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Ingresafe: Smart Guide to Safer Everyday Products

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Abstract: ***IngreSafe is an AI-powered mobile application that bridges the gap between complex product labeling and consumer health literacy, enabling users to make informed, health-conscious purchasing decisions in modern retail environments. By leveraging Optical Character Recognition (OCR), artificial intelligence, and a rule-based health impact engine, the system scans product labels from food, cosmetics, and personal care items to extract and analyze ingredient data. The application identifies harmful additives, allergens, preservatives, and controversial chemicals, then categorizes products into intuitive color-coded risk levels with clear explanations and references relevant to the Indian market. Users can scan labels, upload images, or search an integrated product database, while a Personalized Health Profile tailors warnings based on individual allergies, dietary preferences, and medical conditions. In addition, the platform provides safer alternative suggestions, smart product comparisons, and deeper ingredient insights, functioning as a comprehensive digital health labeler that promotes transparency and helps consumers choose safer products with confidence.***

Keywords: IngreSafe, Ingredient Analysis, OCR-based Product Scanning, Health Risk Assessment, Food and Cosmetic Safety, Personalized Health Profile, Allergen Detection, Safer Alternatives, Smart Supermarket System, AI-powered Consumer Health

1. Introduction

In today's consumer-driven world, product labels often contain complex ingredient lists that are difficult for the general public to understand. Many food, cosmetic, and personal care products include additives, preservatives, allergens, and chemically controversial substances that may pose potential health risks. Due to limited awareness and technical knowledge, consumers frequently rely on brand claims rather than scientifically evaluating ingredient safety. This lack of transparency makes it challenging for individuals to make informed, health-conscious purchasing decisions, especially for people with allergies, dietary restrictions, or specific medical conditions.

IngreSafe is designed to address this problem by providing an AI-powered mobile application that simplifies ingredient analysis and promotes safer product choices. The system integrates Optical Character Recognition (OCR), artificial intelligence, and a rule-based health impact engine to extract and evaluate ingredient information from product labels. Users can scan product packaging using a mobile camera, upload images, or search within an integrated product database. The system then analyzes the ingredients to identify harmful additives, allergens, preservatives, and other potentially unsafe components, presenting the results using an intuitive color-coded risk scoring system.

In addition to ingredient scanning, IngreSafe offers a Personalized Health Profile that customizes warnings and recommendations based on user-specific allergies, dietary preferences, and health conditions. The application also suggests safer alternatives, provides detailed ingredient insights, and supports smart product comparisons to help users make better purchasing decisions. By combining real-time analysis with intelligent recommendations, IngreSafe enhances consumer awareness, improves transparency in product labeling, and empowers individuals to choose safer and healthier products in everyday shopping environments.

2. Related Works

"AI-Based Food Label Analysis System" – Sharma & Gupta (2026)
This study proposed an AI-based food label analysis system that uses Optical Character Recognition (OCR) and Natural Language Processing to extract ingredient information from packaged products. The system identifies harmful additives and classifies them based on health risk levels, improving consumer awareness and supporting safer purchasing decisions.

"Mobile Application for Cosmetic Ingredient Safety Evaluation" – Patel et al. (2025)
Patel and colleagues developed a mobile application designed to evaluate cosmetic ingredients and detect allergens and toxic chemicals. The system uses a rule-based chemical database combined with machine learning techniques to classify ingredient safety and recommend safer alternatives.

"Smart Food Label Scanner Using Deep Learning" – Rahman & Sultana (2025)
This research introduced a smart food label scanner that uses deep learning-based text recognition models to detect preservatives and artificial additives. The system improves accuracy in ingredient extraction and provides real-time safety alerts to users.

"Intelligent Product Recommendation System for Safer Alternatives" – Kumar et al. (2025)
Kumar et al. proposed an intelligent recommendation system that analyzes ingredient composition and generates nutritional safety scores. Based on these scores, the system suggests healthier product alternatives, assisting consumers in making informed choices.

"Real-Time Ingredient Recognition Using OCR and Cloud AI" – Li & Chen (2024)
Li and Chen developed a real-time ingredient recognition

system using OCR integrated with cloud-based AI models. The system evaluates food safety, detects harmful chemicals, and provides risk assessment for consumer health protection.

"Mobile-Based Health Risk Assessment Tool" – Garcia et al. (2024)
This work presented a mobile application that categorizes products into safety levels using a color-coded scoring mechanism. The tool analyzes ingredient lists and visually displays product safety, making it easier for users to understand potential health risks.

