

HIRKANI: An AI-Powered Food Safety Guide for Pregnant Women

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Abstract: Pregnancy is a vital stage for any woman. The dietary preferences significantly influence the mother's health and the growth of the baby. Nevertheless, pregnant women in India face difficulties in understanding whether a particular packaged food is safe for their health during pregnancy. The reasons include complicated labeling systems, confusing scientific names of ingredients used in the food products, and absence of specific information regarding the pregnancy-related safety of such products. Thus, this research paper introduces HIRKANI – a web application, which combines AI technologies and other approaches for providing timely and evidence-based information about food safety for pregnant women. Specifically, HIRKANI applies the barcode scanning technique, OCR algorithms, and image recognition performed by AI for identifying different food products and assessing their safety. The product safety rating is evaluated using a rule engine that considers the recommendations issued by FSSAI, ICMR-NIN, and WHO. In total, the application distinguishes between safe, consume with caution, and avoid food products.

Keywords: Pregnancy nutrition, food safety, artificial intelligence, barcode scanning, OCR, FSSAI guidelines, maternal health, machine learning

I. INTRODUCTION

Indeed, pregnancy is a very important phase in the life of a woman. Nutrition plays a critical role during pregnancy, determining both maternal and fetal well-being. Proper nutrition during pregnancy helps prevent preterm delivery, infant low birth weight, and developmental problems in babies [1]. Nevertheless, there remain many barriers to making safe food choices by Indian pregnant women, especially when it comes to packaged or processed foods. In recent years, the Indian packaged food industry has grown significantly due to urbanization, increased disposable incomes, and evolving consumption practices. In its report, the Food Safety and Standards Authority of India noted considerable growth in the Indian processed food industry, with millions of products currently available at stores [2]. The growth in the popularity of packaged foods has resulted in significant health-related

concerns for consumers, especially with regards to knowledge of proper nutrition, label reading, and health risks. According to studies, many Indian consumers, including pregnant women and elderly people, experience difficulties with comprehending nutritional information, ingredient content, and allergen information [3]. In their research, Patil and Bhide (2022) found that more than 65% of urban consumers could not properly identify either high-sodium or high-sugar products using only their nutritional information, even though Existing tech solutions do not fully address this problem. But General food scanning apps like Yuka, while effective for a wide audience, do not include pregnancy- specific dietary restrictions and have also have limited product coverage in the Indian market. Pregnancy health apps in India, such as Mylo and BabyChakra, provide community support and general dietary tips, but they lack real-time food product scanning, barcode-based

ingredient retrieval, or AI-driven safety evaluation capabilities. HIRKANI, which takes its name from the mythical Marathi woman who symbolizes a mother's unrelenting and unflinching commitment towards her offspring's safety, is proposed as an AI-integrated web application to bridge this vital gap. In order to facilitate this process, pregnant women can simply scan barcodes of food packages by taking pictures using their mobile phones or PC cameras. Following a multi-modal product identification mechanism involving the use of OCR and AI-based image recognition, the system collects information about the products to validate them using a curated rule-based engine

Maternal Nutrition and Food Safety During Pregnancy

However, the necessity of macro and micronutrients for pregnant women has been greatly emphasized by WHO through the years as a strategy against negative pregnancy outcomes like pre-term delivery, low birth weight, and infant mortality. According to WHO, pregnant women should eat different types of food such as iron, folic acid, iodine, calcium, and zinc at the same time, while they must avoid eating mercury-laden food, raw food, and too much caffeine intake. In India, guidelines for ICMR-NIN provided in 2020 describe the energy, protein intake along with micronutrients in the context of pregnant women by considering the physiology and nutritional deficits such as iron-deficiency anemia and vitamin D deficiency in pregnant women in India [8]. Furthermore, certain hazards related to the consumption of raw sprouts, unpasteurized dairy products, foods with high salt content, and artificial food additives are also mentioned in these guidelines.

AI for Food Recognition

Convolutional Neural Networks (CNNs) have been used widely for food image recognition tasks. Bossard et al.'s Food-101 dataset has widely used as a benchmark for food image classification tasks, and various CNNs such as ResNet, InceptionV3, and EfficientNet have been reported to achieve over 90% classification accuracy on this dataset [9]. Very recently, Vision Transformers (ViT) have been reported to show promising results for

food image classification tasks. image classification by capturing global contextual dependencies through self-attention mechanisms [10].

