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Smart Infant Nutrition Advisory System using Whatsapp with Catboost Prediction and Topsis-Based Food Recommendation

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***Abstract*—Proper nutrition during infancy is essential for healthy physical growth, cognitive development, and long-term well-being. However, many parents face difficulties in selecting safe, age-appropriate, and nutritionally balanced foods due to limited knowledge about feeding stages, allergies, and dietary requirements. To address this challenge, this work proposes a data-driven baby food recommendation system integrated with a WhatsApp chatbot interface that provides personalized guidance for infant food. The system utilizes structured nutrition datasets and automated workflows to generate recommendations based on parameters such as baby age, allergies, health conditions, and dietary preferences. The chatbot is deployed using the Twilio** WhatsApp API**, enabling real-time interaction with caregivers. Workflow orchestration is managed using n8n, which is an automation tool for chatbots that handles user input processing, dataset retrieval, response generation, and alert notifications. The system also delivers features such as allergy warnings, nutrition summaries, and doctor appointment support. By combining data-driven analytics, automation, and conversational AI, the proposed approach improves access to infant nutrition guidance and supports parents in making accurate decisions. In order to suggest the best foods, the TOPSIS ranking is used.**

***Keywords*— Conversational AI, Food Recommendation, Healthcare Recommendation, Infant Nutrition, WhatsApp Chatbot, Workflow Automation.**

I. Introduction

Smart infant nutrition advisory systems refer to the application of data-driven technologies, artificial intelligence, and automated communication platforms to assist parents in selecting appropriate foods for infants according to their nutritional needs. These systems analyze nutritional datasets and user inputs to generate personalized feeding recommendations that support healthy growth and development during early childhood.

In the proposed article, we have considered a structured baby food dataset [1] to generate suitable dietary recommendations based on infant age, allergies, and nutritional requirements. Infant nutrition plays a critical role in physical growth, brain development, and immune system strengthening during the first two years of life. According to global health guidelines, improper feeding practices can lead to malnutrition, developmental delays, and long-term health complications [2].

The World Health Organization emphasizes that appropriate complementary feeding between six and twenty-four months is essential to ensure adequate intake of energy, protein, and micronutrients required for optimal growth [3]

In this article, we propose a methodology that integrates a data-driven recommendation approach with a conversational chatbot interface to assist parents in selecting appropriate foods for infants. The system analyzes nutritional datasets and user inputs such as infant age, allergies, and dietary preferences to generate personalized food recommendations.

User queries are processed via a WhatsApp-based chatbot implemented with the Twilio WhatsApp API, and automated workflow management is handled by n8n. This integrated framework enables real-time interaction, efficient data processing, and delivery of age-appropriate dietary suggestions. The system also provides additional features such as allergy alerts and nutrition guidance to support informed feeding decisions.

The paper is structured as follows: Section I introduces the study; Section II describes the categories of infant feeding stages; Section III presents the CatBoost algorithm and chatbot workflow; Section IV explains the methodology and results; Section V concludes the study; Section VI gives the future enhancements.

II. Categories Of Infant Food Recommendation

Infant food recommendations can be broadly classified into three categories—Normal, Special Nutritional Needs, and Medical Condition–Based—based on the baby's age, growth requirements, and health indicators. These categories help in suggesting appropriate and safe foods to support healthy development.

A. Liquid Stage (0–6 Months)

During the initial months of life, infants primarily depend on breast milk or infant formula as their main source of nutrition. According to pediatric health guidelines, exclusive breastfeeding is recommended for the first six months because it provides essential nutrients, antibodies, and immune protection.

At this stage, introducing solid foods is generally not recommended since the infant's digestive system is still developing.

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Therefore, the system mainly provides nutrition guidance and feeding reminders rather than solid-food recommendations.

B. Semi-Solid Stage (6–12 Months)

Between six and twelve months, babies gradually transition from liquid diets to semi-solid foods. At this stage, complementary foods are introduced while continuing breastfeeding or formula feeding.

