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AI Based Personalized Health Aware Diet Recommendation System

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Abstract: *Nowadays, as people get more aware of their health since more illnesses are tied to how we live, the importance of eating a balanced diet has become much clearer and also we get know how useful a diet can be for you. Eating healthy food is absolutely necessary in order to manage your weight, stopping long-term illnesses, and improving how you feel overall. But the normal ways of planning what to eat are too general and usually don't consider what specific nutrients you need, what foods you can't or don't eat, and your personal health. This research proposes an AI Based Health Aware personalized Diet Recommendation System to solve these problems - it creates eating plans designed for you based on your health Parameters. To interpret each person's health, the system takes things like age, height, weight, Body Mass Index (BMI), how much they exercise and what nutritional needs they have as input. Then, it uses artificial intelligence and a content-based recommendation method to know how nutritious foods are and what's in them, and recommend suitable meals and plans. By looking at a huge amount of food information including recipes and nutritional details system looks for foods that match the person's health and diet goals. The system's backend is built with FastAPI to quickly process information and link to an API, and Streamlit is used for the front end (what you see and use) so it's easy and usable. The system aims to give you a diet that is suitable to you, and available easily everywhere, to help you eat healthy food and*
make good choices about nutrition.

Keywords: AI, Diet Recommendation System, Health Mon-itoring, Machine Learning, Nutrition

I. INTRODUCTION

To make intelligent health systems which gives personalised health care advice, such as dietary suggestions new technolo-gies like artificial intelligence (AI) and data analytics is used (Shelke et al., 2023). The proposed AI-Based personalized Health Aware Diet Recommendation System aims to give per-sonalised diet suggestions suitable to each individual's distinct health profile (Ge et al., 2015). In order to suggest the best foods and meal combinations the system uses AI algorithms and a content-based recommendation strategy to look at user inputs and figure out how to manage nutrition (Freyne and Berkovsky, 2013). This system includes structured food dataset that has recipe details and complete nutritional values (Ge et al., 2015).It works on the data and suggest health-focused diet in real time using an interactive user interface .Many latest technologies are used which works in this system to recommend best diet (Khaire et al., 2020). The systems ease of use, speed, and ability to grow can help dietitians, fitness instructors, and healthcare platforms and many other people (Singh et al., 2020). The subsequent sections of this work delineate the literature review, system design, methodology, implementation specifics, and performance evaluation of the proposed AI-Based Health Aware Diet Recommendation Sys-tem (Phanich et al., 2010).

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In this paper, we propose an AI-based personalized health aware diet recommendation system that uses machine learning techniques to interpret user health parameters and preferences (Kardam et al., 2021). The aim of the system is to generate optimized meal plans that meet nutritional requirements and also align with individual health goals (Ge et al., 2015). The proposed system improve overall health outcomes and suggest sustainable dietary habits by incorporating intelligent algorithms and user-centric design (Toledo et al., 2019)

II. LITERATURE REVIEW

Iwendi et al. [1] suggested an IoMT-assisted patient diet recommender that preprocesses clinical features and compares ML/deep models (MLP, RNN, LSTM, GRU). They say that the LSTM/GRU model works best for predicting diet classes and making meal plans.Toledo et al. [2] created a food-recommender that combines nutritional restrictions with user preferences. It then optimises daily meal plans to meet nutrient needs while also taking preferences into account. [3]presented a DASH-diet recommendation system for hypertensive patients using feature engineering and ML classifiers to map patient profiles to DASH-compliant 5 meals. Results demonstrated improved hypertension-aware recommendations versus na¨ıve baselines.

Wickramasinghe et al. [4] (LSC/IEEE) proposed dietary prediction for Chronic Kidney Disease (CKD) patients by incorporating blood potassium levels and using ML models to suggest safe food items; experimental results showed clinically useful prediction accuracy for dietary adjustments. Phanich et al. [5] (IEEE conference) used clustering for a diabetic-patient food recommender — clustering food items and patient profiles then matching clusters to recommend safer choices for glycaemic control; evaluation on clinical/recipe data reported better suitability for diabetic users. Iwendi et al. [6] (addi-tional analysis) implemented deep learning (LSTM/GRU) on patient feature sets and reported that sequence/deep models outperformed classic ML for nutrient/meal predictions in het-erogeneous medical datasets.

