NutriPurna – The Recipe Generator

[1]Shravani Halaye, [2]Gauri Rane, [3]Anjali Gupta, [4]Dr. Divya Tamma

[1]UG Scholar, [2]UG Scholar,, [3]UG Scholar, [4]Assistant Professor
[1]Artificial Intelligence and Data Science,
[1]Rajiv Gandhi Institute of Technology, Mumbai, India
[1]shravani.halaye@gmail.com, [2]gaurirane2211@gmail.com, [3]msanjaligupta14@gmail.com , [4]divya.tamma@mctrgit.ac.in

Abstract— With health and wellness becoming a priority in modern life, personalized nutrition is essential for maintaining a balanced diet. However, meal planning, ingredient selection, and adherence to dietary restrictions pose significant challenges. This research introduces NutriPurna, a comprehensive platform that integrates personalized nutrition with advanced technology. The platform provides customized meal plans, nutrient tracking, ingredient substitutions, and disease-specific dietary recommendations to simplify healthy eating. By leveraging AI-driven insights, NutriPurna empowers users to make informed dietary choices, promoting healthier lifestyles. This paper explores the challenges in personalized nutrition, details NutriPurna's core features, and analyzes its potential impact on improving dietary habits and overall well-being.

Index Terms—Recipe generation, nutrition, meal planning, dietary restrictions, cuisines.

I. Introduction

As health and wellness become priorities in modern life, personalized nutrition is more important than ever. However, managing nutrition, dietary preferences, and meal planning can be challenging due to time constraints, ingredient choices, and dietary restrictions. Many individuals struggle to maintain a balanced diet that aligns with their specific health goals and lifestyle due to difficulties in meal planning, selecting the right ingredients, and adhering to dietary restrictions. There is a need for a solution that simplifies personalized nutrition and meal preparation.

This research aims to develop NutriPurna, a comprehensive platform that integrates personalized nutrition with advanced technology. The primary objectives include providing customized meal plans, enabling nutrient tracking, suggesting ingredient substitutions, and offering disease-specific dietary recommendations. NutriPurna has the potential to transform the way individuals approach nutrition by making healthy eating more accessible and personalized. It empowers users to make informed dietary choices, promotes healthier lifestyles, and addresses specific nutritional concerns efficiently. This paper begins with an introduction to the importance of personalized nutrition, followed by an exploration of the challenges individuals face. It then details NutriPurna's core features, including the Recipe Generator, Nutrient Tracking, Meal Planning, and Disease-Based Diet Information, concluding with an analysis of its potential impact on user's health and wellness.

II. Related Work

1. Application of AI in the Culinary Domain

In recent years, AI-enabled technologies have significantly impacted the culinary industry, particularly in recipe generation, ingredient classification, meal planning, and nutritional tracking. This project aims to integrate AI into the Indian cuisine ecosystem by leveraging machine learning and natural language processing techniques. The authors reviewed 80 research papers on AI applications in the culinary domain, shortlisting 50 papers specifically on AI-enabled recipe generation. Out of these, 20 papers focused on AI-driven Indian recipe generation, and 18 existing applications in the same domain were analyzed.

Indian cuisine is diverse, with recipes varying in taste and composition across different regions. Traditionally, home-cooked meals are preferred, making AI-driven recipe generation a promising yet underexplored area. Through extensive literature review and market analysis, it was observed that while recipe recommendation systems are common in AI-based culinary applications, no existing models focus on Indian Recipe Generators. This gap highlights the novelty of the proposed system, which aims to automate Indian recipe generation while considering the complex combinations of spices, flavors, and cooking techniques unique to Indian cuisine.

2. Existing Research on AI-Based Recipe Generation

Several studies have explored AI-driven recipe generation across different cuisines. The "ChefAI.IN: Generating Indian Recipes with AI Algorithm" study trained an AI model using 6,000 traditional Indian recipes, demonstrating AI's potential in understanding ingredient relationships and automating recipe creation. The system achieved an 86% acceptance rate among users, though improvements in instruction clarity were recommended [1]. Similarly, "AutoChef: Automated Generation of Cooking Recipes" introduced an open-source recipe generator using natural language processing and genetic algorithms to evolve new recipes, which were then validated by human experts [2].