Typical foods recommended during this stage include:

- Mashed fruits (banana, apple puree)
- Vegetable purees (carrot, potato, pumpkin)
- Cereal-based foods (rice cereal, ragi porridge)
- Soft traditional foods such as Suji kheer

The chatbot analyzes age, allergy information, and nutrition data to recommend safe and balanced foods for this stage. It also provides allergy alerts and choking risk warnings when necessary.

C. Solid Food Stage (12–24 Months)

After one year, infants gradually transition to more solid foods and a wider variety of dietary options. At this stage, the child's digestive system is more developed, allowing the introduction of balanced meals that include proteins, carbohydrates, vitamins, and minerals.

Recommended foods during this stage may include:

- Soft rice with vegetables
- Dal and mashed legumes
- Soft chapati with curry
- Eggs, fruits, and dairy products

The chatbot generates nutritionally balanced meal suggestions by combining dataset information with AI-driven query processing. It also helps parents maintain a balanced diet plan for proper growth and development.

III. CatBoost–TOPSIS Hybrid Technique

The proposed system integrates CatBoost and TOPSIS to improve prediction and decision-making performance. CatBoost is used to build an accurate predictive model by learning patterns from the dataset using gradient boosting on decision trees **[5]**, while ranking techniques are used to prioritize recommended alternatives based on multiple nutritional criteria. This hybrid approach enhances both prediction accuracy and decision prioritization by combining machine learning with multi-criteria evaluation techniques.

The steps involved in the CatBoost–TOPSIS hybrid technique are as follows:

Step1: Collect and preprocess the dataset by cleaning missing values and preparing the relevant features.
Step2: Split the dataset into training and testing sets for model development and validation.
Step3: Train the CatBoost model using the training data to learn relationships between input features and the target variable.
Step4: Generate prediction results or probability scores using the trained CatBoost model.
Step5: Construct a decision matrix using the predicted values and selected evaluation criteria.
Step6: Normalize the decision matrix and assign weights to each criterion.
Step7: Determine the ideal best and ideal worst solutions based on the weighted criteria.
Step8: Calculate the distance of each alternative from the ideal solutions and compute the relative closeness score.
Step9: Rank the alternatives based on the TOPSIS score to identify priority levels or risk categories.

A. Chatbot Workflow

The proposed workflow offers several advantages for intelligent infant nutrition guidance. First, the integration of rule-based safety checks ensures that medical situations are handled responsibly. Second, the combination of structured dataset retrieval and AI-based reasoning improves the quality and relevance of recommendations. Third, the multi-platform architecture enables the chatbot to operate seamlessly across different messaging environments. Finally, the use of conversational memory allows the system to maintain context across interactions, improving user experience.

Algorithm: Baby Food Guidance Chatbot Workflow

Input: User query message
Output: Context-aware baby food recommendation or advisory response

Step1: Receive the user query from the messaging platform trigger.

Step2: Normalise the input message by extracting key information such as message text, user ID, timestamp, and session identifier.

Step3: Perform query classification to determine the intent category (greeting, medical concern, nutritional advice, or appointment request).

Step4: Check for medical emergency indicators in the query. If detected, generate a safety advisory response and terminate further processing.

Step5: If the query relates to appointment booking, generate an appointment guidance response.

Step6: If the query is a greeting, generate a conversational greeting response.

Step7: For nutritional queries, retrieve relevant baby food records from the dataset based on the detected baby age and query keywords.

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Step8: Process the retrieved dataset and construct contextual information for the AI model.

Step9: Pass the contextual data and user query to the AI agent for generating an appropriate recommendation.

Step10: Format the generated response into a standardized message structure.

Step11: Route the response to the appropriate messaging platform (e.g., WhatsApp or Telegram).

Step12: Deliver the final response to the user.

