLC) system was prepared following the standard operating procedure for carbohydrate analysis using the Agilent Hi-Plex Calcium (Ca) column. The preparation steps were performed as follows:

##### 3.4.8.1 Mobile Phase Preparation

1. Deionized water was used as the sole mobile phase for all chromatographic runs.

2. The deionized water was filtered and degassed to remove particulates and dissolved gases, then transferred into the solvent reservoir bottle.

##### 3.4.8.2 Degassing and System Priming

1. The HPLC pump was switched on, and the purge valve was opened to initiate solvent flow.

2. The system was purged at a flow rate of 0.6 to 1.0 mL per minute for approximately 2 minutes to eliminate air bubbles from the solvent line.

3. After purging, the valve was closed, and the flow was momentarily paused to proceed with column setup.

##### 3.4.8.3 Column Installation

1. The guard column was connected to the Agilent Hi-Plex Ca analytical column, ensuring correct directional alignment.

2. The analytical column was then connected to the Refractive Index Detector (RID) according to manufacturer guidelines.

##### 3.4.8.4 Flow Stabilization

1. The flow rate was set to 0.6 mL per minute, as specified in the validated analytical method.

2. The system was allowed to run until a stable chromatographic baseline was achieved, confirming that temperature, pressure, and detector response were fully equilibrated.

#### 3.4.9 Agilent ChemStation Operation, Injection Volume, and Quality Control (QC)

The chromatographic analysis was performed using Agilent ChemStation software (version B.04.03) on the High-Performance Liquid Chromatography (HPLC) control workstation. The procedure consisted of the following steps:

##### 3.4.9.1 Software Initialization

1. Launch the Agilent ChemStation program on the HPLC control computer.
2. Confirm that the software version in use is B.04.03, which supports Refractive Index Detector (RID) acquisition.

##### 3.4.9.2 Login and Project Selection

1. Log in using authorized laboratory credentials.
2. Select the designated project folder and ensure that the Refractive Index Detector (RID) is correctly recognized and active within the method configuration.

##### 3.4.9.3 Method Parameter Configuration

The chromatographic method was configured with the following validated parameters:

1. Column: Agilent Hi-Plex Calcium (Ca), 300 × 7.7 mm, 8 μm particle size
2. Detector: Refractive Index Detector (RID)
3. Mobile phase: Deionized water, isocratic mode
4. Flow rate: 0.6 mL per minute
5. Column temperature: 65 degrees Celsius

##### 3.4.9.4 System Equilibration

1. The system was allowed to run under the specified method conditions until a stable baseline was achieved.
2. System pressure and detector temperature were monitored to ensure that all values remained within the acceptable operating range.

#### 3.4.9.5 Sample Injection

1. Select Inject Mode, followed by Run Sample within the ChemStation interface.
2. Inject a 10-microliter aliquot of the filtered sample.
3. Proceed with acquisition only after the software displays “Injection Complete.”

#### 3.4.9.6 Data Acquisition

1. Monitor the chromatogram during acquisition and verify the peak shape and baseline stability.
2. Record the retention time of arabinose for each injection and ensure alignment with the standard.

#### 3.4.9.7 Quality Control (QC)

Quality control procedures were performed throughout the analytical sequence to ensure accuracy and reproducibility:

1. Confirm peak identification and integration by comparing each chromatogram with the L-arabinose standard curve.
2. Inject a mid-level check standard after every 10 sample injections. The back-calculated concentration was required to fall within 90–110 percent of the nominal value.
3. Run a blank injection after high-concentration samples to verify the absence of carryover.
4. All chromatographic data files were saved in the designated project directory for documentation and traceability.

#### 3.4.10 Software for Analysis and Visualization

Chromatographic acquisition and integration: Agilent ChemStation (B.04.03)

Statistical analyses: R version 4.3.2 with packages rstatix and dunn.test

Data visualization and figure preparation: ggplot2

#### 3.4.11 Printing Test Results

After chromatographic analysis, test results were printed and archived following the laboratory’s documentation protocol. The steps were performed as follows:

- 3.4.11.1 Open the Browse Project section and navigate to the designated Results folder.

3.4.11.2 Right-click the specific test-result file and select Preview to review the analytical output.

3.4.11.3 From the preview options, select Default Individual Report, then click OK to generate the printable version.

3.4.11.4 Examine the chromatogram carefully to ensure that peak identification, baseline integration, and retention-time assignments are accurate prior to printing

3.4.11.5 Navigate to File > Print Chromatogram to print the analytical report.

3.4.11.6 Save the report as a digital file (for example, PDF format) and store it in the project folder to ensure proper documentation and long-term traceability.

#### 3.4.12 HPLC Shutdown Procedure

Upon completion of all analytical runs, the High-Performance Liquid Chromatography (HPLC) system was shut down following the standard laboratory procedure to maintain instrument integrity and prolong column lifespan.

3.4.12.1 On the control panel, select Stop Pump and exit the Agilent ChemStation software.

3.4.12.2 Shut down the computer and switch off the HPLC system.

3.4.12.3 Disconnect both the guard column and the analytical column from the instrument.

3.4.12.4 Flush each column with deionized water, followed by 20% ethanol when recommended by the manufacturer, in order to remove residual contaminants and prevent microbial growth.

3.4.12.5 Cap both ends of the columns securely and store them in a clean, dry, and light-protected environment.

3.4.12.6 Use a syringe to remove any remaining solvent from the mobile-phase tubing.

3.4.12.7 Rinse the sample loop with deionized water by flushing it two to three times to remove residual sample deposits.

3.4.12.8 Turn off the pump, detector, and voltage stabilizer.

3.4.12.9 Document the shutdown steps and column-cleaning procedure in the HPLC system logbook to ensure traceability and compliance with laboratory quality-control standards.

To complement the 2.00 g + 8.00 g extraction protocol used for quantitative analysis, the following section documents an additional laboratory workflow involving the dissolution of 0.100 g of sample in 25 mL of deionized water. This secondary workflow is part of the laboratory's internal SOP and is presented here for completeness, as it applies to specific sample types and processing conditions.

#### 3.4.13 HPLC Analysis Workflow for Arabinose in Peach Gum

##### Scope:

This workflow outlines the procedure for preparing raw and boiled peach gum samples for quantitative analysis using High-Performance Liquid Chromatography (HPLC). Drinking water was used during heat treatment, while all analytical dissolution steps were performed using deionized water according to the laboratory's standard operating procedure.

##### 3.4.13.1 Weighing the Sample

Accurately weigh 0.100 g of peach gum (either raw or boiled) using an analytical balance with four-digit precision.

Record the exact weight for use in subsequent calculations.

##### 3.4.13.2 Dissolution in Deionized Water

Raw peach gum: Dissolve the weighed sample in 25 mL of deionized water at room temperature (approximately 25 degrees Celsius) with gentle stirring until fully hydrated.

Boiled peach gum: Dissolve the sample in 25 mL of warm deionized water (greater than 25 degrees Celsius) to ensure complete dissolution of the softened matrix.

##### 3.4.13.3 Filtration

1. Filter each solution through a 0.45-micrometer membrane filter into a clean HPLC vial.

2. Filtration removes any insoluble particles that may obstruct the column or reduce chromatographic resolution.

#### 3.4.13.4 HPLC Injection

1. Inject the filtered sample into the HPLC system under validated conditions using the Agilent Hi-Plex Calcium (Ca) column with Refractive Index Detection (RID).

2. Use the isocratic method with deionized water as the mobile phase, an injection volume of 10 microliters, and the standardized flow and temperature parameters established in the validated method.

3. Run an L-arabinose standard solution to generate a calibration peak for quantitative comparison.

#### 3.4.13.5 Result Interpretation

The concentration of arabinose was reported separately for the gum matrix and, when analyzed, for boiling-water extracts:

1. Peach gum (solid): Expressed as percentage weight per weight (% w/w), representing millig of arabinose per 100 millig of gum.