The "Classification of Cuisines from Sequentially Structured Recipes" study incorporated both ingredients and cooking techniques into cuisine classification, achieving 73.30% accuracy with the RoBERTa model. This research emphasizes the importance of structured recipe data in improving classification methods [3]. Another work, "An AI-Based Approach for Personalized Nutrition and Food Menu Planning," leveraged image recognition and machine learning to analyze nutritional intake, streamlining dietary tracking and meal personalization [4].

Further, studies such as "Machine Learning and Image Processing for Recipe Selection" explored ingredient-based recipe generation through real-time image recognition, identifying YOLOv5 as the most efficient model for ingredient detection [5]. The

"Food Nutritional Detection, Visualization, and Recommendation for Health Monitoring" study proposed a system that identifies food items from images and provides real-time calorie tracking via Android devices [6].

3. Advanced AI Techniques in Recipe Generation

Research into neural network-based recipe generation, n models has evolved to include multiple AI techniques:

- Text-based AI models: Studies used NLP-based recommendation systems, such as word embeddings and fuzzy logic, to substitute ingredients while maintaining recipe quality [7].
- AI-enhanced cuisine classification: Various classifiers, including Naïve Bayes, Logistic Regression, and Random Forest, were tested, with Linear SVC achieving the highest accuracy (79%) [8].
- Reinforcement Learning-based recipe generation: Systems like Pic Breeder-style AI models allowed users to iteratively refine recipes using feedback mechanisms [9].
- Neural Network Language Models: Encoder-decoder architectures and N-gram models were used to generate recipes, with a skip-gram model helping identify substitute ingredients [10].
- Image-to-recipe models: AI systems like ResNet-50 encoders and transformer-based decoders extracted ingredients and cooking steps from images, enabling automatic recipe text generation [11].
- GAN-based cooking models: Researchers developed step-by-step Generative Adversarial Networks (GANs) that simulated ingredient addition/removal for image-based cooking process generation [12].
- Hierarchical Recipe Generators: LSTM-based Hierarchical Neural Networks were employed to structure ingredient lists, cooking steps, and instructions in an organized manner [13].

4. Comparative Analysis and Research Gaps

While previous studies have explored AI-driven recipe generation, ingredient classification, and nutritional tracking, most focus on isolated aspects of nutrition management. NutriPurna differentiates itself by integrating recipe generation, ingredient substitution, nutrient tracking, meal planning, and disease-based diet recommendations into a single, comprehensive platform. Unlike studies that rely solely on image recognition or predefined datasets, NutriPurna combines user preferences, dietary restrictions, and health goals to deliver highly personalized meal recommendations. This holistic approach bridges the gap between existing research and real-world applications, making NutriPurna a more dynamic and adaptive solution for modern nutrition management.

III. Findings And Discussion

1. Analysis:

The findings indicate that the integration of AI into Indian recipe generation is a viable solution to bridge the gap in the culinary domain. The system demonstrated a strong ability to adapt to regional cuisines, creating recipes that were authentic, nutritionally balanced, and user-centric. Several key points emerge from the analysis of the findings:

1. Cultural Relevance: The AI model's ability to generate region-specific recipes is a major strength, as it acknowledges the diverse flavors, cooking techniques, and dietary preferences that exist across India. By focusing on ingredient combinations and traditional cooking methods, NutriPurna respected the authenticity of Indian cuisine while also introducing flexibility in terms of health-conscious options.
2. Personalization: The personalization aspect of the model, including ingredient substitution and nutritional tracking, is a key advantage. Unlike generic systems that offer static recipes, NutriPurna adapts based on real-time user feedback, making it a valuable tool for individuals with specific dietary goals or restrictions. This level of personalization could drive wider adoption in the health and wellness space.
3. Scalability and Future Applications: The AI model’s adaptability to various dietary needs and regional cuisines presents significant opportunities for scaling the system to other ethnic or regional cuisines worldwide. The core approach could be expanded to other food cultures by tailoring the AI model to understand local ingredient relationships, cooking styles, and nutritional preferences.