Barcode and OCR Technologies

Product Recognition based on barcodes is a very useful approach when it comes to recognizing and retrieving the product details at real-time through the use of barcode recognition. Some of the libraries that can be used in this approach are ZXing and Google ML kit, both of which provide very efficient APIs to recognize the product data via 1D & 2D barcodes [11]. OCR technology, Tesseract OCR provided by Google, offers multi-language and multi-font support.

Table I: Comparative Study of Existing Works in the Area of AI based Food Product Recognition & Evaluation

Study	Method	Accuracy	Limitation
Smith et al. (2021)	CNN + OCR	90%	No pregnancy rules
Kumar & Sharma (2022)	Barcode + APIs	75%	Limited India coverage
Patel et al. (2023)	Rule-based	65%	No label scan
Jain & Rao (2024)	NLP	78%	English only
HIRKANI (2025)	OCR + Barcode + AI	92%	Expanding DB

TABLE I. Comparison of Existing Research Studies

II. METHODOLOGY

System Architecture

The HIRKANI system is structured as a multi-tier system with five integrated modules: Product Identification Workflow, Frontend/UI Components, Backend and APIs,

Pregnancy Rules Engine, and Model Hosting and Infrastructure. The system implements a sequential product identification flow where it attempts to decode barcodes, then proceeds to OCR-based product label recognition, and finally attempts AI-based product image classification in case the other two fail.

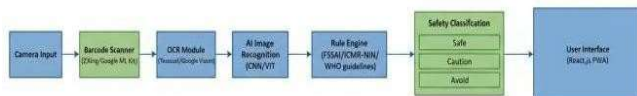


Fig. 1. HIRKANI System Architecture

Identification Pipeline

This system implements a three-stage sequential process for product identification. Attempt 1: Uses barcode recognition through the use of ZXing/Google ML Kit for extraction of data from the FSSAI database, GS1 product database, or internal caching systems. Attempt 2: Uses the Tesseract OCR/Google Vision API for detection and extraction of ingredient information and nutrition data from images of the food products. Attempt 3: Uses CNN or Vision Transformer models to classify the food product type based on visual features

Safety Rule Engine

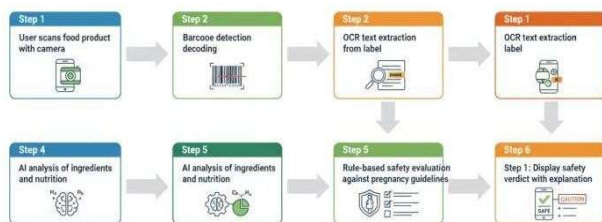


Fig. 2. HIRKANI Application Workflow

The rule engine compares extracted nutritional and ingredient data against pregnancy safety parameters from FSSAI, ICMR-NIN, and WHO guidelines. Table II summarizes the key safety evaluation criteria implemented in the system.