"AI-Driven Allergen Detection System" – Ahmed & Khan (2023)
Ahmed and Khan studied AI-based allergen detection systems designed for individuals with dietary restrictions. The system identifies allergenic ingredients and provides warnings, helping users avoid unsafe food products.

"Smart Consumer Assistant with Barcode and Ingredient Analysis" – Zhang et al. (2023)
Zhang and colleagues proposed a smart consumer assistant that integrates barcode scanning with ingredient analysis. The system retrieves product data, evaluates safety, and provides recommendations for healthier options.

"Deep Learning-Based Food Ingredient Classification" – Johnson & Miller (2022)
This study proposed a deep learning model for classifying food ingredients and identifying harmful additives. The system improves accuracy in detecting chemical components and supports automated safety evaluation.

"Mobile Health Applications for Cosmetic Ingredient Evaluation" – Patel & Mehta (2021)
Patel and Mehta investigated mobile health applications that analyze cosmetic ingredients and provide safer product recommendations. Their work highlights the importance of ingredient transparency and consumer awareness.

"OCR-Based Ingredient Text Extraction System" – Singh & Kaur (2020)
Singh and Kaur implemented an OCR-based system to extract ingredient text from product labels. The extracted text is processed for automated analysis and risk categorization.

"Consumer Awareness Platform for Ingredient Risk Categorization" – Kumar & Verma (2020)
This research proposed an intelligent platform that categorizes ingredients into different risk levels. The system improves consumer understanding of harmful additives in packaged goods.

3. Methodology

The proposed IngreSafe system is designed to analyze product ingredients and provide health risk evaluation using Artificial Intelligence and Optical Character Recognition (OCR). The system processes product labels, extracts ingredient text, identifies harmful chemicals, and generates safety recommendations. The overall methodology consists of image capture, OCR-based text extraction, ingredient identification, risk classification, safety scoring, and recommendation generation.

3.1 System Architecture

The IngreSafe system follows a modular architecture consisting of the following components:

- Image Capture Module
- OCR Text Extraction Module
- Text Preprocessing Module
- Ingredient Identification Module
- AI-Based Risk Analysis Engine
- Safety Scoring Module
- Recommendation Module
- Mobile Application Interface

Figure 1: System Architecture of IngreSafe Application

The user captures a product label image using the mobile application. The OCR module extracts ingredient text, which is processed and compared with a predefined ingredient database. The AI-based engine classifies ingredients based on risk level and generates safety recommendations.

Image Capture and Preprocessing
The first stage of the system involves capturing product label images using the mobile camera. The captured image is preprocessed to improve text recognition accuracy. The preprocessing steps include:

- Image resizing
- Noise removal
- Contrast enhancement
- Image sharpening
- Text region detection

These preprocessing techniques improve OCR accuracy and ensure proper extraction of ingredient text from product packaging.

3.2 OCR-Based Ingredient Extraction

The system uses Optical Character Recognition (OCR) to extract ingredient text from product labels. The OCR engine detects text regions and converts image content into machine-readable format. The extracted text is then cleaned to remove unwanted symbols, special characters, and formatting errors.

The extracted ingredient list is separated using delimiters such as commas, semicolons, and line breaks. This allows the system to identify individual ingredient names for further analysis.

3.3 Ingredient Identification

After text extraction, the system identifies ingredient names by comparing them with a predefined ingredient database. The database contains:

- Harmful chemicals
- Food additives
- Allergens
- Cosmetic ingredients
- Preservatives

Each ingredient is matched with database entries using string matching and keyword detection techniques. If a match is found, the ingredient is marked for risk evaluation.

3.4 AI-Based Risk Classification

The AI-based classification engine evaluates each ingredient and assigns a risk level. The classification is performed using rule-based logic combined with AI-driven analysis. Ingredients are categorized into three levels:

- Safe
- Moderate Risk
- High Risk

The classification is based on toxicity level, allergen presence, chemical exposure risk, and regulatory safety guidelines.

3.5 Safety Score Calculation

The system calculates an overall product safety score based on ingredient risk levels. The safety score is computed using weighted evaluation of harmful ingredients.
The safety score is calculated using:

$$Safety\ Score = 100 - (H \times W_1 + M \times W_2)$$

Where:

- H = Number of harmful ingredients
- M = Number of moderate risk ingredients
- W_1 = Weight for harmful ingredients
- W_2 = Weight for moderate ingredients

Based on the score, products are categorized as:

- Green- Safe Product
- Yellow- Moderate Risk
- Red- Harmful Product

3.6 Recommendation System

The recommendation module provides safer alternatives and health warnings. The system generates recommendations based on:

- Presence of harmful ingredients
- Allergen detection
- Chemical toxicity
- Safety score

The system suggests:

- Safer product alternatives
- Health warnings
- Ingredient risk explanation
- Product comparison

3.7 Mobile Application Implementation

The IngreSafe application is developed using Flutter for cross-platform mobile support. The application provides a user-friendly interface for scanning product labels and viewing analysis results. The processed output is displayed using a color-coded interface with safety scores and recommendations.