2. Research Gaps

While the findings provide valuable insights into the application of AI in the culinary domain, several gaps and questions emerged during the study:

1. Complexity of Indian Cuisine: Despite the model's success in generating recipes and suggesting substitutions, some challenges arose when dealing with complex recipes that require multi-step cooking processes and interactions between ingredients. More advanced AI techniques may be necessary to improve the system’s ability to handle intricate recipes, where ingredient changes could alter the entire cooking process.
2. Data Availability: One of the limitations was the limited availability of comprehensive datasets specific to Indian cuisine. While a sizable dataset was collected for this study, the richness and diversity of Indian food culture necessitate more extensive data to improve model accuracy and handle uncommon regional dishes.
3. User Feedback Integration: Although the system generated user-specific recipes, further integration of user feedback (e.g., taste preferences, satisfaction with substitutions) is needed to make the model more adaptive and dynamic. This would allow the system to continuously improve its recipe suggestions and ensure higher user satisfaction.
4. Accuracy of Nutritional Analysis: While the nutritional analysis of the generated recipes was reasonably accurate, there were instances where certain regional ingredients posed challenges for the nutritional database, especially those with

limited scientific data on their nutritional values. Future studies should aim to build a more comprehensive nutritional database specific to Indian foods.

5. Real-Time Image Recognition: The ingredient recognition model based on YOLOv5 was effective in most cases, but it struggled with image quality or unusual ingredient shapes. Continued improvements in real-time image processing and deep learning models for better ingredient recognition would help address these issues.

This study highlights the significant potential of AI in transforming the culinary landscape, specifically within the context of Indian cuisine. However, further exploration and development are required to address the challenges and gaps identified in the findings, ultimately leading to a more robust and adaptable recipe generation system.

IV. PROPOSED SYSTEM

1. System Architecture

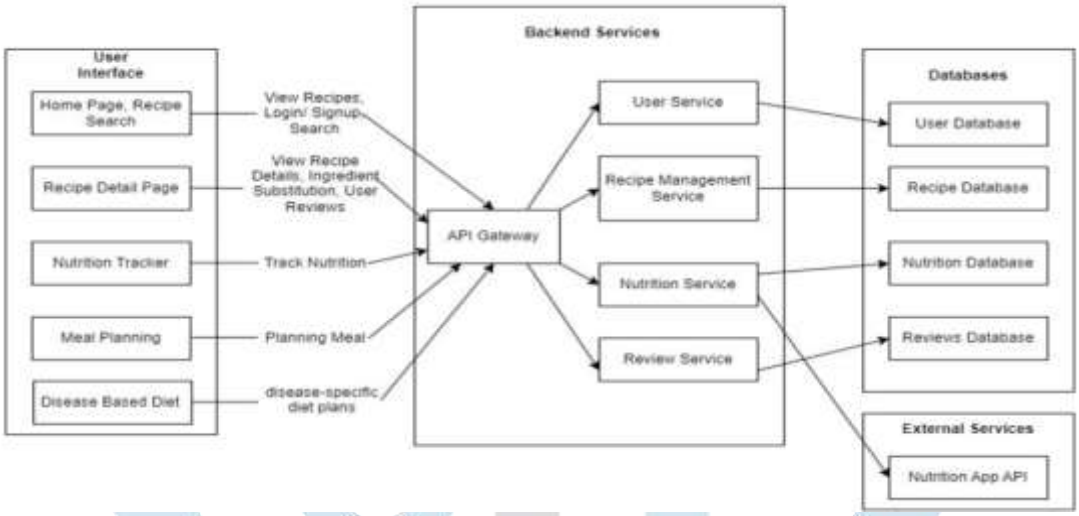

Fig. 1: System Architecture

Figure 1 shows the system architecture of NutriPurna which follows a modular and service-oriented approach, integrating user interaction, backend processing, and data management. The architecture is divided into three main components:

