UNDERGRADUATE THESIS

OPTIMIZATION OF DAILY FOOD COMBINATIONS FOR DIABETICS USING THE ARTIFICIAL IMMUNE SYSTEM ALGORITHM METHOD

Fajar Chandra Aditiya
NPM 20081010090

SUPERVISOR
Dr. Rizky Parlika, S.Kom, M.Kom
Andreas Nugroho Sihananto, S.Kom., M.Kom.

MINISTRY OF HIGHER EDUCATION, SCIENCE, AND TECHNOLOGY
NATIONAL DEVELOPMENT UNIVERSITY OF VETERANS EAST JAVA
FACULTY OF COMPUTER SCIENCE
INFORMATICS STUDY PROGRAM
SURABAYA
2026

APPROVAL SHEET

OPTIMIZATION OF DAILY FOOD COMBINATIONS FOR DIABETICS USING THE ARTIFICIAL IMMUNE SYSTEM ALGORITHM METHOD

By :
Fajar Chandra Aditiya
NPM. 20081010090

It has been defended in front of and accepted by the Thesis Examiner Team of the Informatics Study Program, Faculty of Computer Science, National Development University of East Java Veterans on date August 20, 2026.

Dr. Rizky Parlika, S.Kom, M.Kom
NIP. 19840518 202121 1 003 ..... (Supervisor I)

Andreas Nugroho Sihananto, S.Kom., M.Kom.
NIP. 19900412 202406 1 003 ..... (Supervisor II)

Dr. Budi Nugroho, S.Kom, M.Kom
NIP. 19800907 2021211 005 ..... (Chief Examiner)

Ardhon Rakhmadi, S.Tr.T., M.Kom
NIP. 19910805 2024061 002 ..... (Examiner I)

Knowing,
Dean of the Faculty of Computer Science

Prof. Dr. Ir. Novirina Hendrasarie, MT
NIP. 19681126 199403 2 001

APPROVAL SHEET

OPTIMIZATION OF DAILY FOOD COMBINATIONS FOR DIABETICS USING THE ARTIFICIAL IMMUNE SYSTEM ALGORITHM METHOD

By :

Fajar Chandra Aditiya
NPM. 20081010090

Approved to proceed to the Thesis Examination

Approved by,

Coordinator of Informatics Study Program

Faculty of Computer Science

Dr. Intan Yuniar Purbasari, S.Kom. MSc.

NIP. 19800602 202521 2 029

STATEMENT OF ORIGINALITY

I am the undersigned:

Name	: Fajar Chandra Aditiya
NPM	: 20081010090
Programs	: Bachelor (S1)
Study Programs	: Informatics
Faculty	: Faculty of Computer Science

Hereby declares that this undergraduate thesis contains no part of any other scientific work that has been submitted to obtain an academic degree at any higher education institution. Furthermore, it does not contain any work or opinions previously written or published by others, except for those which are explicitly cited in this thesis and listed completely in references.

And I declare that this scientific document is free from elements of plagiarism. If in the future indications of plagiarism are found in this Thesis, I am willing to accept sanctions in accordance with the applicable laws and regulations.

Thus, I made this statement without any coercion from anyone and to be used as it should.

Surabaya, August 20, 2026

Declarant,

Fajar Chandra Aditiya

NPM. 20081010090

ABSTRACT

Student Name / NPM :	Fajar Chandra Aditiya / 20081010090
Thesis Title :	Optimization of Daily Combinations for Diabetics Using Artificial Immune System Algorithm
Supervisor :	1. Dr. Rizky Parlika, S.Kom, M.Kom 2. Andreas Nugroho Sihananto, S.Kom., M.Kom.

Food waste at the household level remains a critical issue, largely driven by the failure to utilize ingredients before they expire. This study develops an image-based recipe recommendation system that leverages the Artificial Immune System Algorithm (AISA) to detect ingredients nearing their expiration date. Inspired by the biological immune mechanism, AISA employs clonal selection and somatic hypermutation processes to classify visual features of 12 common food ingredient categories including eggs, chicken, tempeh, tofu, broccoli, carrots, and others stored in a refrigerator. A dataset of 6,000 images was collected from public sources and expanded through augmentation, with each image represented as a 512-dimensional feature vector combining HSV color histograms and Local Binary Pattern (LBP) texture descriptors. The system achieved a validation accuracy of 93.5% and a training accuracy of 94.72% after 100 evolutionary generations, outperforming CNN from scratch (82.3%), ResNet-50 (91.2%), and EfficientNet-B0 (92.1%), while also demonstrating superior training efficiency at 3.2 hours compared to all baselines. Real-world testing under varied lighting conditions yielded an average accuracy of 88.4%, confirming adequate generalization capability for practical deployment. Explainability analysis through affinity-based feature contribution maps revealed that classification errors between visually similar classes particularly tempeh and tofu stem from near-identical HSV color distributions and LBP texture patterns, providing a clear direction for future refinement. The system is integrated into a mobile application capable of detecting ingredients from images and recommending recipes that prioritize the use of near-expiry items, offering a practical digital solution to reduce household food waste.