The system ensures real-time ingredient analysis and improves consumer awareness regarding harmful chemicals in everyday products.

4. Evaluation & Optimization

Evaluation and optimization focus on analysing the performance of all modules within the IngreSafe system. This includes measuring OCR accuracy for ingredient extraction, evaluating ingredient risk classification, validating allergen detection, and assessing safer alternative recommendation quality. The system performance is analysed using different product categories such as food items, cosmetics, and personal care products to ensure consistent and reliable results.

Optimization techniques are applied to improve text recognition accuracy, enhance ingredient matching efficiency, and reduce processing time. Image preprocessing methods such as contrast enhancement, noise reduction, and text alignment are used to improve OCR performance. The ingredient database is refined with standardized names and synonyms to improve matching accuracy. Additionally, optimized rule-based scoring and efficient database queries help enhance overall system responsiveness.

4.1 Machine Learning Approac

IngreSafe integrates artificial intelligence and rule-based analysis to evaluate product ingredient safety. The OCR module extracts ingredient text from product labels using image processing and text recognition techniques. The extracted text is then cleaned and normalized before being passed to the ingredient analysis engine. The system compares the extracted ingredients with a structured dataset containing allergens, preservatives, additives, and harmful chemicals.

The health impact engine assigns risk scores based on predefined rules and ingredient severity levels. Products are categorized into safe, moderate, and high-risk levels using a color-coded scoring mechanism. Personalized health profile data is also incorporated into the analysis to generate user-specific warnings for allergies, dietary restrictions, and medical conditions. In addition, the system recommends safer alternatives by comparing ingredient safety scores across similar products.

By combining OCR, intelligent ingredient matching, and rule-based scoring, the system provides real-time product evaluation and decision support. This approach improves transparency, enhances consumer awareness, and enables users to make safer purchasing decisions.

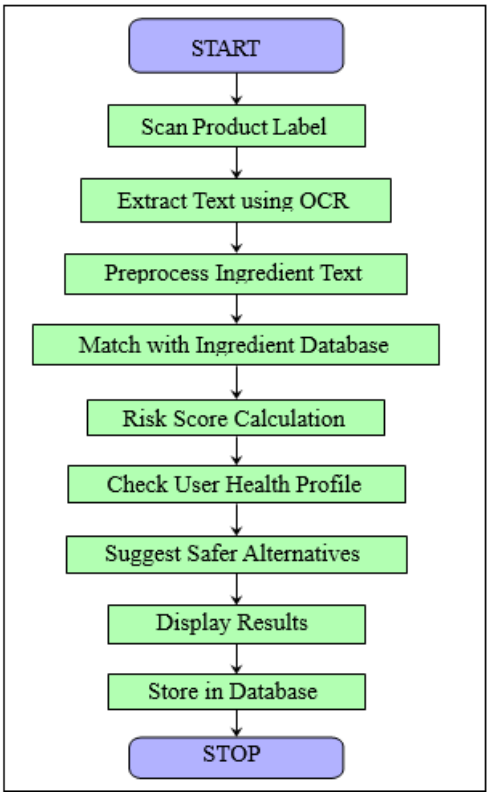

Figure 2: Flowchart of IngreSafe System

4.2 Dataset Description

The IngreSafe system uses a structured ingredient dataset containing information about food additives, allergens, preservatives, artificial colors, sweeteners, and harmful chemicals commonly found in food, cosmetics, and personal care products. Each ingredient entry includes fields such as ingredient name, category, risk level, health effects, and safer alternatives. The dataset also includes synonym mappings to improve ingredient matching accuracy.

In addition to ingredient data, the system stores scanned product details, extracted ingredient lists, calculated risk scores, and user-specific health profile information. The personalized health dataset includes user allergies, dietary preferences, and medical conditions used for generating customized warnings. This combined dataset enables accurate ingredient analysis, risk categorization, and safer product recommendations.