Min et al. [7] (IEEE Transactions on Multimedia) surveyed food-recommendation frameworks and demonstrated that hy-brid approaches (knowledge + content + collaborative) better manage nutritional constraints; they highlighted evaluation and health-safety challenges for real deployments. Rahma et al. [8] (ICORIS / IEEE) proposed nutrition lifestyle recommenda-tions for patients recovering from COVID-19, combining pa-tient data and rule/ML inference to tailor nutrient suggestions; they reported usable guidance for regional patient cohorts. Banerjee Nigar [9] (ICCCI / IEEE) designed a nourishment recommender for children using matching algorithms and ML to map nutrient requirements to available foods; experiments showed improved coverage of micronutrient needs for target age groups.

Wickramasinghe et al. [10] (another IEEE forum) used supervised ML to predict patient dietary classes (gain/lose/maintain) based on clinical and lifestyle features. They found that automated diet categorisation was very ac-curate in small datasets. Phanich, Pholkul Phimoltares [11] (IEEE proceedings) developed a food recommender using clustering tailored for diabetic patients, showing that cluster-based substitution suggestions helped meet diabetic dietary rules in test runs. Iwendi et al [12] related IEEE works collectively show that combining IoMT, feature normalization, and deep sequence models yields diet plans with strong energy/macronutrient matching.

Zhang et al. [13] proposed a personalized diet recom-mendation system using reinforcement learning, where user feedback is continuously used to improve meal suggestions. Their approach adapts dynamically to user preferences and health goals, showing improved recommendation accuracy over traditional static models. Chen et al. [14] developed a deep learning-based food recommendation system that inte-grates user dietary history and nutritional requirements using a neural network model. Experimental results demonstrated better prediction of user-preferred meals while maintaining nutritional balance.

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III. PROPOSED METHODOLOGY

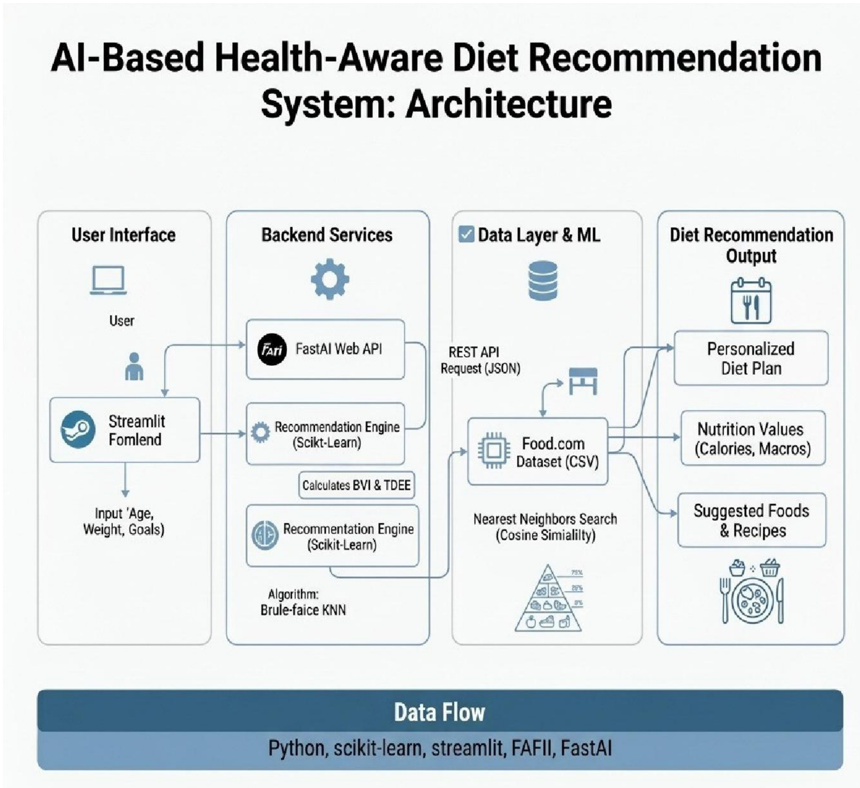

Fig. 1. AI Based Personalized Health Aware Diet Recommendation System

The fig.1 shows entire workflow of the AI-Based personal-ized Health Aware Diet Recommendation System . The first step of the workflow of the system start from the frontend where user gives input, where the user enters the required information, such as height, weight, age, and nutritional needs (Khaire et al., 2020). A user profile, considering the unique health problems of every individual, is created (Phanich et al., 2010) .To maintain consistency and proper execution of the workflow, the system preprocesses the nutritional in-formation of the food items after collecting the required information. This involves data cleaning, normalization, and structuring(Rostami et al., 2024).