1. User Interface (Frontend)

The user interface provides an interactive platform for users to access NutriPurna's features. It includes:

- Home Page & Recipe Search: Users can search for recipes based on ingredients, cuisine, and dietary preferences.
- Recipe Detail Page: Displays recipe details, ingredient substitutions, and user reviews.
- Nutrition Tracker: Allows users to track their daily nutrient intake.
- Meal Planning: Assists in planning meals according to personal preferences and nutritional needs.
- Disease-Based Diet: Suggests diet plans based on specific diseases or symptoms.

2. Backend Services

The backend handles business logic, data processing, and integration. It consists of multiple microservices connected through an API Gateway, ensuring seamless communication. The key services include:

- User Service: Manages user authentication, profiles, and preferences.
- Recipe Management Service: Handles recipe retrieval, modifications, and ingredient substitutions.
- Nutrition Service: Computes nutritional values for recipes and tracks user diet plans.
- Review Service: Manages user-generated reviews for recipes.

3. Databases

NutriPurna relies on multiple databases to store structured information:

- User Database: Stores user profiles, preferences, and authentication details.
- Recipe Database: Maintains structured data on various recipes.
- Nutrition Database: Contains nutritional information for ingredients and meals.
- Reviews Database: Stores user feedback and ratings for different recipes.

V. EXPERIMENTAL SETUP

1. Algorithm

A. Nutrient Calculation Algorithm

The nutrient calculation algorithm determines the nutritional content of a recipe by analyzing its ingredients. It retrieves nutrient data from a database (e.g., USDA FoodData Central), normalizes ingredient quantities, sums nutrient contributions, and adjusts values based on portion sizes. The algorithm also calculates macronutrient percentages and compares nutrients

against recommended daily values (RDVs). It is integral to NutriPurna's nutrient tracking, meal planning, and personalized recipe generation.

B. Large Language Model (LLM)

NutriPurna utilizes an LLM, powered by the Google API, to generate personalized recipes based on user input. The system processes inputs such as cuisine type, meal type, available ingredients, and dietary preferences to form structured queries. The LLM extracts relevant features, ranks recipes based on semantic relevance and constraints, and generates structured outputs, including ingredient lists, cooking instructions, and nutritional information. This approach enhances user experience by providing tailored recipe suggestions.

- Data Collection & Preprocessing – Gather and clean recipe data, tokenize text.
- Model Training – Fine-tune a pre-trained LLM on recipe datasets.
- Ingredient Understanding – Use NER and embeddings to extract and relate ingredients.
- Recipe Generation – Generate step-by-step recipes using NLP techniques.
- Dietary Constraints – Filter based on nutrition, allergens, and preferences.
- Verification & Refinement – Validate ingredient compatibility and refine via feedback.
- User Feedback Loop – Improve recipes using user interactions and ratings

C. Rule-Based Algorithm

A rule-based algorithm is used for disease-based meal planning, symptom-based search, and personalized 7-day meal plans. Users can either select a disease from a predefined list or input symptoms to identify relevant conditions using IF-THEN rules. The system retrieves disease-specific information, including causes, symptoms, recommended foods, and dietary precautions. For personalized meal planning, the algorithm considers user profiles, dietary preferences, and health conditions to generate balanced meal plans. This deterministic approach ensures accurate, customized dietary recommendations.

These algorithms collectively enhance NutriPurna's ability to provide precise nutritional analysis, AI-driven recipe generation, and medically relevant meal planning.