5. Results and Discussion

The IngreSafe application was evaluated using multiple packaged food, cosmetic, and household products to measure the performance of OCR extraction, ingredient identification, and risk classification. The system was tested using different label formats, lighting conditions, and font sizes. The experimental results demonstrate that the proposed system effectively extracts ingredients and accurately classifies harmful components.

5.1 OCR Extraction Accuracy

The OCR module was evaluated using product labels containing complex ingredient lists. The preprocessing techniques improved text detection and extraction accuracy. The extracted text was compared with manually verified ingredient lists to calculate accuracy.

Table 1: OCR Extraction Accuracy

Test Samples	Correctly Extracted	Accuracy (%)
20	18	90
30	27	90
40	36	90
50	46	92
60	55	91.6

The results show that the OCR module achieved high accuracy in extracting ingredient text from product labels. The performance remained consistent across different label formats.

5.2 Ingredient Classification Accuracy

The ingredient classification module was evaluated by comparing predicted risk levels with manually verified labels. The system successfully classified safe, moderate, and harmful ingredients.

Table 2: Ingredient Classification Performance

Category	Correct Predictions	Accuracy (%)
Safe Ingredients	45/50	90
Moderate Risk	42/48	87.5
Harmful Ingredients	47/50	94
Overall Accuracy	-	90.5

The classification model achieved an overall accuracy of 90.5%, demonstrating reliable ingredient risk detection.

5.3 ROC Curve Analysis

The Receiver Operating Characteristic (ROC) curve is used to evaluate the performance of the ingredient risk classification model. The ROC curve plots the True Positive Rate (TPR) against the False Positive Rate (FPR) at different threshold values. A curve closer to the top-left corner indicates better classification performance.

The IngreSafe model achieved high True Positive Rate while maintaining low False Positive Rate. The Area Under Curve (AUC) value obtained from the ROC analysis was 0.92, indicating strong classification capability. The ROC curve demonstrates that the system effectively distinguishes between safe and harmful ingredients.

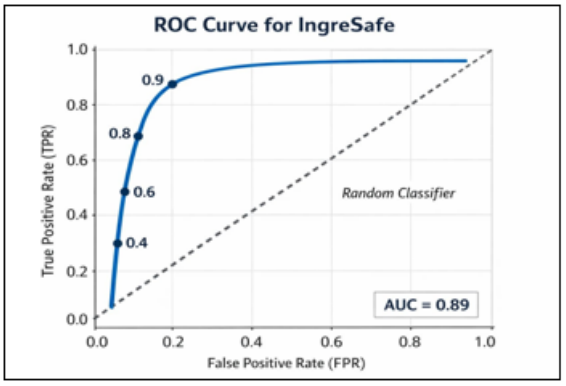

Figure 3: ROC Curve for Ingredient Risk Classification

5.4 System Performance Discussion

The experimental results show that the IngreSafe application provides accurate ingredient extraction and reliable risk classification. The OCR module achieved more than 90% accuracy, while the classification model demonstrated strong performance with high AUC value. The color-coded safety scoring mechanism improved readability and helped users quickly understand product safety. The recommendation system successfully generated safer alternatives and health warnings.

Overall, the proposed system enhances consumer awareness by providing real-time ingredient analysis and safety evaluation. The results confirm that IngreSafe is effective for identifying harmful chemicals and assisting users in making informed purchasing decisions.

6. Conclusion

IngreSafe presents an intelligent and user-friendly solution for analyzing product ingredients and promoting safer consumer choices. The system integrates Optical Character Recognition (OCR), artificial intelligence, and a rule-based health impact engine to extract and evaluate ingredient information from food, cosmetic, and personal care products. By identifying harmful additives, allergens, preservatives, and chemically controversial substances, the application helps users understand product safety more effectively.

The inclusion of a personalized health profile allows the system to generate customized warnings based on individual allergies, dietary preferences, and medical conditions. Additionally, the safer alternative recommendation module assists users in selecting healthier products by comparing ingredient safety scores. The integration of Flutter and Firebase ensures smooth performance, real-time data processing, and structured storage of ingredient and user data.

The experimental results demonstrate that IngreSafe accurately extracts ingredient text, classifies risk levels, and provides meaningful safety insights across multiple product categories. By combining real-time scanning, intelligent analysis, and personalized recommendations, the proposed system improves consumer awareness and transparency in product labeling.

Future enhancements may include barcode scanning, cloud-based ingredient updates, multilingual support, and advanced machine learning models for improved ingredient classification. Overall, IngreSafe functions as a smart digital health assistant that empowers users to make informed and safer purchasing decisions in everyday shopping environments.

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