After the preprocessing of the food items profile matching of the user requirements and available food items is done (Bhagat and Tuteja, 2023).This step of the workflow ensures that only relevant food choices are considered. The system then calculates the similarity scores of the food items and the user requirements, considering how well the food items meet the nutritional requirements of the user (Papastratis et al., 2024). The ranking of the food items is done by using machine learning algorithms, such as K-Nearest Neighbors (KNN), along with cosine similarity.

A structured diet plan along with nutritional information, including calories and macronutrients, is included in the personalized diet recommendations that are generated by the system based on the results of the machine learning algorithm (Oskouei and Hashemzadeh, 2024). The final result of the workflow of the system, i.e., the diet recommendations, is then shown to the user in a format that is easily understandable, so that a healthy lifestyle can be maintained.

The four main modules of the system architecture Diet Recommendation Output, Backend Services, Data Layer and Machine Learning, and User Interface are shown in above figure (Ge et al., 2015).The frontend user interface module, is implemented by Streamlit, which allows the user to easily give the required inputs to the system . To perform basic calculations, including BMI and TDEE the backend Services module uses machine learning libraries, such as Scikit-learn (Toledo et al., 2019).The Data Layer module handles the food items and uses algorithms based on similarities for generating recommendations. The Output module shows a scalable and efficient AI-based recommendation system (Kardam et al., 2021).

A. Dataset

For this purpose, from Food.com Recipe and Review Dataset was used. The dataset was obtained from the Kaggle platform. The dataset comprises over 1.4 million user ratings and over 500,000 recipes. Each recipe in the dataset has comprehensive nutritional information such as the number of calories, fat content, protein content, carbohydrates, and sugar (Ge et al., 2015). In addition, the dataset provides details such as ingredients and cooking instructions. For better comprehension of user behavior and the popularity of dishes, the dataset provides user interactions such as ratings and reviews.

Pre-processing techniques such as cleaning, normalization, and feature extraction are implemented in the dataset for handling missing values and improving data quality. Following this process, the dataset is utilized to analyze nutritional data and implement the content-based filtering approach. In recommended diet. FastAPI improves the speed and performance of the system through asynchronous processing. This system is suitable for developing real-time recommendation systems due to its ability to integrate effectively with machine learning packages like Scikit-learn.(Golagana et al., 2023).

B. Technologies Used

Streamlit: The open-source Python-based framework used to build interactive web applications for data science and machine learning-based applications is called Streamlit. The user interface of the proposed system is developed using the Streamlit framework. This allows the user to input personal de-tails such as age, height, weight, activity level, and nutritional preferences (Bhagat and Tuteja, 2023). Real-time interaction with the user is facilitated by the user-friendly interface of the proposed system. The user interface is developed in such a way that it includes interactive features such as sliders, input fields, and buttons. The development process is simplified by avoiding the need for complex front-end technologies such as HTML, CSS, and JavaScript (Gouthami and Gangappa, 2020). **FastAPI: FastAPI** is a cutting-edge fast web framework for developing APIs in Python. In this system, data processing and communication between the machine learning model and the user interface are carried out by the backend framework FastAPI(Bhagat and Tuteja, 2023). This system is effective in handling user requests, calculating BMI and Total Daily Energy Expenditure (TDEE), and returning the results for the

C. K-Nearest Neighbors (KNN) Algorithm

The proposed diet recommendation system follows the steps below using the K-Nearest Neighbors (KNN) algorithm:

1. Data Collection: The system collects user-specific health parameters such as age, height, weight, Body Mass Index (BMI), Total Daily Energy Expenditure (TDEE), and medical conditions (Ge et al., 2015).
2. Data Preprocessing: The collected data is preprocessed to handle missing values and ensure consistency. Feature scaling or normalization is applied to maintain unifor-mity across different attributes.
3. Feature Representation: Each user is represented as a feature vector:
   X = (Age, BMI, TDEE, Medical Condition)
4. Selection of K Value: A suitable value of K is selected, representing the number of nearest neighbors(Shelke et al., 2023).The value of K is chosen experimentally to balance bias and variance.
5. Distance Computation: The similarity between the new user and existing users is computed using a distance metric, typically Euclidean distance:

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$$d(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

6. Neighbor Identification: Top K nearest neighbors are selected (Singh et al., 2020).
7. Recommendation Generation: The system generates diet recommendations based on the selected neighbors. For classification, the most frequent diet plan is chosen (Ge et al., 2015). For regression, the average nutritional values or calorie intake is calculated.
8. Output Generation: The final personalized diet plan is provided to the user based on similarity with the nearest neighbors and health parameters such as BMI and TDEE.