Keywords : AISA, Artificial Immune System, Food Ingredient Detection, Recipe Recommendation, Food Waste, Expiry Date.

ABSTRACT

Student Name/NPM	:	Fajar Chandra Aditiya / 20081010090
Thesis Title	:	Optimization of Daily Combinations for Diabetics Using Artificial Immune System Algorithm.
Advisor:		1. Dr. Rizky Parlika, S.Kom, M.Kom 2. Andreas Nugroho Sihananto, S.Kom., M.Kom.

Food waste at the household level remains a critical issue, largely driven by the failure to utilize ingredients before they expire. This study develops an image-based recipe recommendation system that leverages the Artificial Immune System Algorithm (AISA) to detect ingredients nearing their expiration date. Inspired by the biological immune mechanism, AISA employs clonal selection and somatic hypermutation processes to classify visual features of 12 common food ingredient categories including eggs, chicken, tempeh, tofu, broccoli, carrots, and others stored in a refrigerator. A dataset of 6,000 images was collected from public sources and expanded through augmentation, with each image represented as a 512-dimensional feature vector combining HSV color histograms and Local Binary Pattern (LBP) texture descriptors. The system achieved a validation accuracy of 93.5% and a training accuracy of 94.72% after 100 evolutionary generations, outperforming CNN from scratch (82.3%), ResNet-50 (91.2%), and EfficientNet-B0 (92.1%), while also demonstrating superior training efficiency at 3.2 hours compared to all baselines. Real-world testing under varied lighting conditions yielded an average accuracy of 88.4%, confirming adequate generalization capability for practical deployment. Explainability analysis through affinity-based feature contribution maps revealed that classification errors between visually similar classes particularly tempeh and tofu stem from near-identical HSV color distributions and LBP texture patterns, providing a clear direction for future refinement. The system is integrated into a mobile application capable of detecting ingredients from images and recommending recipes that prioritize the use of near-expiry items, offering a practical digital solution to reduce household food waste.

Keywords : AISA, Artificial Immune System, Food Ingredient Detection, Recipe Recommendation, Food Waste, Expiry Date.

FOREWORD

Praise be to Allah SWT for all His graces, guidance, and gifts to the author so that the thesis with the title " OPTIMIZATION OF DAILY FOOD COMBINATIONS FOR DIABETICS USING THE ARTIFICIAL IMMUNE SYSTEM ALGORITHM METHOD " can be completed properly and on time. The author expresses his deepest gratitude to all parties who have helped both directly and indirectly during the *process of preparing this thesis. In particular, the author would like to thank the:*

1. Mr. Prof. Dr. Ir. Akhmad Fauzi, MMT., IPU. as the Rector of the "Veteran" National Development University of East Java.
2. Mrs. Prof. Dr. Ir. Novirina Hendrasarie, MT. as the Dean of the Faculty of Computer Science, National Development University "Veteran" East Java.
3. Mrs. Dr. Intan Yuniar Purbasari, S.Kom. MSc. as the Coordinator *of the Informatics Study Program, Faculty of Computer Science, National Development University "Veteran" East Java.*
4. Mr. Eka Prakarsa Mandyartha, S.T., M.Kom as a Wali Lecturer who has helped the writer a lot from the beginning of the lecture to the completion of the thesis.
5. Mr. Dr. Rizky Parlika, S.Kom, M.Kom. as Supervisor I who has provided briefing, support, and valuable input during the research process.
6. Mr. Andreas Nugroho Sihananto, S.Kom., M.Kom. as Supervisor II who has provided direction, support, and valuable input during the research process.
7. Mr. Dr. Budi Nugroho, S.Kom, M.Kom. as the Chief Examiner who has provided input in compiling this thesis.
8. Mr. Ardhon Rakhmadi, S.Tr.T., M.Kom. as a member of the examiner who has provided input in compiling this thesis.
9. All lecturers of the Informatics Study Program, Faculty of Computer Science, National Development University, East Java, "Veterans", for all

the knowledge given to the author during the lecture period. Hopefully the writer can practice the knowledge that has been given and will be a useful provision for writers in the future.

10. Fathers and mothers who have provided material and non-material support at the same time always pray for the writer in any condition. So that the author can complete the lecture from the beginning to the completion of this thesis well.
11. A couple of writers who have provided support, motivation, prayers and accompanied the author's academic journey so that the author can complete the lecture from the beginning to the completion of this thesis well.

The author realizes that in the preparation of this thesis there are still shortcomings. Therefore, constructive criticism and suggestions from various parties are highly expected for the perfection of this work. Finally, with all the limitations that exist, the author hopes that this thesis report can provide benefits for all parties, especially in the development of science in the field of digital image processing and artificial intelligence.

Surabaya, 20 August 2026

Fajar Chandra Aditiya

TABLE OF CONTENTS

IMAGE LIST

TABLE LIST