2. Boiling water (liquid): Expressed as percentage weight per volume (% w/v) or millig per milliliter (mg/mL).

#### Unit definitions

Gum (% w/w):

$\text{mg arabinose per 100 mg gum}$

Water (% w/v):

$\text{g arabinose per 100 mL}$   $\quad$  ( $\text{also expressed as mg/mL}$ )

#### Calculation overview

Concentration: Calculated from the external calibration curve (peak area  $\rightarrow$  mg/mL).

Compare arabinose concentrations across all experimental conditions, including:

1. Raw peach gum (unboiled)
2. Boiled samples at 100 °Cs Celsius for 30 minutes
3. Time-dependent boiling at 30, 45, 60, and 90 minutes
4. Pre-soaked samples (1, 2, and 3 hours) followed by boiling for 5–30 minutes

Evaluate changes in arabinose concentration relative to boiling duration and soaking duration to determine release behavior (kinetics).

#### Statistical Analysis Overview

Non-parametric statistical methods were used because of the small sample size ( $n = 3$ ) and the inability to assume normal distribution:

##### Mann–Whitney U test

(two-sided; applied to two-group comparisons in Module A)

1. Effect size reported as rank-biserial correlation ( $r_{rb}$ )

##### Kruskal–Wallis test

(applied to comparisons across three or more groups in Modules B and C)

2. Effect size reported as epsilon-squared ( $\epsilon^2$ )

##### Post-hoc testing:

Dunn’s test with Holm adjustment was applied when overall significance was detected.

##### Reporting standards:

Results were presented as median [interquartile range], with p-values evaluated at  $\alpha = 0.05$ .

#### 3.4.14 Validation of HPLC Method for Arabinose Identification and Quantification

Method validation was performed to ensure that the High-Performance Liquid Chromatography (HPLC) approach was suitable for the qualitative identification and quantitative measurement of arabinose in peach gum samples.

A standard L-arabinose solution was analyzed under the same chromatographic conditions used for sample analysis. Using the Agilent Hi-Plex Calcium (Ca) column ( $300 \times 7.7$  mm,  $8 \mu\text{m}$ ) with deionized water as the mobile phase under isocratic flow at 0.6 mL per minute and a column temperature of 65 degrees Celsius, the arabinose standard produced a single, symmetrical peak with a retention time of  $8.50 \pm 0.05$  minutes. This retention time served as the reference for qualitative identification of arabinose in all peach gum chromatog.

A five-point external calibration curve was constructed using L-arabinose standard solutions at concentrations of 0.1, 0.5, 1.0, 2.0, and 5.0 millig per milliliter.

The calibration curve exhibited excellent linearity, described by the regression equation:

$$y = 102.480x + 1.265 \quad (R^2 = 0.9985)$$

where y represents peak area and x represents arabinose concentration (mg/mL).

Linearity above  $R^2 > 0.99$  confirmed that the method was appropriate for quantitative analysis.

The limit of detection (LOD) and limit of quantification (LOQ) were determined to be 0.02 mg/mL and 0.06 mg/mL, respectively, demonstrating adequate sensitivity for detecting low levels of arabinose.

Precision testing, performed through triplicate injections ( $n = 3$ ) for each condition, yielded a relative standard deviation (%RSD) of less than 2%, meeting laboratory standards for reproducibility. No interfering peaks were observed near the analyte retention time, confirming peak specificity.

System suitability criteria included:

Retention time (%RSD < 1%,  $n = 3$ )

Peak symmetry factor between 0.9 and 1.

Stable Refractive Index Detector (RID) baseline within acceptable drift limits

Mid-level check-standard recovery of 90–110% every 10 injections

Absence of carryover confirmed by blank injections following high-concentration samples

In summary, the HPLC method demonstrated accuracy, precision, linearity, and sensitivity suitable for the detection and quantification of arabinose in peach gum matrices. The retention time of  $8.50 \pm 0.05$  minutes was used as the benchmark for all subsequent analyses in this study.

### 3.5 Statistical Testing and Data Analysis

This section outlines the planned statistical procedures for analyzing arabinose content after completion of all experimental runs. All data analyses were designed to ensure methodological rigor and valid interpretation of results.

Each experimental condition was conducted in triplicate ( $n = 3$ ) to enhance reliability and account for variability. The groups included:

1. Raw peach gum (unboiled control)
2. Boiled peach gum at 100 °Cs Celsius for 30, 45, 60, and 90 minutes
3. Boiling-water extracts from the 30-minute boiling condition
4. Pre-soaking treatments, consisting of:
  - 1) Soaking for 1 hour at room temperature followed by boiling for 5, 10, 15, or 30 minutes
  - 2) Soaking for 2 hours, followed by boiling for 5, 10, 15, or 30 minutes
  - 3) Soaking for 3 hours, followed by boiling for 5, 10, 15, or 30 minutes

A full statistical analysis plan—including the selection of tests, assumptions, effect-size measures, and reporting format—appears in the following subsection (3.5.1).

#### 3.5.1 Planned Statistical Analysis (Revised, Formal Version)

The statistical analysis plan was developed to evaluate differences in arabinose content across the experimental conditions and to ensure appropriate handling of small-sample, non-normally distributed data. All analyses will be performed using non-parametric procedures unless stated otherwise.

##### 3.5.1.1 Descriptive Statistics

For each experimental condition ( $n = 3$ ), data will be summarized using the median and interquartile range (IQR), which are appropriate for small sample sizes without distributional assumptions.

Mean  $\pm$  standard deviation (SD) values may be included in an appendix for reference but will not be used for inferential interpretations.

##### 3.5.1.2 Inferential Testing

Two-group comparisons (Module A) will be conducted using the Mann–Whitney U test (two-sided).

Comparisons across three or more groups (Modules B and C) will be carried out using the Kruskal–Wallis test.

For Module C, which contains multiple soak–boil combinations, analyses will proceed using:

A stratified Kruskal–Wallis test within each soaking duration (1 h, 2 h, 3 h).

A stratified Kruskal–Wallis test within each fixed boiling duration (5, 10, 15, 30 min).

This approach allows detection of differences within parallel experimental structures.

#### 3.5.1.3 Post-Hoc Procedures

When a Kruskal–Wallis test indicates statistical significance, pairwise comparisons will be performed using Dunn’s test with Holm correction to control the familywise error rate.

#### 3.5.1.4 Visualization of Trends

Arabinose content will be visualized using line graphs, boxplots, and heatmaps to illustrate trends across boiling and soaking durations.

No formal trend-test (e.g., Jonckheere–Terpstra) will be applied, as the study is primarily comparative rather than monotonic-trend driven.

#### 3.5.1.5 Significance Level

Statistical significance will be defined as  $\alpha = 0.05$  (two-sided).

#### 3.5.1.6 Effect Size Reporting

Rank-biserial correlation ( $r_{rb}$ ) will be reported for Mann–Whitney U tests. Epsilon-squared ( $\epsilon^2$ ) will be reported for Kruskal–Wallis analyses.

#### 3.5.1.7 Quality Control (QC) and Outlier Handling

If an injection fails quality control—defined as peak integration error, unacceptable peak symmetry, or a check-standard recovery outside 90–110%—the sample will be re-injected once.

Persistently problematic replicates will be excluded with documented justification.

No statistical imputation will be performed to replace missing or invalid values.

#### 3.5.1.8 Rationale for Non-Parametric Approach

Given the small sample size ( $n = 3$ ) per group and the inability to assume normal distribution or homogeneity of variance, non-parametric exact tests are preferred and will be applied whenever available.

### 3.5.2 Justification for Selected Statistical Tests

This study includes multiple independent experimental conditions, each representing a distinct combination of pre-soaking and boiling parameters:

1. Raw (unboiled) peach gum
2. Boiled peach gum at 100 °Cs Celsius for 30, 45, 60, and 90 minutes
3. Peach gum pre-soaked for 1, 2, or 3 hours, followed by boiling for 5, 10, 15, or 30 minutes

Although all samples were sourced from a single manufacturing lot to minimize chemical variability, each condition represents an independent experimental unit, prepared in a separate vessel, subjected to independent heating, and processed through independent extraction and purification. Therefore, independence between groups is maintained.