IV. Proposed Methodology

In this study, a data-driven methodology is proposed for developing an intelligent baby food recommendation system using predictive modeling and multi-criteria decision-making techniques. Intelligent recommendation systems based on artificial intelligence and machine learning have been widely used to support decision-making in health and nutrition domains **[8]**. The objective of the proposed system is to identify suitable and nutritionally appropriate food items for infants based on their age group and nutritional requirements. The dataset used for this work contains 500 records and 7 attributes, including food item name, age range (in months), texture type, calories per 100 grams, protein content, allergens, and preparation notes. The dataset attributes were compiled from reliable sources, including recognized health organizations like the World Health Organization (WHO), UNICEF, and established pediatric nutrition platforms to ensure data accuracy and credibility**.[2]**

TABLE I.
A STRUCTURED DATASET FOR INFANT COMPLEMENTARY FOODS: AGE, TEXTURE, NUTRITION, AND ALLERGY INFORMATION.

Food Item	Age Range (month)	Texture	Calories	Protein	Allergens	Notes
Banana	6	Mashed	89	1.1	None	Easy to mash, no cooking required.
Rice Cereal	8-9	Puree	130	2.7	Gluten	Mix with breastmilk or formula.
Sweet Potato	6	Puree/Mashed	86	1.6	None	Steam and mash for a smooth puree.
Apple	6	Puree	52	0.3	None	Cook and puree for easy digestion.
Carrot	6	Puree/Mashed	41	0.9	None	Steam until soft before mashing.
Egg Yolk	8	Mashed	155	13	Egg	Introduce gradually; monitor for allergies.
Oatmeal	7-8	Puree	68	2.4	Gluten	Cook with water or breastmilk.
Avocado	8	Mashed	160	2	None	Mash to creamy texture; no cooking required.
Chicken (Boiled)	9	Puree/Mashed	165	15	None	Boil and shred finely or puree for babies.

Initially, data preprocessing was carried out to ensure the quality and consistency of the dataset. This step included handling missing values, removing duplicate records, and converting categorical variables such as food item names and texture types into numerical or encoded formats suitable for machine learning algorithms. In addition, feature selection was performed to identify the most relevant attributes influencing the suitability of baby food. Important nutritional parameters such as calorie content, protein value, texture consistency, and age suitability were selected for further analysis because they play a critical role in infant nutrition and digestion **[6]**.

After preprocessing, the dataset was divided into training and testing subsets to evaluate the predictive performance of the model. Approximately 80% of the dataset was used for training, while the remaining 20% was reserved for testing. This split ensures that the model learns patterns from the training data and is then evaluated on unseen data to measure its generalization capability. Such machine learning evaluation practices are commonly used in predictive analytics research [4]**.**

For predictive analysis, the CatBoost algorithm was employed. CatBoost is an advanced gradient boosting technique that builds multiple decision trees sequentially in order to minimize prediction errors and effectively handle categorical features **[5]**.

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It is particularly effective when dealing with categorical data and complex feature interactions. During the training phase, the CatBoost model learns the relationships between the nutritional attributes and the suitability of food items for infants. The algorithm iteratively improves the model by correcting the errors made by previous decision trees, which results in improved predictive accuracy and stability.

Once the model was trained, it was evaluated using standard classification performance metrics such as accuracy, precision, recall, and F1-score. These metrics provide a comprehensive understanding of the model's predictive capability. The experimental results obtained from the CatBoost model demonstrate reliable classification performance. The model achieved an overall accuracy of 82%, indicating that it correctly classified the majority of food suitability cases in the dataset. The precision values obtained were 0.80 for class 0 and 0.87 for class 1, indicating a strong ability of the model to correctly identify relevant instances.

- Accuracy: 82%
- Precision: 0.80 (Class 0), 0.87 (Class 1)
- Recall: 0.93 (Class 0), 0.65 (Class 1)
- F1-Score: 0.86 (Class 0), 0.74 (Class 1)
- Weighted F1-Score: 0.81

Although predictive classification provides an indication of suitable food items, it does not directly provide a ranking of alternatives. Therefore, to further enhance the recommendation process, a multi-criteria decision-making approach was integrated into the system. The TOPSIS method was applied to rank food items based on their nutritional and suitability criteria. TOPSIS is a widely used technique that determines the best alternative by measuring the distance of each option from the ideal best solution and the ideal worst solution.