2. Methodology

- Requirement Analysis: Understand the user requirements, including dietary preferences, restrictions, and desired features (e.g., recipe generation, nutrition tracking), ensuring comprehensive coverage of user needs.
- System Design: Design the overall architecture, database structure, and user interface, focusing on scalability, efficiency, and ease of use.
- Algorithm Development: Develop algorithms for recipe generation, nutrient tracking, and meal planning, optimizing for accuracy, personalization, and diversity.
- Implementation: Build the system using the defined technologies, including database setup, API integration, and UI development, ensuring seamless interaction between components.
- Testing and Validation: Test the system for accuracy, user experience, and performance, conducting iterative refinements based on feedback.
- Deployment: Deploy the system on a cloud server for scalability and accessibility, ensuring reliability and security.
- Maintenance and Updates: Regularly update the system with new recipes, nutritional data, and features, incorporating user feedback and technological advancements.

This approach ensures the development of a smart and user-friendly recipe system that effectively meets dietary and nutritional needs. It begins with understanding user requirements, including meal planning and nutrition tracking. A well-structured design ensures smooth functionality and scalability. Algorithms drive personalized recipe generation, optimizing for accuracy and variety.

3. Implementation

The attribute information for the dataset is structured as follows:

- Recipe Name: Name of the recipe (string type).
- Total Time (in minutes): The total time required to prepare the dish (integer type).
- Serving Count: Number of servings the recipe yields (integer type).
- Ingredients: List of ingredients used in the recipe, including quantity (string type).
- Instructions: Step-by-step procedure to prepare the dish (string type).
- Nutrition Info (Per Recipe): Nutritional information per serving, including calories, protein, fats, carbohydrates, etc. (string type).
- Tips: Additional cooking tips, variations, and chef recommendations for better preparation (string type).
- Image URL: Link to an image of the recipe (URL type).

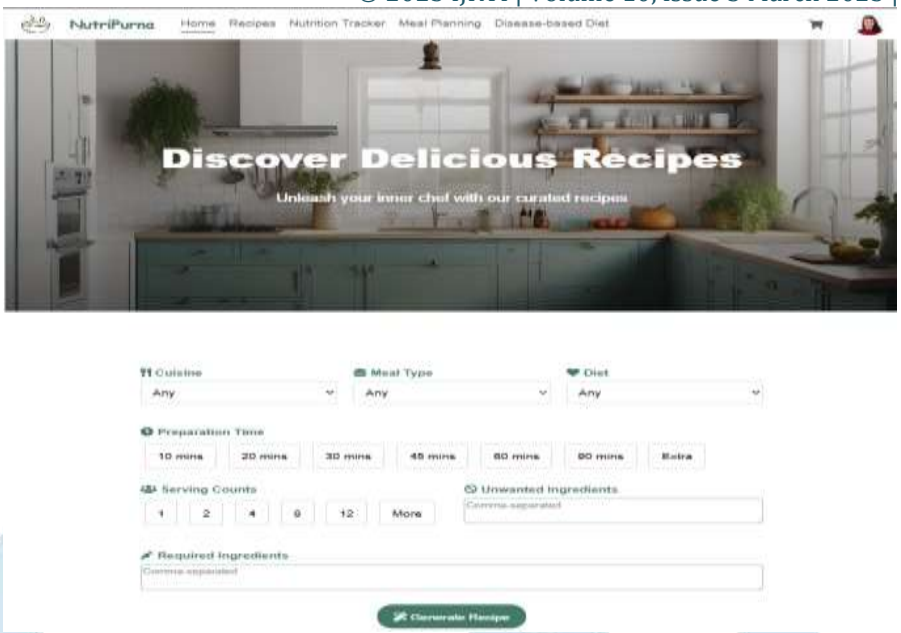

Fig. 2: Home Page

Figure 2 illustrates the home page of the system, which serves as the primary interface for user interaction. This page allows users to input their preferences, dietary restrictions, or specific ingredients they wish to include or exclude. The input mechanism ensures personalized recipe recommendations based on user-defined criteria, enhancing the overall experience and usability of the system.