Given the limited sample size per group ( $n = 3$ ) and the absence of evidence to support assumptions of normality or equal variance, non-parametric statistical methods were chosen as the most appropriate analytical approach:

#### 3.5.2.1 Two-Group Comparisons

For Module A, which directly compares raw vs. 30-minute boiled samples, the Mann–Whitney U test (two-sided) will be used.

The test statistics reported will include U, p-value, and the rank-biserial correlation ( $r_{rb}$ ) as the effect-size measure.

#### 3.5.2.2 Three or More Groups

For Modules B and C, comparisons across  $\geq 3$  experimental conditions will be performed using the Kruskal–Wallis test.

Reported values will include the H statistic, degrees of freedom (df), p-value, and epsilon-squared ( $\epsilon^2$ ).

#### 3.5.2.3 Reporting Format

Results will be summarized using median, interquartile range (IQR), range (min–max), and mean rank.

Statistical significance will be interpreted at  $p < 0.05$ .

#### 3.5.2.4 Primary Objective of Statistical Testing

The goal of the statistical analyses is to determine whether:

1. Boiling at 100 °Cs Celsius for different durations (30–90 minutes),  
and/or

2. Pre-soaking for 1–3 hours followed by short boiling (5–30 minutes)

Results in statistically significant differences in the arabinose concentration  
within the peach-gum matrix.

This structured statistical framework ensures robust comparison across  
experimental conditions while maintaining transparency in assumptions and analytical  
rigor.



## CHAPTER 4

### RESEARCH RESULT

#### 4.1 The Arabinose's Concentration of the Raw and 30-minute Heating Duration Samples (Module A)

The results from the High-Performance Liquid Chromatography (HPLC) analysis of the raw peach gum and those are treated with continuous heating at 100 °C to identify the arabinose's concentrations are demonstrated in the table 4.1. The weight-by-weight percentage (%w/w) reflects the mass of arabinose divided by the mass of the sample that undergoes High-Performance Liquid Chromatography (HPLC) analysis.

##### 4.1.1 Arabinose concentration of the raw peach gum sample

The mean concentration of arabinose of the raw peach gum sample is 2.88 weight-by-weight percentage with a standard deviation of 0.02.

##### 4.1.2 Arabinose concentration of the 30-minute heating samples

The mean arabinose's concentrations of the 30-minute heating samples are 0.66 for the boiled specimen and 1.04 %w/w for the boiling water extract.

**Table 4.1** Arabinose's concentrations (% w/w) of the raw and 30-minute heating samples

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

**Note** For each category, three samples of the same group are analyzed by the HPLC method then the arabinose's concentrations are presented in mean and standard deviation (SD) of weight-by-weight percentage. The Mann-Whitney U test is used to evaluate the difference of the mean arabinose concentration between the raw and boiled peach gum with the p-value of 0.1.

4.1.3 Statistical significance of the difference of arabinose concentration between the raw and the boiled peach gum samples

The Mann–Whitney U test (exact, two-sided) comparing the raw (non-boiled) samples with the 30-minute boiled samples ( $n = 3$  per group) yielded a p-value of approximately 0.10, which did not meet the significance threshold of  $\alpha = 0.05$ .

## 4.2 The Concentration of Arabinose of the Boiled Peach Gum Samples Treated with Extended Heat Duration (Module B)

4.2.1 Arabinose's concentrations of the boiled peach gum samples with different heat durations

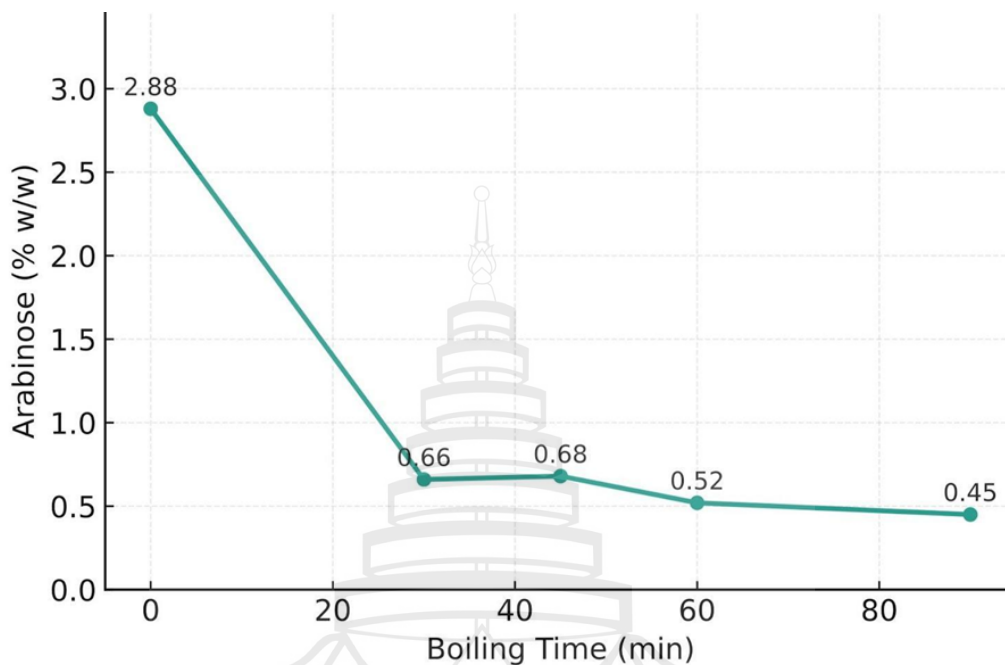
The mean and standard deviation of the arabinose's concentration within the boiled peach gum samples which are treated by 100 °C heating with various durations at 45, 60 and 90 minutes are demonstrated in the table 4.2. The mean concentration of the arabinose remain are 0.68, 0.52, and 0.45 % w/w for 45-, 60- and 90-minute heating samples respectively.

**Table 4.2** Arabinose's concentrations (% w/w) of the extended heating duration samples

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

**Note** For each category, three samples of the same group are analyzed by the HPLC method then the arabinose's concentrations are presented in mean and standard deviation (SD) of weight-by-weight percentage. The p-value on the fourth column, 0.0133, determined by Kruskal-Wallis test indicates that at least one of the 3 groups has statistically distinguished mean arabinose's concentration when compare to the others.

The mean concentrations of boiled peach gum samples treated with different heat duration are presented by the graph of the figure 4.1.



**Figure 4.1** Time-course of arabinose content (% w/w) in peach gum boiled at 100 °C

4.2.2 Statistically different arabinose's concentrations of the boiled peach gum samples with various heat durations.

The Kruskal–Wallis's test comparing arabinose concentrations across the four boiling durations (30, 45, 60, and 90 minutes) showed that the mean concentration of arabinose of at least one specimen among the four boiling samples is significantly different from others, p-value 0.0133.

Dunn-Bonferroni post-hoc comparison of the mean arabinose concentration of the 45-minute boiling sample were significantly higher than the 90-minute boiling sample, p-value 0.0114. The comparison between the rest of boiled samples found no statistical significance as demonstrated in table 4.3.

**Table 4.3** Statistical significance of the difference of mean arabinose concentration between two samples evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module B (30–90 min boiling)

<b>Peach gum samples undergo different boiling duration (minute)</b>	<b>30</b>	<b>45</b>	<b>6</b>	<b>90</b>
30	-	1.0000	1.0000	0.2302
45	1.0000	-	0.2302	0.0114
60	1.0000	0.2302	-	1.0000
90	0.2302	0.0114	1.0000	-

**Note** The p-values in the table represent the statistical significance of the difference between mean arabinose's concentration between 2 boiled samples of distinct duration. The p-value that lesser than 0.05 indicates the statistically significant difference of mean arabinose's concentration (%w/w) between the two samples.