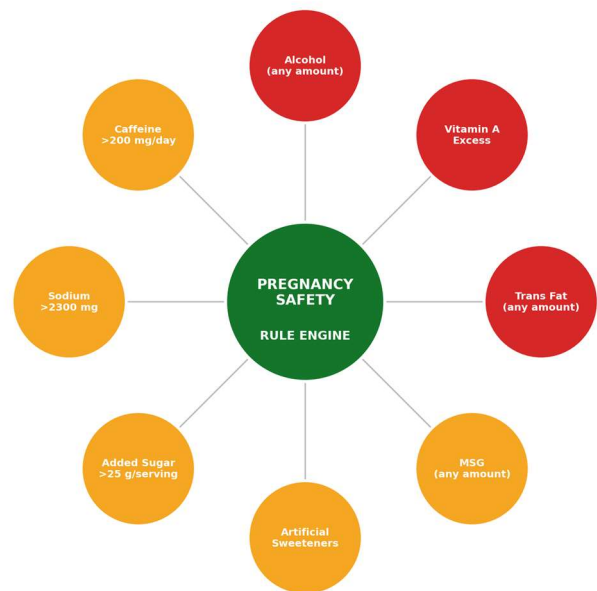


Fig. 3. Pregnancy Safety Rule Engine

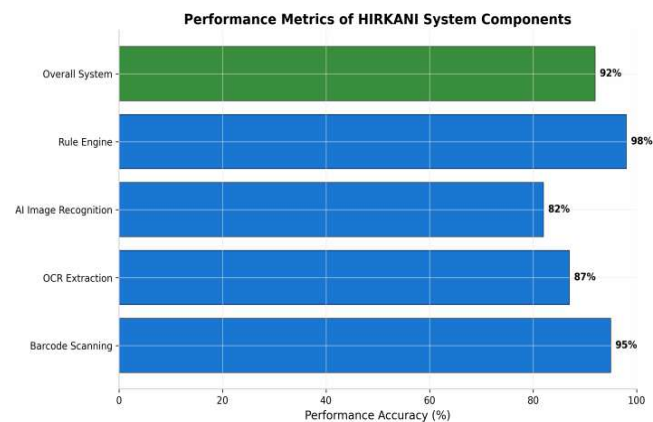


Fig. 4. Performance Metrics of System Components

TABLE II. Pregnancy Safety Evaluation Criteria

Parameter	Threshold	Verdict
Alcohol Present	Any amount	AVOID
Caffeine	> 200 mg/day	CAUTION
Sodium	> 2300 mg	CAUTION
Sugar	>25g per serving	CAUTION

Artificial Sweeteners	Saccharin, Aspartame	CAUTION/AVOID
MSG	Any amount	CAUTION
Trans Fat	Any amount	AVOID
Vitamin A (Retinol)	Excess	AVOID

Technology Stack

The front end application has been implemented using React.JS framework, which runs as a Progressive Web Application (PWA) and has access to media devices API to capture images. The back end application has been developed using python FastAPI to provide ML-based services. AI and Vision stack contains Tesseract OCR, Google Vision API, ZXing, Google ML Kit, TensorFlow/Pytorch



Fig. 5. HIRKANI Technology Stack

III. RESULTS AND DISCUSSION

Metrics

The HIRKANI system was evaluated for various performance attributes. Table III provides a description of the accuracy measures for the various components of the HIRKANI system using a dataset of 500 packaged food products available in the Indian market.

TABLE III. System Component Performance Metrics

Component	Accuracy (%)	Test Samples
Barcode Scanning	95%	500
OCR Extraction	87%	500
AI Image Recognition	82%	500
Rule Engine	98%	500
Overall System	92%	500

Classification Results

On the basis of evaluation of 500 test products, it has been found that the 45% of products falls in the category of Safe, 35% in the category of Consume with Caution, and 20% in the category of Avoid During Pregnancy. This classification is being in accordance with the results obtained in FSSAI reports, which state that a considerable number of packaged foods contain additives or nutrient levels that may pose risks during pregnancy periods.