D. Mathematical Formulation

1. Body Mass Index (BMI)

$$BMI = \frac{Weight(kg)}{Height(m)^2} \quad (1)$$

2. Basal Metabolic Rate (BMR)

$$BMR = 10W + 6.25H - 5A + S \quad (2)$$

3. Total Daily Energy Expenditure (TDEE)

$$TDEE = BMR \times Activity\ Factor \quad (3)$$

4. Euclidean Distance (KNN)

$$d(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

5. Cosine Similarity

$$Similarity(A, B) = \frac{A \cdot B}{\|A\|\|B\|}$$

IV. RESULTS AND DISCUSSION

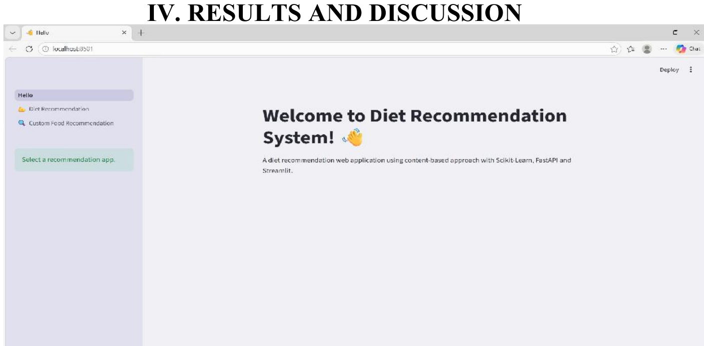

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Fig.2 shows home page of the Diet Recommendation System, which is shown when the program is run locally (Toledo et al., 2019). It is the main entry point of the system, and it also offers an easy-to-navigate interface. A welcome message and an overview of the system, which indicates that it is a web-based application built with Scikit-Learn, FastAPI, and Streamlit, are shown in the center panel(Gouthami and Gangappa, 2020) . "Diet Recommendation" and "Custom Food Recommendation" are the main options in the sidebar on the left

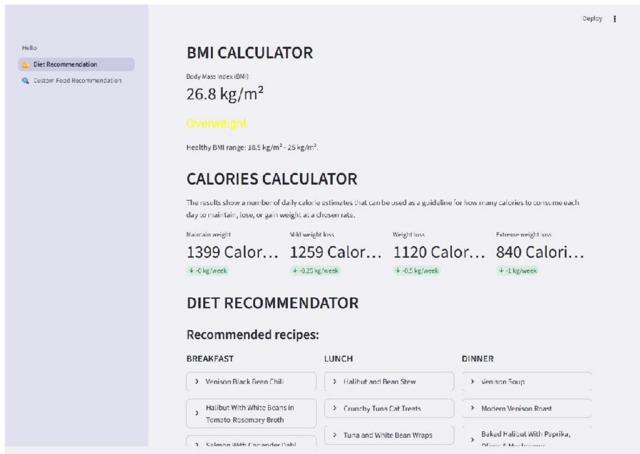

Fig. 3. Generated Diet Plan

Fig.3 represents the output page of the Automatic Diet Rec-ommendation System. Users enter important personal details such as age, height, weight, gender, activity level, weight gain/loss goal, and the number of meals per day (Qarajeh et al., 2023). The interface is user-friendly as it offers sliders and input boxes that make it easy to change the settings. The user can easily enter the details and make the desired choices quickly (Qarajeh et al., 2023). Once the user clicks the 'Generate' button after entering the details, the system generates the diet plan based on the details entered (Papastratis et al., 2024).Depending on the user's lifestyle and goals, such as weight loss or gain, the system determines the calorie needs of the user and provides the appropriate diet.

Fig. 4. Meal Composition and Calorie Comparison Visualization

Fig.4 shows results that the Diet Recommendation System derived from the input data provided by the user are shown on this output screen. The Body Mass Index (BMI), which in this case is 26.8 kg/m2, is shown along with the range of a healthy BMI and the state "Overweight" (Oskouei and Hashemzadeh, 2024) .This helps the user understand the state of his or her body at a particular time (Rostami et al., 2024).The calorie calculator then displays the approximate number of calories required on a daily basis for a number of goals, such as maintaining weight, losing weight, losing a certain amount of weight, and losing a large amount of weight. Based on this, the user gets to know how many calories he or she needs to consume for a particular purpose.