### **4.3 The Arabinose's Concentration of Soaked Peach Gum Samples that Undergoes Boiling (Module C)**

4.3.1 Arabinose's concentrations of the soaked gum samples treated with different heat durations

The mean and standard deviation of the arabinose's concentration within the boiling samples of the soaked peach gum are detailed in the tables 4.4, 4.6 and 4.8. The statistical significance of the difference of the mean arabinose's concentration between 2 independent samples of soaked peach gum treated by boiling at distinct duration are reviewed in the tables 4.5, 4.6 and 4.7.

The arabinose's concentrations of the 1-hour soaking peach gum treated with different heat durations are shown in the table 4.4.

**Table 4.4** Arabinose's concentration of the 1-hour soaking duration peach gum in water that undergoes boiling to 100 °C for different durations

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

**Note** For each category, 3 samples of the same group were analyzed by the HPLC method then the arabinose's concentrations are presented in mean and standard deviation (SD) of weight-by-weight percentage. The p-value on the fourth column, 0.0131, determined by Kruskal-Wallis test indicates that at least one of the 4 groups has statistically distinguished mean arabinose's concentration when compare to the others.

According to the table 4.4, Comparison of the mean arabinose's concentrations between two different boiling samples of 1-hour soaking peach gum are demonstrated in the table 4.5.

**Table 4.5** Statistical significance of the difference of mean arabinose concentration between two samples of 1-hour soaking peach gum treated with different boiling duration evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module C (5, 10, 15 and 30-minutes boiling durations)

<b>Group of 1-h soaking peach gum in water treated with different boiling duration (minute)</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>30</b>
5	-	1.0000	0.0111	0.2281
10	1.0000	-	0.2281	1.0000

**Table 4.5** (continued)

<b>Group of 1-h soaking peach gum in water treated with different boiling duration (minute)</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>30</b>
15	0.0111	0.2281	-	1.0000
30	0.2281	1.0000	1.0000	-

**Note** The p-values in the table represent the statistical significance of the difference between mean arabinose's concentration between 2 boiled samples of distinct duration. The p-value that lesser than 0.05 indicates the statistically significant difference of mean arabinose's concentration (%w/w) between the two samples.

**Table 4.6** Arabinose's concentration of the 2-hour soaking duration peach gum in water that undergoes boiling to 100 °C for different durations

<b>Module C samples</b>	<b>Boiling duration</b>	<b>Arabinose concentration (% w/w, Mean ± SD)</b>	<b>p-value</b>
Marinated peach gum in water (2-h soaking)	100 °C for 5 minutes in 600 mL water	0.95 ± 0.00	0.0138
Marinated peach gum in water (2-h soaking)	100 °C for 10 minutes in 600 mL water	1.21 ± 0.00	
Marinated peach gum in water (2-h soaking)	100 °C for 15 minutes in 600 mL water	1.11 ± 0.01	
Marinated peach gum in water (2-h soaking)	100 °C for 30 minutes in 600 mL water	0.84 ± 0.00	

**Note** For each category, 3 samples of the same group were analyzed by the HPLC method then the arabinose's concentrations are presented in mean and standard deviation (SD) of weight-by-weight percentage.

**Table 4.7** Statistical significance of the difference of mean arabinose concentration between two samples of 2-hour soaking peach gum treated with different boiling duration evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module C (5, 10, 15 and 30-minutes boiling durations)

Group of 2-h soaking peach gum in water treated with different boiling duration (minute)	5	10	15	30
5	-	0.2344	1.0000	1.0000
10	0.2344	-	1.0000	0.0118
15	1.0000	1.0000	-	0.2344
30	1.0000	0.0118	0.2344	-

**Note** The p-values in the table represent the statistical significance of the difference between mean arabinose's concentration between 2 boiled samples of distinct duration. The p-value that lesser than 0.05 indicates the statistically significant difference of mean arabinose's concentration (%w/w) between the two samples.

**Table 4.8** Arabinose's concentration of the 3-hour soaking duration peach gum in water that undergoes boiling to 100 °C for different durations

Module C samples	Boiling duration	Arabinose concentration (% w/w, Mean $\pm$ SD)	p-value
Marinated peach gum in water (3-h soaking)	100 °C for 5 minutes in 600 mL water	1.19 $\pm$ 0.00	0.0148
Marinated peach gum in water (3-h soaking)	100 °C for 10 minutes in 600 mL water	2.22 $\pm$ 0.02	
Marinated peach gum in water (3-h soaking)	100 °C for 15 minutes in 600 mL water	1.51 $\pm$ 0.01	
Marinated peach gum in water (3-h soaking)	100 °C for 30 minutes in 600 mL water	0.31 $\pm$ 0.01	

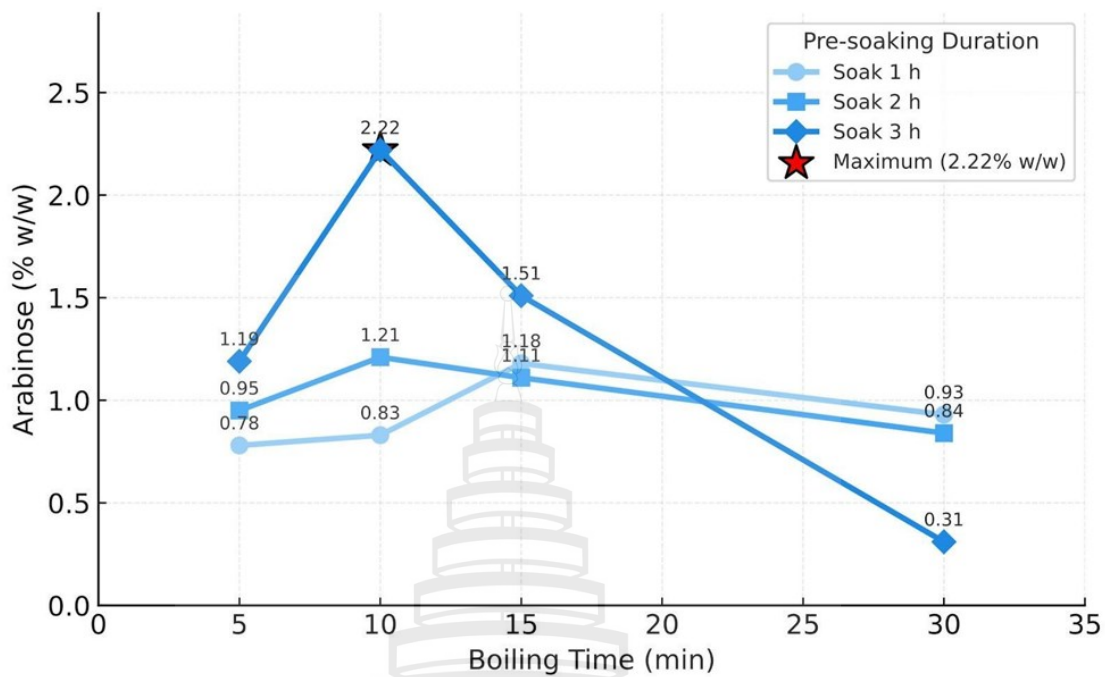
**Note** For each category, 3 samples of the same group were analyzed by the HPLC method then the arabinose's concentrations are presented in mean and standard deviation (SD) of weight-by-weight percentage.

**Table 4.9** Statistical significance of the difference of mean arabinose concentration between two samples of 3-hour soaking peach gum treated with different boiling duration evaluated by Dunn–Bonferroni post-hoc pairwise test (adjusted p-values) for Module C (5, 10, 15 and 30-minutes boiling durations)

<b>Group of 3-h soaking peach gum in water treated with different boiling duration (minute)</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>30</b>
5	-	0.2428	1.0000	1.0000
10	0.2428	-	1.0000	0.0127
15	1.0000	1.0000	-	0.2428
30	1.0000	0.0127	0.2428	-

**Note** The p-values in the table represent the statistical significance of the difference between mean arabinose's concentration between 2 boiled samples of distinct duration. The p-value that lesser than 0.05 indicates the statistically significant difference of mean arabinose's concentration (%w/w) between the two samples.

Figure 4.2 demonstrates the mean concentrations of marinated peach gum samples treated with different heating duration.



**Figure 4.2** Arabinose content (% w/w) in pre-soaked peach gum (1–3 h) after short boiling (5–30 min) under Module C conditions.