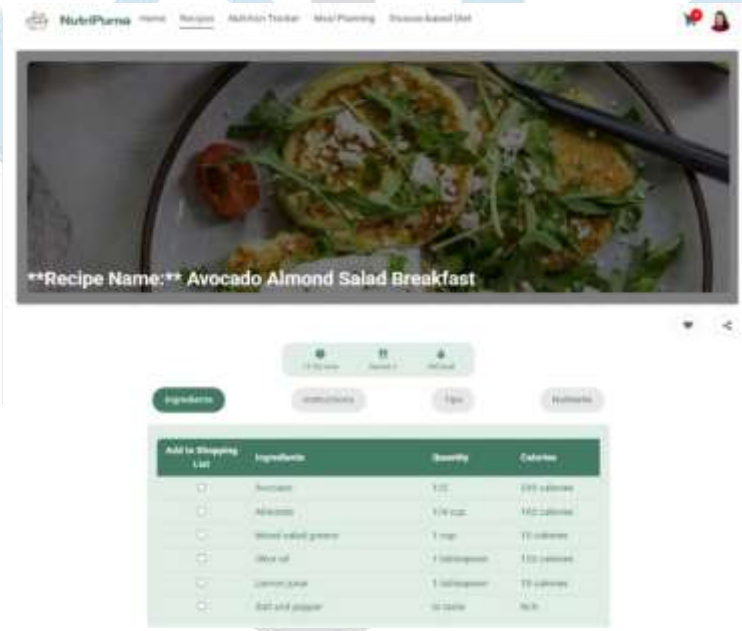

Fig. 3: Recipe Page

Figure 3 presents the recipe page, which provides a detailed breakdown of the generated recipe. This includes a comprehensive list of ingredients, step-by-step cooking instructions, useful tips for preparation or substitutions, and a calculated nutritional profile. The nutritional values, including calorie count, macronutrient distribution, and other relevant dietary information, enable users to make informed decisions about their meals. This structured approach ensures clarity, accessibility, and user engagement.

