

**EFFECT OF BLEACHING TREATMENT AND PARTICLE SIZE DISTRIBUTION
ON THE PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF
FIBER POWDERS FROM FRUIT AND NUT BY-PRODUCTS**

By

Jane Angeline

12105153

BACHELOR'S DEGREE
in

FOOD TECHNOLOGY
FACULTY OF LIFE SCIENCES AND TECHNOLOGY



SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

Revised after the Thesis Defense on July 8th, 2025

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.



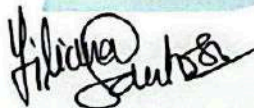
Jane Angeline

Student

20.07.2025

Date

Approved by:

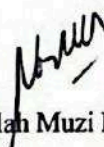


Dr. rer. nat. Filiana Santoso

Thesis Advisor

20.07.2025

Date



Dr. Ir. Abdullah Muzi Marpaung, M.P.

Thesis Co-Advisor

21. 07 - 2025

Date



Dr. Hery Sutanto, S.Si., M.Si.

Dean

21.07.2025

Date

Jane Angeline

ABSTRACT

EFFECT OF BLEACHING TREATMENT AND PARTICLE SIZE DISTRIBUTION ON THE PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF FIBER POWDERS FROM FRUIT AND NUT BY-PRODUCTS

By

Jane Angeline

Dr. rer. nat. Filiana Santoso, Advisor

Dr. Ir. Abdullah Muzi Marpaung, M.P., Co-Advisor

SWISS GERMAN UNIVERSITY

Agro-industrial by-products such as orange peel, pineapple peel, and almond pulp represent sustainable and underutilized sources of dietary fiber and bioactive compounds. This study aimed to optimize their use in fiber drink formulations by evaluating the effects of bleaching treatments and particle size on functional, physicochemical, and sensory properties. The by-products were pre-treated using citric acid and potassium metabisulfite at various concentrations and dried under optimized conditions: 105 minutes at 115°C for orange peel, 135 minutes at 100°C for pineapple peel, and 60 minutes at 100°C for almond pulp. Color analysis using the CIELAB system showed that bleaching with 2% citric acid significantly improved powder lightness while maintaining acceptable color intensity. Particle size distribution analysis revealed that orange and pineapple peel powders predominantly fell within 250–420 μm range, similar to commercial fiber drink powders. Larger particle sizes ($>420 \mu\text{m}$) exhibited higher water holding capacity (WHC), and swelling capacity (SC), particularly in pineapple peel, indicating their suitability for

improving viscosity and satiety in beverage drinks. Sensory evaluation with 100 untrained panelists revealed that Formulation 1 (1.4 g orange peel, 0.6 g almond pulp, and 5 g sugar) received the highest overall acceptability score (7.51 ± 0.49), outperforming both other experimental formulations and a commercial psyllium-based product.

Keywords: Orange peel, pineapple peel, almond pulp, bleaching, particle size distribution, dietary fiber, fiber drink formulation





© Copyright 2025
by Jane Angeline
All rights reserved

DEDICATION

I dedicate this research to Almighty God for His guidance and strength,
to my lecturers and family for their unwavering support,
to my friends for their encouragement,
and to the future of Food Science and Technology.



ACKNOWLEDGEMENTS

I would like to begin by expressing my deepest gratitude to Almighty God for His blessings, guidance, and strength throughout the course of this thesis. Without His grace, this work would have been impossible.

I would like to thank my thesis advisor, Dr. rer. nat. Filiana Santoso, and co-advisor, Dr. Ir. Abdullah Muzi Marpaung, MP, for their invaluable guidance, feedback, and support throughout this research.

My sincere gratitude goes to my family for their constant support during this journey. To my friends who contributed to the completion of this thesis, I am sincerely thankful for your help and encouragement.

Lastly, I wish to thank the Life Sciences and Technology lab members, the faculty, and the staff at Swiss German University for their assistance and support during my thesis work.