## CHAPTER 5

### CONCLUSION AND DISCUSSION

#### 5.1 Summary of the Experimental Results

According to the results in the table 4.1, the mean arabinose concentration of the 30-minute duration of boiling peach gums,  $0.66 \pm 0.00$  weight by weight percentage (%w/w), is lesser than the raw sample,  $2.88 \pm 0.02$  %w/w, but does not demonstrate statistical significance, p value 0.1. This finding suggests there is no different in arabinose's mean concentrations between the raw and 30 minute-boiled samples.

Further comparison of the mean arabinose concentration in the module B, the mean concentrations of arabinose of the decline with the increasing duration of boiling from 45 to 60 and 90 minutes respectively. The Kruskal-Wallis test of these samples indicates that there is a statistical significance, p-value 0.013, in arabinose's concentration among the three specimens. The Dunn–Bonferroni post-hoc pairwise test is used to further determination of the difference of mean arabinose concentration and demonstrates a significant differentiation between the 45-minute and 90-minute boiling duration groups, p-value 0.014. (see tables 4.2 and 4.3) The module B's findings indicate that the arabinose's mean concentration of sample with 45 minute-boiling period is significantly higher than the 90 minute-boiling period specimen.

According to the table 4.4, the arabinose's mean concentrations of the 1 hour-soaked peach gums which are boiled at 100 C with different durations are 0.78 (5 minute- boiling duration), 0.83 (10 minutes), 1.18 (15 minutes) and 0.93 (30 minutes) %w/w. The peak concentration of arabinose is attained at the 15 minute-boiling period and has a significant differentiation in comparison to the 5 minute-boiling time, p-values 0.0131 on Kruskal-Wallis test and 0.0111 on Dunn–Bonferroni pairwise test. (see tables 4.4 and 4.5) The results signify the arabinose's mean concentration of the 1 hour-soaked peach gum treated by 15 minute-boiling yields the highest arabinose remain and is significantly higher than the 5 minute-boiling specimen.

The mean arabinose's concentrations of the 2 hour- and 3 hour-soaked peach gums which are boiled at 100 C with different periods (see tables 4.6 and 4.8) demonstrate similar trends with their peak values,  $1.21 \pm 0.00$  %w/w (2 hour-soaked specimen) and  $2.22 \pm 0.02$  %w/w (3 hour-soaked specimen), at 10 minute-boiling duration. These peak values are also significantly different when compare to their 30 minute-boiling samples, p-values 0.0118 (2 hour-soaked group, table 4.7) and 0.0127 (3 hour-soaked group, table 4.9). According to these findings, 2 hour- and 3 hour-soaked peach gums provide highest arabinose concentrations at 10 minute-duration of boiling and is significantly higher than the 30 minute-boiling samples. A longer period of boiling results in decline of arabinose content.

## 5.2 Discussion of the Experimental Results

Peach gum, a naturally edible resin from the bark of peach tree, has been used for centuries for dessert and sweet soup (tong sui) in Chinese cuisine. It contains polysaccharide specifically arabinogalactan which mainly composes of arabinose and galactose. Arabinose, an important subject of this study, is a 5-carbon aldopentose sugar that exerts several health benefits including control of satiety, insulin sensitivity and anti-inflammatory effect. The experimental findings indicate that boiling and soaking affect the concentration of arabinose. Boiling causes attenuation of arabinose concentration while soaking increases arabinose content. The investigators of this study have reviewed all the related researches about peach gum processing with boiling and soaking on arabinose content and there has been no previous study. Therefore, this experiment is the first study which documents this context. There are some authors' opinion on the finding of this experiment as following.

### 5.2.1 Boiling retains arabinose but its level decreases with longer cooking

The primary objective of this research was to determine whether arabinose remains after household-style boiling.

Our results confirmed that arabinose was detectable in all boiled samples, demonstrating that it is heat-stable.

However, a clear time-dependent decrease was observed: the raw sample had the highest arabinose concentration ( $2.88 \pm 0.00$  % w/w), boiling for 30 minutes maintained a measurable level ( $0.66 \pm 0.00$  % w/w), and longer boiling for 45, 60, and 90 minutes gradually reduced the amount (0.68%, 0.52%, and 0.45% w/w, respectively).

This indicates that prolonged heating is unnecessary and may lead to partial degradation or diffusion of arabinose into the boiling water, reducing its concentration in the gum.

### 5.2.2 Optimal boiling time and texture considerations

Although 30 minutes of boiling without soaking provided a measurable amount of arabinose, texture evaluation revealed that cooking time also affects the gum's softness.

Soaked 1 h: Boiling for 5 minutes left the center of the gum firm; at least 10 minutes was needed to achieve uniform softness.

Soaked 2 h: Boiling for 5 minutes produced fully cooked, soft gum.

Soaked 3 h: Even 5 minutes of boiling yielded completely softened gum. Prolonged boiling (15–30 minutes) made it softer but still structurally intact.

These findings suggest that the best preparation balances nutrient preservation and desired texture.

Boiling for 30 minutes without soaking is acceptable for convenience, but pre-soaking reduces required heating time, saving energy and preventing over-softening.

### 5.2.3 Effect of pre-soaking on arabinose retention

Pre-soaking enhanced arabinose retention significantly. HPLC data showed that 3-hour soaking followed by 10 minutes of boiling yielded the highest arabinose concentration ( $2.22 \pm 0.00$  % w/w) — about 77% of the raw sample.

This condition provided a sweet spot between nutrient stability and cooking efficiency.

In contrast, boiling for longer than 15 minutes after soaking caused a rapid decline in arabinose, confirming that short heating after hydration is the most effective approach.

#### 5.2.4 Nutritional significance

The persistence of arabinose even after boiling confirms that peach gum remains a valuable source of this compound under common cooking conditions.

Additionally, a portion of arabinose (about 1.04% w/v) was detected in the boiling water, suggesting that heat may help release arabinose from the gum matrix, potentially increasing its bioavailability and functional benefits, such as promoting glucose control or gut health.

#### 5.2.5 Final interpretation

Overall, the results indicate that boiling peach gum for 30 minutes is currently the most practical household method for achieving both complete cooking and measurable arabinose retention.

However, when pre-soaking is applied, 3-hour soaking followed by 10-minute boiling is the optimal condition for maximizing arabinose retention (2.22 % w/w) while ensuring ideal texture and energy efficiency.

These findings support the principle that gentle processing helps preserve functional nutrients in natural plant gums.

### 5.3 Recommendations and Future Research

Our results demonstrated that peach gum boiled at 100 °C for 30, 45, 60, and 90 minutes still contained detectable levels of L-arabinose.

Pre-soaking the samples for 1–3 hours before boiling further enhanced the release and retention of arabinose, even with shorter boiling times.

These findings confirm the heat stability of arabinose and provide a solid foundation for optimizing preparation methods that preserve the maximum amount of bioactive compounds.

Future research directions are proposed as follows:

1. Optimization of texture under conditions that preserve the highest arabinose content – Evaluate texture profile analysis (TPA) parameters (hardness, cohesiveness, springiness, and gumminess), rheological behavior, and consumer acceptance

2. to determine the most suitable “soaking + short-boiling” combination that maintains arabinose stability while achieving desirable mouthfeel quality.

3. Antioxidant potential – Conduct oxygen radical absorbance capacity (ORAC), 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azino-bis(3-ethylbenzothiazole-6-sulfonic acid) (ABTS), and ferric reducing antioxidant power (FRAP) assays to confirm antioxidant and radical-scavenging activity.

4. Glycemic Control and Insulin Sensitivity – Perform postprandial glucose and insulin resistance assessments in pilot human studies.

5. Lipid profile improvement – Investigate changes in high-density lipoprotein (HDL) / low-density lipoprotein (LDL) ratio, triglyceride levels, and non-alcoholic fatty liver disease (NAFLD) risk reduction.

6. Metabolism and Weight Control – Examine effects on resting metabolic rate, fat oxidation, and appetite-regulating hormones.