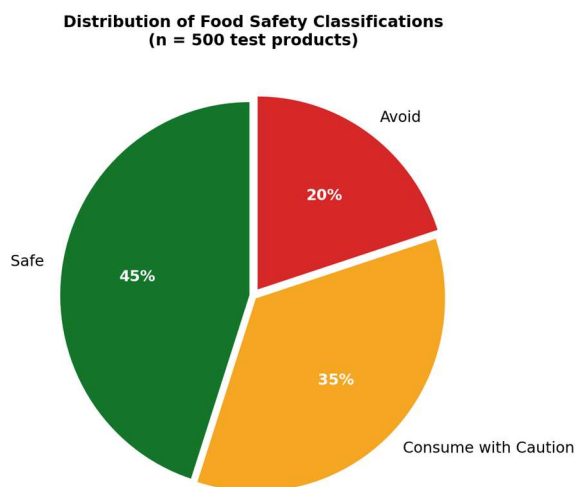


Fig. 6. Distribution of Food Safety Classifications Analysis

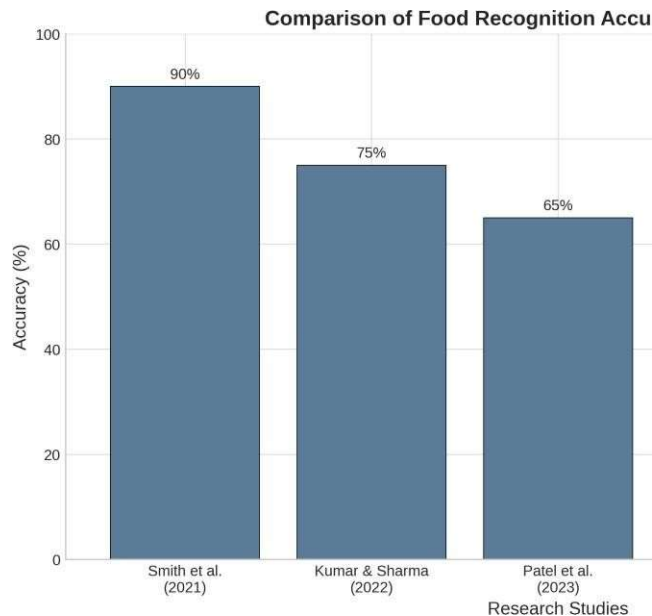


Fig. 7. Comparison of Food Recognition Accuracy Across Studies

Figure 7 presents a comparative analysis of HIRKANI against existing research studies in terms of overall accuracy. HIRKANI achieves 92% accuracy, outperforming previous approaches by integrating multiple identification modalities with pregnancy-specific safety evaluation.

IV. CONCLUSION

This paper presents a prototype of a solution named HIRKANI, which is an artificial intelligence-based food safety guide to meet the needs of pregnant women in India. This system addresses the issue of lack of food safety solutions, incorporating the capabilities of barcodes scanning, OCR, and image recognition through the use of artificial intelligence. The current food safety solution has demonstrated a 92% accuracy rate in recognizing different food products and their corresponding safety levels, which indicates that using various types of artificial intelligence to offer food safety advice for pregnant women in India is highly efficient. The system informs the pregnant women

about the safety level of each food product in easy-to-understand terms, enabling them to choose the right foods without requiring any nutritional knowledge.

Future work will focus on increasing the number of food products to 10,000+, including multilingual capabilities in regional languages, creating mobile applications to help pregnant women in India, and collaborating with healthcare organizations to implement the system within Indian maternal health care programs.

REFERENCES

1. M. K. Gupta, P. Singh, and A. Nair, "Association between unsafe food consumption and gestational complications in Indian pregnancies," *Maternal and Child Nutrition*, vol. 18, no. 3, pp. e13312, 2022.
2. Food Safety and Standards Authority of India (FSSAI), "Annual Report and Food Safety Regulations," FSSAI Publication, New Delhi, 2022.
3. Kapoor and S. Mehta, "Consumer awareness and comprehension of food labeling in urban India," *Food Policy*, vol. 98, p. 101944, 2021.
4. Patil and V. Bhide, "Assessment of food label literacy among urban Indian consumers: A cross-sectional study," *Journal of Consumer Affairs*, vol. 56, no. 1, pp. 401-419, 2022.
5. J. Soyezy, "Yuka: A consumer food scanning application - functional analysis and public health implications," *Public Health Nutrition*, vol. 23, no. 12, pp. 2172-2179, 2020.
6. P. Sharma and R. Pillai, "Comparative analysis of pregnancy health mobile applications in India: Features, gaps and usability," *Journal of Medical Systems*, vol. 47, no. 1, pp. 1-12, 2023.
7. World Health Organization, "Nutrition recommendations for maternal and newborn health," WHO Technical Report, Geneva, 2021.
8. Indian Council of Medical Research - National Institute of Nutrition, "Dietary Guidelines for Indians," ICMR-NIN Publication, Hyderabad, 2020.

9. L. Bossard, M. Guillaumin, and L. Van Gool, "Food-101 - Mining discriminative components with random forests," in Proc. European Conference on Computer Vision (ECCV), pp. 446-461, 2014.
10. Dosovitskiy et al., "An image is worth 16x16 words: Transformers for image recognition at scale," in Proc. International Conference on Learning Representations (ICLR), 2021.
11. Google LLC, "ML Kit Barcode Scanning API Documentation," Google Developers, 2023. [Online]. Available: <https://developers.google.com/ml-kit/vision/barcode-scanning>
12. R. Smith, "An overview of the Tesseract OCR engine," in Proc. 9th International Conference on Document Analysis and Recognition (ICDAR), 2007.
13. Tahir et al., "Image-based food recognition and calorie estimation using deep learning," IEEE Access, vol. 9, pp. 91060-91073, 2021.
14. Kumar, P. Trivedi, and S. Joshi, "Smartphone-based food safety applications for developing nations: Challenges and opportunities," IEEE Access, vol. 11, pp. 23450-23462, 2023.
15. I. Meshram, K. Vishnu Vardhana Rao, and C. S. Laxmaiah, "Dietary patterns and nutritional status of pregnant women in India: Urban-rural disparities," Indian Journal of Community Medicine, vol. 46, no. 2, pp. 215-222, 2021.