I acknowledge that this thesis may still have areas for improvement, and I apologize for any shortcomings. I hope this work can be beneficial for others, and I am truly grateful for everyone's contribution to its success.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	6
ACKNOWLEDGEMENTS.....	7
TABLE OF CONTENTS.....	8
LIST OF FIGURES.....	10
LIST OF TABLES.....	11
CHAPTER 1 - INTRODUCTION.....	12
1.1 Background.....	12
1.2 Research Problems.....	13
1.3 Research Objectives.....	14
1.4 Significance of Study.....	14
1.5 Research Questions.....	14
1.5 Hypothesis.....	15
CHAPTER 2 – LITERATURE REVIEW.....	16
2.1 Functional Foods and the Role of Dietary Fiber.....	16
2.2 Fiber-Enriched Beverages.....	18
2.3 Fruit and Nut By-Products as Fiber Sources.....	19
2.3.1 Orange Peel.....	19
2.3.2 Pineapple Peel.....	21
2.3.3 Almond Pulp.....	22
2.4 Challenges of Fiber Drink Development.....	23
2.5 Pretreatment Techniques to Improve Color Quality.....	24
2.6 Hydration Properties of Fiber.....	25
2.7 Sensory Considerations in Fiber Drink Formulation.....	26
CHAPTER 3 – RESEARCH METHODS.....	27

3.1	Materials.....	27
3.2	Equipment.....	27
3.3	Sample Preparation.....	27
3.4	Analytical Methods.....	28
	3.4.1 Moisture Content.....	28
	3.4.2 CIELAB Color.....	28
	3.4.3 Particle Size Distribution.....	29
	3.4.4 Water Holding Capacity (WHC).....	29
	3.4.5 Swelling Capacity (SC).....	29
	3.4.6 Total Dietary Fiber Analysis.....	30
	3.4.7 Powder Formulation Trials.....	30
	3.4.8 Organoleptic Test.....	30
	3.4.9 Data Analysis.....	30
CHAPTER 4 – RESULTS AND DISCUSSIONS.....		32
4.1	Effect of Bleaching Treatment on Moisture Content and Color.....	32
	4.1.1 Moisture Content.....	32
	4.1.2 CIELAB Color Parameters (L*, a*, b*, Chroma).....	33
4.2	Particle Size Distribution.....	39
4.3	Hydration Properties of Fiber Powders.....	40
	4.3.1 Water Holding Capacity (WHC).....	40
	4.3.2 Swelling Capacity (SC).....	43
4.4	Total Dietary Fiber Content.....	46
4.5	Formulation and Sensory Evaluation of Fiber Drink.....	47
	4.5.1 Optimization of Powder Ratios.....	47
	4.3.2 Organoleptic Test Results.....	48
CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS.....		53
5.1	Conclusions.....	53
5.2	Recommendations.....	54
REFERENCES.....		56
APPENDICES.....		71
CURRICULUM VITAE.....		84

LIST OF FIGURES

Figures	Page
Figure 3.1 Design of Experiment	28
Figure 4.1 Moisture Content of Orange Peel, Pineapple Peel, and Almond Pulp at Different Drying Times and Bleaching Concentrations	32
Figure 4.2 Orange Peel Powders with Different Bleaching Concentrations	36
Figure 4.3 Pineapple Peel Powders with Different Bleaching Concentrations	37
Figure 4.4 Almond Pulp Powders with Different Bleaching Concentrations	38
Figure 4.5 Particle Size Distribution of Orange Peel, Pineapple Peel, and Almond Pulp Powders Processed by Blender Grinder and Disk Mill, Compared to Commercial Sample	39
Figure 4.6 Fiber drinks produced from formulation 1, formulation 2, formulation 3, formulation 4, and formulation 5	49

LIST OF TABLES

Table	Page
Table 2.1 Proximate Analysis and Phytochemical Composition of Sweet Orange ...	20
Table 2.2 Proximate Analysis and Bioactive Compounds of Pineapple Peel	22
Table 2.3 Proximate Analysis and Bioactive Compounds of Almond Pulp	23
Table 4.1 Color of L*, a*, b*, and Chroma of Orange Peel, Pineapple Peel, and Almond Pulp Powder Treated with Citric Acid	34
Table 4.2 Color of L*, a*, b*, and Chroma of Orange Peel, Pineapple Peel, and Almond Pulp Powder Treated with Potassium Metabisulfite	34
Table 4.3 Water Holding Capacity of Orange Peel, Pineapple Peel, Almond Pulp, and Commercial Fiber Powder	41
Table 4.4 Swelling Capacity of Orange Peel, Pineapple Peel, Almond Pulp, and Commercial Fiber Powder	44
Table 4.5 Dietary Fiber Content in Orange Peel, Pineapple Peel, and Almond Pulp	46
Table 4.6 Composition of Fiber Drink Formulations	48
Table 4.7 Sensory Evaluation Results of Fiber Drink Formulations	49