7. Immune Modulation and Gut Microbiota – Use microbiota sequencing and cytokine profiling to evaluate immunomodulatory effects.

8. Product Development and Innovation – Develop low-GI bubble tea pearls or functional desserts; test shelf-life, texture, and sensory properties.

9. Clinical Pilot Trials – Conduct human studies on glucose, lipid, and inflammatory markers to support health-claim validation and regulatory approval.

10. Translational consumption equivalence – Under the best preparation (pre-soak 3 h + 10 min boil; 2.22 % w/w),

100 g of cooked peach gum contains about 2.22 g of L-arabinose.

To match the human effective dose (7.5 g with 50 g sucrose), approximately 338 g is required; for a typical 500-mL milk tea (25–35 g sucrose), the target 3.75–5.25 g of L-arabinose would correspond to approximately 169–236 g of peach gum.

Practically, sucrose should be reduced and/or co-fortified with a small amount of purified L-arabinose while maintaining the 3 h pre-soak + 10 min boil method (Pasmans et al., 2022).

This Independent Study successfully fulfilled its primary objective on arabinose retention under household-style boiling.

However, the secondary objectives involving biological and functional evaluations were intentionally excluded from this study's scope and will be addressed in future research as outlined above.



## REFERENCES

- Arabinose. (2025, September 25). In *Wikipedia*.  
<https://en.wikipedia.org/w/index.php?title=Arabinose&oldid=1313302869>
- Canfora, E. E., Jocken, J. W. E., & Blaak, E. E. (2015). Short-chain fatty acids in control of body weight and insulin sensitivity. *Nature Reviews Endocrinology*, *11*(10), 577–591. <https://doi.org/10.1038/nrendo.2015.128>
- Chambers, E. S., Viardot, A., Psichas, A., Morrison, D. J., Murphy, K. G., Zaccarelli, S. E. K., MacDougall, K., Preston, T., Tedford, C., Finlayson, G. S., Blundell, J. E., Bell, J. D., Thomas, E. L., Mt-Isa, S., Ashby, D., Gibson, G. R., Kolida, S., Dhillon, W. S., Bloom, S. R., . . . Frost, G. (2015). Effects of targeted delivery of propionate to the human colon on appetite regulation, body weight maintenance and adiposity in overweight adults. *Gut*, *64*(11), 1744–1754. <https://doi.org/10.1136/gutjnl-2014-307913>
- Chen, H., Iqbal, S., Wu, P., Pan, R., Wang, N., Bhutto, R. A., Rehman, W., & Chen, X. D. (2024). Enhancing rheology and reducing lipid digestion of oil-in-water emulsions using controlled aggregation and heteroaggregation of soybean protein isolate-peach gum microspheres. *International Journal of Biological Macromolecules*, *273*, 132964.  
<https://doi.org/10.1016/j.ijbiomac.2024.132964>
- Dai, K.-Y., Ding, W.-J., Li, Z.-T., Liu, C., Ji, H.-Y., & Liu, A.-J. (2024). Comparison of structural characteristics and anti-tumor activity of two alkali extracted peach gum arabinogalactan. *International Journal of Biological Macromolecules*, *279*, 135407.  
<https://doi.org/10.1016/j.ijbiomac.2024.135407>
- dapur.ummuyara. (2020, June 30). [Photograph of peach gum exudate on a peach tree]. Instagram. <https://www.instagram.com/p/CCCoPTfgHyz/>

- den Besten, G., Bleeker, A., Gerding, A., van Eunen, K., Havinga, R., . . . Bakker, B. M. (2015). Short-chain fatty acids protect against high-fat diet-induced obesity via a PPAR $\gamma$ -dependent switch from lipogenesis to fat oxidation. *Diabetes*, *64*(7), 2398–2408. <https://doi.org/10.2337/db14-1213>
- Garin, N., De Pourcq, J. T., Martín-Venegas, R., Cardona, D., Gich, I., & Manges, M. A. (2014). Viscosity differences between thickened beverages suitable for elderly patients with dysphagia. *Dysphagia*, *29*, 483–488. <https://doi.org/10.1007/s00455-014-9533-x>
- Hamer, H. M., Jonkers, D., Venema, K., Vanhoutvin, S., Troost, F. J., & Brummer, R.-J. (2008). Review article: The role of butyrate on colonic function. *Alimentary Pharmacology & Therapeutics*, *27*(2), 104–119. <https://doi.org/10.1111/j.1365-2036.2007.03562.x>
- Higaki, S., & Matsuo, T. (2018). Toxicity of d-arabinose in male and female rats. *Shokuhin Eiseigaku Zasshi (Journal of the Food Hygienic Society of Japan)*, *59*(3), 114–120. <https://doi.org/10.3358/shokueishi.59.114>
- Huang, B., Lu, M., Wang, D., Song, Y., & Zhou, L. (2018). Versatile magnetic gel from peach gum polysaccharide for efficient adsorption of Pb<sup>2+</sup> and Cd<sup>2+</sup> ions and catalysis. *Carbohydrate Polymers*, *181*, 785–792. <https://doi.org/10.1016/j.carbpol.2017.11.077>
- Kardošová, A., & Machová, E. (2006). Antioxidant activity of medicinal plant polysaccharides. *Fitoterapia*, *77*(5), 367–373. <https://doi.org/10.1016/j.fitote.2006.05.001>
- Kardošová, A., Rosík, J., & Kubala, J. (1978). Enzyme preparations from *Aspergillus flavus* for structural studies of the peach gum polysaccharide. *Folia Microbiologica*, *23*(2), 97–102. <https://doi.org/10.1007/BF02915308>
- Kaur, B., Quek, R. Y. C., Ng, G. C. F., Ponnalagu, S., & Henry, C. J. (2022). Comparison of boba pearls made from tapioca starch and other unconventional flours and starches: Their glycaemic response (GR). *Malaysian Journal of Nutrition*, *28*(3), 357–368. <https://doi.org/10.31246/mjn-2021-0091>
- Li, C., Tao, J., & Zhang, H. (2017). Peach gum polysaccharides-based edible coatings extend shelf life of cherry tomatoes. *3 Biotech*, *7*, 168. <https://doi.org/10.1007/s13205-017-0845-z>

- Louis, P., & Flint, H. J. (2017). Formation of propionate and butyrate by the human colonic microbiota. *Environmental Microbiology*, *19*(1), 29–41.  
<https://doi.org/10.1111/1462-2920.13589>
- Michelin Guide Digital-Singapore. (2018, May 5). *Ingredient: Peach Gum*.  
<https://guide.michelin.com/sg/en/article/wellness/the-asian-secret-to-beautiful-skin-peach-gum>
- Noer, E. R., Sulchan, M., Kusumastuti, A. C., Murbawani, E. D., Probosari, E., Nuryanto, Veicinlun, S. Y., Rosma, S. N., & Ardiaria, M. (2023). Ameliorative effect of peach gum on metabolic syndrome components and microbial short-chain fatty acids production in streptozotocin-induced rats. *Food Research*, *7*(4), 265–271. [https://doi.org/10.26656/fr.2017.7\(4\).482](https://doi.org/10.26656/fr.2017.7(4).482)
- Parada Venegas, D., De la Fuente, M. K., Landskron, G., González, M. J., Quera, R., Dijkstra, G., Harmsen, H. J. M., . . . Hermoso, M. A. (2019). Short chain fatty acids (SCFAs)-mediated gut epithelial and immune regulation and its relevance for inflammatory bowel diseases. *Frontiers in Immunology*, *10*, 277. <https://doi.org/10.3389/fimmu.2019.00277>
- Pasmans, K., Meex, R. C. R., Trommelen, J., Senden, J. M. G., Vaughan, E. E., van Loon, L. J. C., & Blaak, E. E. (2022). L-arabinose co-ingestion delays glucose absorption derived from sucrose in healthy men and women: A double-blind, randomised crossover trial. *British Journal of Nutrition*, *128*, 1072–1081. <https://doi.org/10.1017/S0007114521004153>
- Pol, E. A., & Mars, M. (2021). Sweet taste of pentoses: A narrative review on D-xylose, D-ribose, L-arabinose, and D-tagatose. *Food & Nutrition Research*, *65*, 6254. <https://doi.org/10.29219/fnr.v65.6254>
- Pol, K., de Graaf, K., Diepeveen-de Bruin, M., Balvers, M., & Mars, M. (2020). The effect of replacing sucrose with L-arabinose in drinks and cereal foods on blood glucose and plasma insulin responses in healthy adults. *Journal of Functional Foods*, *73*, 104114. <https://doi.org/10.1016/j.jff.2020.104114>
- Qian, H. F., Cui, S. W., Wang, Q., & Zhou, H. M. (2011). Fractionation and physicochemical characterization of peach gum polysaccharides. *Food Hydrocolloids*, *25*(5), 1285–1290.  
<https://doi.org/10.1016/j.foodhyd.2010.09.027>