In this stage, a decision matrix was constructed using the relevant attributes such as calorie content, protein value, and other nutritional indicators. The matrix was then normalized to eliminate scale differences among the attributes. After normalization, weights were assigned to each criterion according to their relative importance in infant nutrition. For example, protein and calorie content were considered important factors because they directly influence infant growth and energy requirements [6].

Next, the ideal best solution and ideal worst solution were determined from the weighted normalized matrix. The ideal best solution represents the most nutritionally balanced and suitable food option, while the ideal worst solution represents the least suitable alternative. Based on these scores, the food items were ranked from the most suitable to the least suitable option.

The ranking results generated by the TOPSIS method produced a prioritized list of recommended baby foods. Some of the top-ranked food items included Chicken (Boiled), Egg Yolk, Roasted Foxnuts (Makhana), Puffed Rice (Murmura), and Paneer (Mashed). These foods received higher ranking scores due to their favorable nutritional content, digestibility, and suitability for infants within specific age ranges, which align with infant nutrition recommendations [6].

To better interpret the results, visualization techniques were also used. Graphs and tabular outputs were generated to illustrate the ranking scores and classification outcomes. These visual representations help in understanding the distribution of food items based on nutritional attributes and suitability categories. The results clearly demonstrate that the combined use of predictive modeling and ranking techniques improves the reliability and usefulness of the recommendation system. Intelligent AI-based recommendation frameworks are increasingly used to support health and nutrition decision-making systems [8].

V. Methodology For Chatbot

The proposed system implements an intelligent baby food guidance chatbot designed to assist parents in making safe and appropriate feeding decisions for infants. The system integrates rule-based safety mechanisms, dataset-driven recommendations, and artificial intelligence to provide reliable nutrition guidance. The chatbot is deployed through the WhatsApp messaging platform using the Twilio API, enabling users to interact with the system conversationally.

The workflow begins when a user sends a message to the chatbot through WhatsApp. The incoming message is captured through a messaging trigger and processed using an automated workflow engine. The system first performs message normalization, where the input text is standardized and key parameters such as the user ID, message content, and timestamp are extracted.

Following preprocessing, the system performs intent classification to identify the purpose of the user's query. The classifier categorizes user messages into different intents such as greetings, nutritional advice, appointment booking, or medical concerns. This classification enables the chatbot to route queries to the appropriate processing module.

If the message contains indicators of a potential medical concern, the system prioritizes safety by generating an advisory message instructing the user to seek medical assistance rather than providing automated medical guidance. This design decision ensures that the chatbot does not replace professional healthcare advice, which is critical in infant health scenarios.

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For nutritional queries, the system analyzes the baby's age and provides age-appropriate feeding recommendations. According to global infant feeding guidelines, complementary feeding typically begins around six months of age, while infants younger than six months rely primarily on breast milk or formula for nutritional needs [6]. The chatbot incorporates these guidelines when generating recommendations to ensure safe feeding practices.

Additionally, the system includes an appointment booking feature that allows users to schedule consultations with childcare experts using an integrated scheduling platform. When the user requests an appointment with doctor, the chatbot provides a booking link through which the user can select an available date and time.

The integration of conversational AI with rule-based logic ensures that the chatbot can provide informative, context-aware responses while maintaining safety and accuracy. The overall workflow enhances accessibility to infant nutrition guidance and supports parents in making informed feeding decisions.

A. Results and System Functionality

The predictive analysis was carried out using key nutritional attributes such as calories, protein content, texture, and age suitability as the primary features. The classification model CatBoost was used to analyze the dataset and determine the suitability of food items for infants [5].

The model assigned each food item a classification outcome indicating whether the food is recommended or not recommended for a particular infant age group. Figure 2 presents an excerpt of sample food items showing their attributes, actual suitability labels, and predicted results generated by the model. This demonstrates the capability of the model to effectively distinguish between suitable and less suitable food options for infants.