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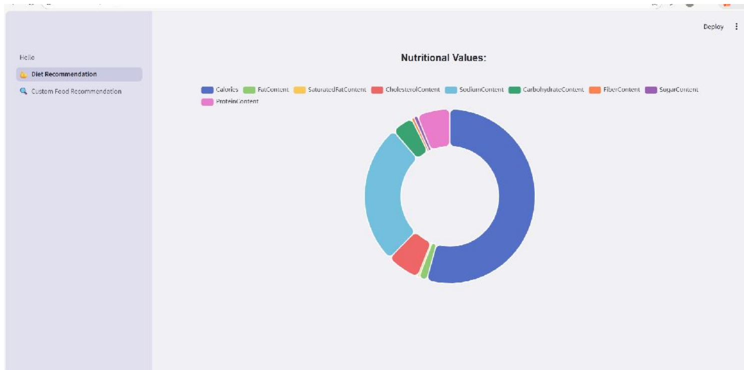

Fig. 5. Nutritional Analysis Using Donut Chart Representation

Fig.5 shows unique feature of the Diet Recommendation System, i.e., the meal composition, can be seen on this particular screen. In this section, the user can manually select the available breakfast, lunch, and dinner options (Toledo et al., 2019). This allows the user to keep track of their nutritional intake while allowing them to personalize their diet plan according to their own needs and wants (Oskouei and Hashemzadeh, 2024). A bar chart showing the difference between the total calories of the selected meals and the calories required to maintain weight will be shown on the screen. This allows the customers to easily identify whether the meals they have selected are within or above their calorie allowance (Shrimal et al., 2021). The customers can then go ahead and make the necessary changes to the meals they have selected to better meet their dietary needs (Singh et al., 2019).The nutritional values section helps customers maintain a healthy diet.

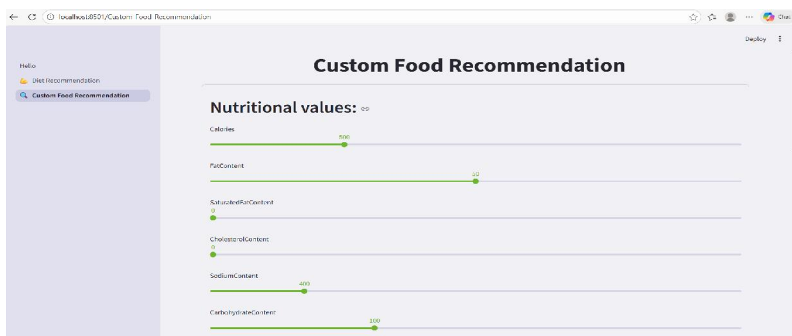

Fig. 6. Custom Food Recommendation Interface Based on Nutritional Preferences

Fig.6 shows an output screen of a user's selected diet plan. In this screen, users can visually analyze their selected diet plan. At the top of this screen, users can compare the number of calories selected by them with the number of calories required to maintain weight (Abhari et al., 2019). This will enable them to make appropriate decisions based on their requirements. Further, the chart of nutritional values in the form of a donut chart displays various nutrients such as calories, fats, carbohydrates, proteins, fiber, sugar, sodium, and cholesterol. In this chart, each portion represents a single nutrient.

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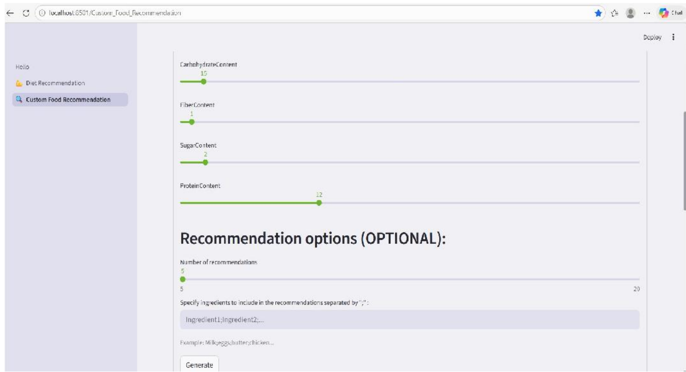