- Ríos-Covián, D., Ruas-Madiedo, P., Margolles, A., Gueimonde, M., de los Reyes-Gavilán, C. G., & Salazar, N. (2016). Intestinal short-chain fatty acids and their link with diet and human health. *Frontiers in Microbiology*, *7*, 185. <https://doi.org/10.3389/fmicb.2016.00185>
- Seri, K., Sanai, K., Matsuo, N., Kawakubo, K., Xue, C., & Inoue, S. (1996). L-arabinose selectively inhibits intestinal sucrase in an uncompetitive manner and suppresses glycemic response after sucrose ingestion in animals. *Metabolism*, *45*(11), 1368–1374. [https://doi.org/10.1016/S0026-0495\(96\)90117-1](https://doi.org/10.1016/S0026-0495(96)90117-1)
- Simas, F. F., Gorin, P. A. J., Wagner, R., Sasaki, G. L., Bonkerner, A., & Iacomini, M. (2008). Comparison of structure of gum exudate polysaccharides from the trunk and fruit of the peach tree (*Prunus persica*). *Carbohydrate Polymers*, *71*(2), 218–228. <https://doi.org/10.1016/j.carbpol.2007.05.032>
- Tan, J., Song, Y., Huang, X., & Zhou, L. (2018). Facile functionalization of natural peach gum polysaccharide with multiple amine groups for highly efficient removal of toxic hexavalent chromium (Cr(VI)) ions from water. *ACS Omega*, *3*, 17309–17318. <https://doi.org/10.1021/acsomega.8b02599>
- Wei, C., Ma, L., Zhou, X., Ye, X., & Chen, S. (2019). Physicochemical properties and conformations of water-soluble peach gums via different preparation methods. *Food Hydrocolloids*, *95*, 571–579. <https://doi.org/10.1016/j.foodhyd.2018.03.049>
- Wei, C., Yao, L., Zhang, L., Zhang, Y., Luo, Q., Qiu, S., . . . Ye, X. (2022). In vitro digestion and fecal fermentation of peach gum polysaccharides with different molecular weights and their impacts on gut microbiota. *Foods*, *11*, 3970. <https://doi.org/10.3390/foods11243970>
- Wei, C., Yao, L., Zhang, Y., Qiu, S., Zeng, X., Chen, S., & Ye, X. (2023). Structural characterization of peach gum polysaccharide and its effects on the regulation of DSS-induced acute colitis. *International Journal of Biological Macromolecules*, *225*, 1224–1234. <https://doi.org/10.1016/j.ijbiomac.2022.11.183>

- Wei, C., Zhang, Y., He, L., Cheng, J., Li, J., Tao, W., . . . Chen, S. (2019). Structural characterization and anti-proliferative activities of partially degraded polysaccharides from peach gum. *Carbohydrate Polymers*, *203*, 193–202. <https://doi.org/10.1016/j.carbpol.2018.09.029>
- Weiß, K., & Alt, M. (2017). Determination of single sugars, including inulin, in plants and feed materials by high-performance liquid chromatography and refraction index detection. *Fermentation*, *3*(3), 36. <https://doi.org/10.3390/fermentation3030036>
- Weitkunat, K., Schumann, S., Nickel, D., Kappo, K. A., Petzke, K. J., Kipp, A. P., Blaut, M., & Klaus, S. (2016). Importance of propionate for the repression of hepatic lipogenesis and improvement of insulin sensitivity in high-fat diet-induced obesity. *Molecular Nutrition & Food Research*, *60*(12), 2611–2621. <https://doi.org/10.1002/mnfr.201600305>
- World Health Organization. (2015). *Guideline: Sugars intake for adults and children*. <https://apps.who.int/iris/handle/10665/149782>
- Wu, S., Lu, M., & Wang, S. (2017). Hypoglycaemic and hypolipidaemic properties of peach gum polysaccharides. *3 Biotech*, *7*, 166. <https://doi.org/10.1007/s13205-017-0852-0>
- Yang, M., Tao, L., Wang, Z., Li, L., Luo, J., Pai, K., . . . Tian, Y. (2023). The mechanism of peach gum polysaccharide preventing UVB-induced skin photoaging by regulating matrix metalloproteinase and oxidative factors. *Molecules*, *28*(10), 4104. <https://doi.org/10.3390/molecules28104104>
- Yao, X.-C., Cao, Y., & Wu, S.-J. (2013). Antioxidant activity and antibacterial activity of peach gum derived oligosaccharides. *International Journal of Biological Macromolecules*, *62*, 1–3. <https://doi.org/10.1016/j.ijbiomac.2013.08.022>
- Zeng, S., Long, J., Sun, J., Wang, G., & Zhou, L. (2022). A review on peach gum polysaccharide: Hydrolysis, structure, properties and applications. *Carbohydrate Polymers*, *279*, 119015. <https://doi.org/10.1016/j.carbpol.2021.119015>

- Zhang, F., Bai, J., Zheng, Y., Liang, S., Lei, L., Deng, X., . . . Ren, Y. (2019). Investigation of the optimum preparation of peach gum polysaccharides and the in vivo and in vitro therapeutic effects on acute pyelonephritis. *Evidence-Based Complementary and Alternative Medicine*, 2019, Article 2729343. <https://doi.org/10.1155/2019/2729343>
- Zhao, L., Zhang, F., Ding, X., Wu, G., Lam, Y. Y., Wang, X., Fu, H., Xue, X., Lu, C., Ma, J., Yu, L., Xu, C., Ren, Z., Xu, Y., Xu, S., Shen, H., Zhu, X., Shi, Y., Shen, Q., . . . Zhang, C. (2018). Gut bacteria selectively promoted by dietary fibers alleviate type 2 diabetes. *Science*, 359(6380), 1151–1156. <https://doi.org/10.1126/science.aao5774>
- Zhou, B., Liu, P., Yao, X., Cao, H., Zhu, H., Wang, Q., . . . Gong, Z. (2024). Hepatoprotective effects of peach gum polysaccharides against alcoholic liver injury: moderation of oxidative stress and promotion of lipid metabolism. *Frontiers in Nutrition*, 10, 1325450. <https://doi.org/10.3389/fnut.2023.1325450>



## APPENDIX A

## ETHICS COMMITTEE EXEMPTION DOCUMENT



## บันทึกข้อความ

หน่วยงาน ส่วนบริหารงานวิจัย สถาบันวิจัยและนวัตกรรมฯ โทรศัพท์ 6551, 7170, 7171 (อัญชิกา)

ที่ อว 7742(1)/3908

วันที่ 15 ตุลาคม 2568

เรื่อง แจ้งผลการพิจารณาโครงการวิจัยที่ขอรับรองจริยธรรมการวิจัยในมนุษย์

เรียน นางสาวัญญา ประเสริฐรุ่งเรือง

ตามที่ ท่านได้ส่งโครงการวิจัย เรื่อง การศึกษาระดับอาราปีโนสในอำพันดอกท้อที่ผ่านการต้มเปรียบเทียบกับอำพันดอกท้อดิบ โดยใช้เทคนิคเอชพีแอลซี (A study of Arabinose levels in boiled peach gum compared to raw peach gum by HPLC) จากสำนักวิชาเวชศาสตร์ชะลอวัยและฟื้นฟูสุขภาพ เพื่อขอรับการพิจารณาจริยธรรมการวิจัยในมนุษย์ จากคณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง โดยคณะกรรมการฯ ได้รับเอกสารครบถ้วนแล้วเมื่อวันที่ 8 ตุลาคม พ.ศ. 2568 นั้น