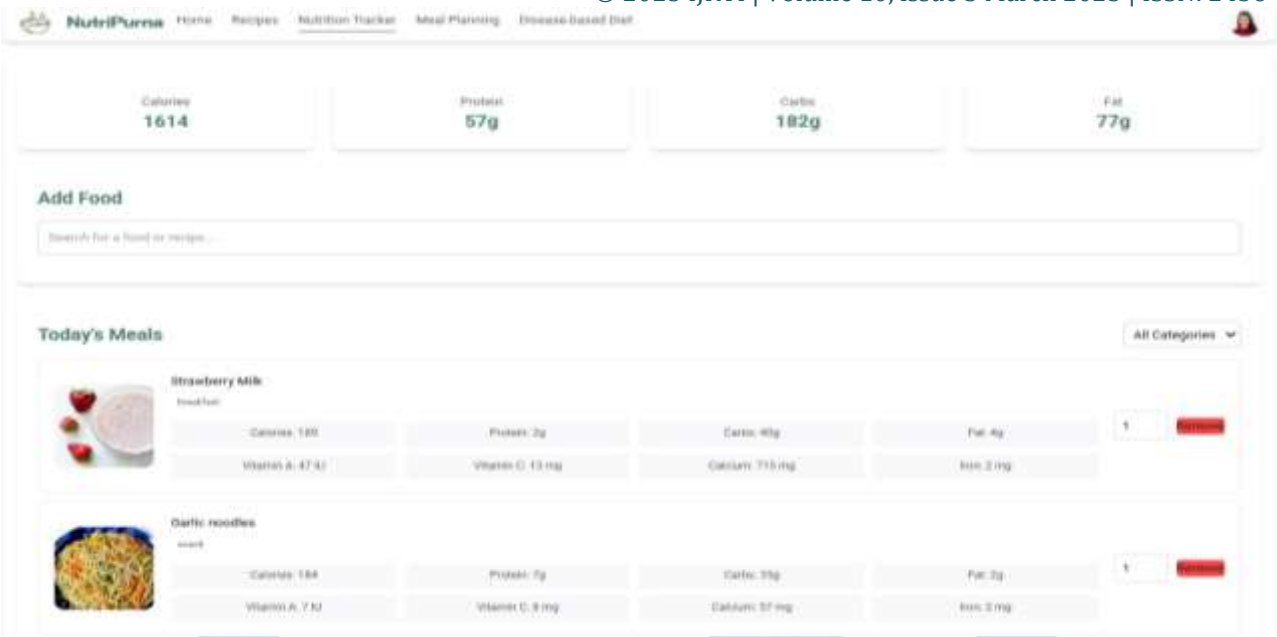

Fig. 4: Nutrition Tracker

Figure 4 illustrates the nutrient tracking system, which enables users to monitor their daily nutritional intake. This system provides a detailed breakdown of essential nutrients, including macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals). By analyzing food consumption patterns, it helps users maintain a balanced diet, track deficiencies or excesses, and align their eating habits with personal health goals.

Fig. 5: Disease based diet

Figure 5 presents the disease-based diet module, which offers a comprehensive reference for various diseases, categorized alphabetically from A to Z. For each disease, the system provides key details, including symptoms, necessary precautions, foods to avoid, and a sample meal plan tailored to dietary requirements. This feature is designed to support users in making informed dietary choices to manage or prevent health conditions effectively.

Other than this, the system also features an AI-powered chatbot designed to assist users with their dietary and nutritional queries. The chatbot provides instant responses to questions related to ingredient substitutions, meal planning, nutritional values, and disease-specific dietary recommendations. It enhances user engagement by offering personalized guidance, making the system more interactive and user-friendly.

VI. RESULTS

To evaluate the performance of NutriPurna, a survey was conducted to assess the authenticity, ingredient accuracy, ease of understanding, appropriateness of the cooking method, and overall usability of the generated recipes. The questions were:

- How authentic does this recipe feel to you? (Based on cultural relevance, traditional methods, and ingredient choices)
- Do you think this recipe matches its intended cuisine?
- Are the ingredient choices accurate for this dish?
- How easy is it to understand and follow this recipe?
- Do you think the cooking method is appropriate for these ingredients?
- Do you think a beginner can successfully make this dish?

- What is your overall rating of this recipe?

The results were as follows:

1. How authentic does this recipe feel to you? (Based on cultural relevance, traditional methods, and ingredient choices)

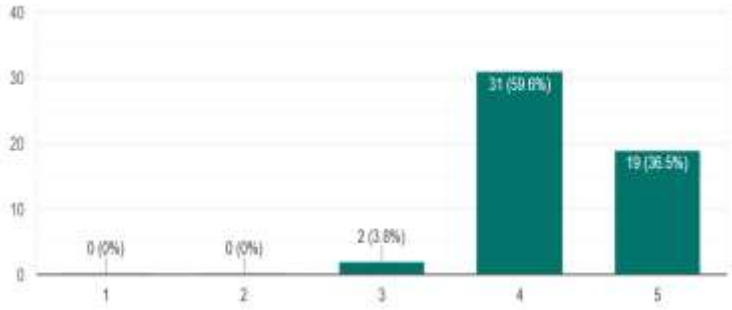

Fig. 6

The recipe is widely regarded as authentic, with 96.1% of respondents giving it a 4 or 5-star rating. There is little to no perception of inauthenticity. The feedback suggests a well-received recipe that aligns with cultural expectations, with only minor areas for possible enhancement.

2. Do you think this recipe matches its intended cuisine?

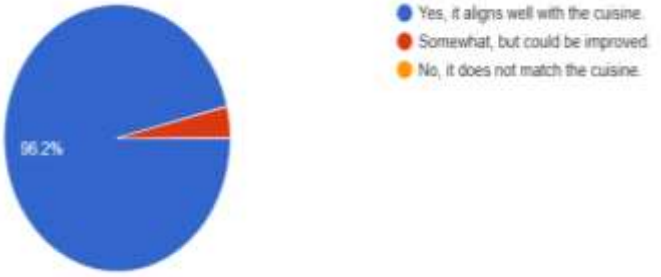

Fig. 7

The high average rating (4.33) and the dominance of 4 and 5-star ratings (96.1%) demonstrate a strong validation of the recipe's authenticity. Users generally found the recipe to be culturally relevant, accurate in ingredient selection, and aligned with traditional cooking methods. While there is minor room for improvement, there is no indication of significant inauthenticity, reinforcing the credibility and effectiveness of the recipe-generation process.