Fig. 7. Advanced Customization Options for Food Recommendation

Fig.7 shows screen above represents the system's feature called Custom Food Recommendation. The sliders enable the user to make various choices based on the nutritional values such as calories, fat, saturated fat, cholesterol, sodium, and carbs rather than automatically creating a diet plan (Singh et al., 2019). The user has the freedom to make the appropriate choices according to the nutritional values that they need. Each slider represents one nutritional value that the user needs (Shrimal et al., 2021). The user can make the appropriate changes according to the nutritional values that they need. The system provides the appropriate food selection according to the user's needs based on the nutritional values that they have chosen (Khaire et al., 2020). The user can benefit if they need to have appropriate nutritional values and balance in creating a more personalized and flexible diet plan.

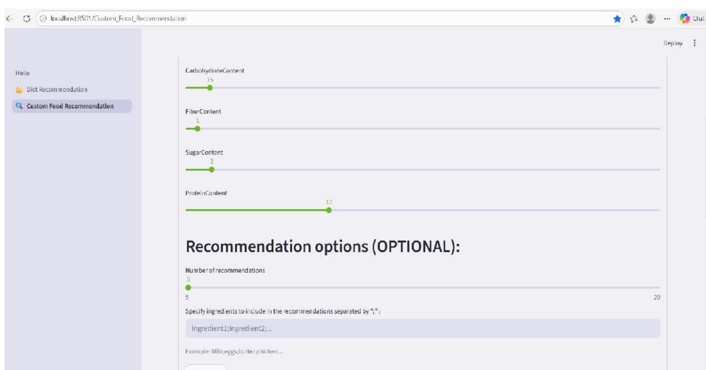

Fig. 8. Advanced Customization Options for Food Recommendation

Fig.8 shows choices available for the Custom Food Recom-mendation System are shown on this page, allowing cus-tomers to fine-tune their food recommendations (Qarajeh et al., 2023).. Once customers have used the sliders to fine-tune the nutritional values of the food, such as protein, sugar, fiber, and carbs, they can alter how the results are generated by going to the recommendation choices section (Toledo et al., 2019). In this section, customers can use the slider to select how many recipe recommendations they would want to receive. Further, customers can add specific ingredients in the input box that they would want to use in the meals. ,

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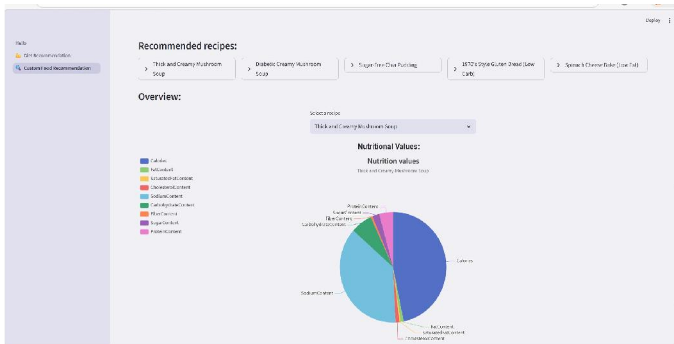

Fig. 9. Final Output of Customized Food Recommendations with Nutritional Breakdown

Fig.9 shows final output of the Custom Food Recommendation System is shown on the screen which offers consumers recom-mendations for food that meets their selected nutritional pref-erences(Shrimal et al., 2021). A list of recommended recipes is presented at the top, giving customers a variety of healthy choices for their meals according to their personalized nutrient values. A customer may view the nutritional information for a specific recipe by clicking on it in the overview section (Ge et al., 2015). The nutritional values chart (pie chart) graphically presents the nutrient value of selected food, including calories, fat, carbohydrates,protein, sodium, and sugar. This will create a balanced and personalized diet plan for consumers as it will be easier for them to understand the nutritional value of each recipe and select the food that meets their nutritional objectives (Shelke et al., 2023).

IV. CONCLUSION

The personalized diet recommendation system through AI technology, as presented in this research, helps users make decisions regarding their diet according to their nutritional requirements. For this purpose, it requires information like age, height, weight, and activity levels. The technology com-pares this information through a content-based approach. The technology helps users select the best food products through nearest neighbors and cosine similarity. The information pro-vided is clear, relevant, and healthy. The system is also easy to use, as it is implemented through Streamlit and FastAPI. The system is helpful for users as it allows them to make healthy and better dietary choices.

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