ตามที่ระบุไว้ในระเบียบมหาวิทยาลัยแม่ฟ้าหลวง ข้อกำหนดและแนวทางการดำเนินงานด้านจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง พ.ศ. 2565 คณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง มีแนวทางการดำเนินงานเพื่อพิทักษ์ซึ่งสิทธิความปลอดภัยความเป็นอยู่ที่ดีของอาสาสมัคร ตามหลักจริยธรรมการวิจัยสากล โดยมีขอบเขตการดำเนินงานในการพิจารณารับรองด้านจริยธรรมการวิจัยในโครงการวิจัยที่ดำเนินการในมนุษย์ คณะกรรมการฯ ได้พิจารณาโครงการวิจัยดังกล่าวแล้ว พบว่าโครงการวิจัยนี้มีได้กระทำต่อมนุษย์ รวมถึงมิได้เป็นการศึกษาวิจัยจากเวชระเบียนหรือฐานข้อมูล วัตถุสิ่งส่งตรวจ น้ำคั่งหลัง เนื้อเยื่อที่ได้จากร่างกายมนุษย์ ซึ่งไม่เข้าข่ายการพิจารณาโครงการวิจัยที่ขอรับรองจริยธรรมการวิจัยในมนุษย์

ทั้งนี้ ผู้วิจัยสามารถติดต่อรับขอรับเอกสารคืน ได้จากผู้ประสานงาน นางสาวอัญชิกา ปัญญาชนกุล สำนักงานคณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง อาคารบริการวิชาการ (AS) ชั้น 4 หมายเลขโทรศัพท์ 053-916-551 เพื่อดำเนินการตามขั้นตอนต่อไป

จึงเรียนมาเพื่อโปรดดำเนินการ

(อาจารย์ นายแพทย์จุลพงศ์ อจลพงศ์)

ประธานคณะกรรมการจริยธรรมการวิจัยในมนุษย์มหาวิทยาลัยแม่ฟ้าหลวง

## APPENDIX B

## REPORT

FM-7.8-01/01 (04/06/2568)



Sugars and Derivatives Analytical Laboratory (SuDAL)

Page 1 / 4

Room 3411, 4th floor, Agro-Industry building 3, Department of Biotechnology, Faculty of Agro-Industry,  
Kasetsart University 50 Ngam Wong Wan Rd, Lat Yao, Chatuchak, Bangkok 10900

Tel: 095-517-6493 E-mail: Labservice.sugars@gmail.com Website: www.csdlabservices.com

## Report

Report Date: 3 November 2025

Report No.: R00559-126-68

Requested form No.: S00570-119-68

Customer name	Saranya Praserttrunguang
Address	84/2 Soi Ladphrao 83 Ladphrao rd. Wangthonglang Klongjaokhunsing Bangkok 10310
Name/Code of sample	<ol style="list-style-type: none"> <li>1) RAW PG</li> <li>2) Boiled PG 30 min</li> <li>3) Boiled PG 45 min</li> <li>4) Boiled PG 60 min</li> <li>5) Boiled PG 90 min</li> <li>6) Soak 1 h + Boiled 5 min</li> <li>7) Soak 1 h + Boiled 10 min</li> <li>8) Soak 1 h + Boiled 15 min</li> <li>9) Soak 1 h + Boiled 30 min</li> <li>10) Soak 2 h + Boiled 5 min</li> <li>11) Soak 2 h + Boiled 10 min</li> <li>12) Soak 2 h + Boiled 15 min</li> <li>13) Soak 2 h + Boiled 30 min</li> <li>14) Soak 3 h + Boiled 5 min</li> <li>15) Soak 3 h + Boiled 10 min</li> <li>16) Soak 3 h + Boiled 15 min</li> <li>17) Soak 3 h + Boiled 30 min</li> <li>18) Water of Boiled PG 30 min</li> </ol>

Characteristics and conditions of the sample (Customer information)	Sample characteristic: Solid
	Type of container: Bottle
	Storage temperature: -4 °C
	Sample condition: Normal
Receipt date	6 October 2025
Analysis date	6 – 31 October 2025

Approved

Boontiva Ninchan

(Assoc.Prof. Boontiva Ninchan)

Head of Sugars and Derivatives Analytical Laboratory

### Results

Name/Code of sample	Analysis items	Methods
	Arabinose (% w/w)	
1) RAW PG	2.88 ± 0.02	HPLC (Column: Agilent Hi-Plex Ca)
2) Boiled PG 30 min	0.66 ± 0.00	
3) Boiled PG 45 min	0.68 ± 0.00	
4) Boiled PG 60 min	0.52 ± 0.00	
5) Boiled PG 90 min	0.45 ± 0.01	
6) Soak 1 h + Boiled 5 min	0.78 ± 0.00	
7) Soak 1 h + Boiled 10 min	0.83 ± 0.00	
8) Soak 1 h + Boiled 15 min	1.18 ± 0.00	
9) Soak 1 h + Boiled 30 min	0.93 ± 0.00	
10) Soak 2 h + Boiled 5 min	0.95 ± 0.00	
11) Soak 2 h + Boiled 10 min	1.21 ± 0.00	
12) Soak 2 h + Boiled 15 min	1.11 ± 0.01	
13) Soak 2 h + Boiled 30 min	0.84 ± 0.00	
14) Soak 3 h + Boiled 5 min	1.19 ± 0.00	
15) Soak 3 h + Boiled 10 min	2.22 ± 0.02	
16) Soak 3 h + Boiled 15 min	1.51 ± 0.01	
17) Soak 3 h + Boiled 30 min	0.31 ± 0.01	
18) Water of Boiled PG 30 min	1.04 ± 0.01	

Note: Mean ± standard deviation

**Details of analysis**

Brand/Model : Agilent 1260 Infinity II  
 Column : Agilent Hi-Plex Ca (300 x 7.7 mm)  
 Temperature : 85° C  
 Flow rate : 0.6 mL/min  
 Mobile phase : DI water  
 Detector : RI  
 Run time : 30 min

**Raw data**

Name/Code of sample	Analysis items			
	Arabinose (% w/w)			
	Rep 1	Rep 2	Rep 3	Average
1) RAW PG	2.87	2.86	2.90	2.88
2) Boiled PG 30 min	0.66	0.65	0.65	0.66
3) Boiled PG 45 min	0.68	0.68	0.68	0.68
4) Boiled PG 60 min	0.52	0.52	0.52	0.52
5) Boiled PG 90 min	0.46	0.44	0.45	0.45
6) Soak 1 h + Boiled 5 min	0.79	0.78	0.78	0.78
7) Soak 1 h + Boiled 10 min	0.83	0.83	0.83	0.83
8) Soak 1 h + Boiled 15 min	1.18	1.17	1.18	1.18
9) Soak 1 h + Boiled 30 min	0.93	0.93	0.93	0.93
10) Soak 2 h + Boiled 5 min	0.96	0.95	0.95	0.95
11) Soak 2 h + Boiled 10 min	1.21	1.21	1.21	1.21
12) Soak 2 h + Boiled 15 min	1.10	1.10	1.11	1.11
13) Soak 2 h + Boiled 30 min	0.84	0.84	0.85	0.84
14) Soak 3 h + Boiled 5 min	1.19	1.20	1.19	1.19
15) Soak 3 h + Boiled 10 min	2.23	2.20	2.23	2.22
16) Soak 3 h + Boiled 15 min	1.51	1.50	1.52	1.51
17) Soak 3 h + Boiled 30 min	0.30	0.31	0.31	0.31
18) Water of Boiled PG 30 min	1.05	1.03	1.05	1.04

- End of Report -

The results are effective only for the analyzed samples