3. Are the ingredient choices accurate for this dish?

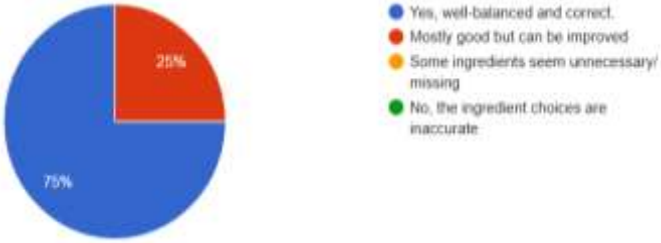

Fig. 8

The majority of users (75%) found the ingredient choices accurate and well-balanced, while 25% saw potential for minor improvements. The absence of negative ratings indicates that the recipe's ingredient selection is fundamentally sound and aligns with traditional expectations. While there is some opportunity for refinement, the results suggest that the NutriPurna Recipe Generator is largely successful in creating culturally appropriate and balanced recipes.

4. How easy is it to understand and follow this recipe?

The average rating of 4.23 and the overwhelming majority of positive responses (92.3% rating it 4 or 5) confirm that the recipe instructions are clear and easy to follow for most users. While a small percentage (7.7%) found some areas challenging, there were no reports of major difficulties. These findings suggest that the NutriPurna Recipe Generator provides well-structured and user-friendly recipes, with slight room for refinement in clarity and instructional detail

5. Do you think the cooking method is appropriate for these ingredients?

The results indicate that 88.5% of respondents found the cooking method well-suited to the ingredients, confirming that the techniques used align well with the dish. However, 11.5% felt some improvements could be made, suggesting that minor adjustments to the cooking process could enhance the overall execution. While the method is generally effective, slight refinements could help optimize the dish's texture, flavor, or efficiency.

6. Do you think a beginner can successfully make this dish?

With 80.8% of respondents stating that the recipe is easy to follow, it is clear that most users found it accessible. However, 19.2% believed that some steps require prior cooking skills, indicating that certain techniques might be challenging for complete beginners. To improve accessibility, simplifying instructions further, offering additional guidance, or providing visual aids could help make the recipe more beginner-friendly.

The results indicate that the recipe generation system performs well in terms of authenticity, ingredient accuracy, and ease of execution. User evaluations suggest that the generated recipes align with their intended cuisines and follow appropriate cooking methods. The clarity of instructions and suitability for beginners further enhance the usability of the system. Overall, the feedback highlights the system's effectiveness in creating culturally relevant, accessible, and well-structured recipes, with room for further refinements based on user preferences and additional testing.

VII. Conclusion

The NutriPurna project successfully demonstrates the potential of AI-driven recipe generation in creating culturally relevant, nutritionally balanced, and easy-to-follow recipes. The survey results indicate that users generally found the recipes authentic, with well-matched ingredients and appropriate cooking methods. Additionally, the majority of respondents felt that the recipes were accessible, even for beginners, though some suggested minor improvements to enhance clarity and execution. The overwhelmingly positive feedback highlights NutriPurna's effectiveness in blending traditional culinary practices with modern technology, making it a valuable tool for home cooks of all skill levels. While there is room for refinement, particularly in simplifying complex steps for beginners and fine-tuning ingredient selections, the project proves that AI can play a significant role in enhancing home cooking experiences. Moving forward, further improvements based on user feedback can help make NutriPurna even more inclusive, adaptable, and precise in recipe generation

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