The TOPSIS method then calculated the distance of each food item from the ideal best and ideal worst solutions. Based on the relative closeness score, food items were ranked to determine the most appropriate recommendations. The ranking results identified several highly suitable foods for infants, including Chicken (Boiled), Egg Yolk, Roasted Foxnuts (Makhana), Puffed Rice (Murmura), and Paneer (Mashed). These foods provide important nutrients that support infant growth and development according to global nutrition guidelines [6].

This ranking mechanism improves the practical usability of the system by not only identifying suitable foods but also prioritizing them according to nutritional value and suitability. The system generates a list of recommended food items along with their ranking scores and preparation notes, which helps parents or caregivers easily interpret the results and select appropriate food options for infants.

```
Dataset shape: (500, 7)
...          Food Item Age Range (months)        Texture  Calories (per 100g)  \
0           Banana                     6         Mashed                   89
1     Rice Cereal                   8-9          Puree                  130
2    Sweet Potato                     6  Puree/Mashed                   86
3           Apple                     6          Puree                   52
4          Carrot                     6  Puree/Mashed                   41

     Protein (g) Allergens                                  Notes
0             1.1       NaN  Easy to mash, no cooking required.
1             2.7    Gluten     Mix with breastmilk or formula.
2             1.6       NaN    Steam and mash for smooth puree.
3             0.3       NaN  Cook and puree for easy digestion.
4             0.9       NaN    Steam until soft before mashing.

CatBoost Results:
Accuracy: 0.82
              precision    recall  f1-score   support

           0       0.80      0.93      0.86        60
           1       0.87      0.65      0.74        40

    accuracy                           0.82       100
   macro avg       0.83      0.79      0.80       100
weighted avg       0.83      0.82      0.81       100


--- Recommended Foods ---
                  Food Item  Final_Score  \
13  Khichdi (Moong Dal + Rice)     0.565789
0                     Banana     0.166506
2                Sweet Potato     0.152774
4                      Carrot     0.092678
3                       Apple     0.072587

                                    Notes
13  Common across India, add ghee for calories.
0             Easy to mash, no cooking required.
2               Steam and mash for smooth puree.
4               Steam until soft before mashing.
3             Cook and puree for easy digestion.
```

Fig .1. Food Suitability Prediction Using Catboost Model

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The experimental results indicate that the CatBoost model achieved an overall accuracy of 82%, demonstrating reliable predictive performance for identifying appropriate food items. The evaluation metrics obtained from the classification model include precision values of 0.80 and 0.87, recall values of 0.93 and 0.65, and F1-scores of 0.86 and 0.74, with a weighted F1-score of 0.81. These results confirm that the model is capable of learning meaningful relationships between nutritional attributes and food suitability using machine learning techniques [5].

To further enhance the recommendation process, a ranking mechanism was integrated using the TOPSIS method. After the prediction stage, the food items identified as suitable were evaluated using multiple nutritional criteria such as calorie value, protein content, and digestibility. A decision matrix was constructed and normalized, and weights were assigned to each criterion based on their importance for infant nutrition [6].

	Food Item	Final_Score
0	Chicken (Boiled)	0.900934
1	Egg Yolk	0.857393
2	Roasted Foxnuts (Makhana)	0.806796
3	Puffed Rice (Murmura)	0.756073
4	Paneer (Mashed)	0.738946

Fig. 2. TOPSIS-Ranked Baby Foods For An 8-Month-Old With Peanut And Milk Allergies

From a functional perspective, the proposed system operates in multiple stages. First, the dataset is processed and analyzed using the CatBoost model to predict food suitability [5]. Second, the predicted results are passed to the TOPSIS ranking module, which evaluates each alternative based on multiple nutritional criteria. Finally, the system generates a prioritized recommendation list for the user.

This layered functionality demonstrates how the predictive model can be deployed in a mobile or web-based application for intelligent baby food recommendation. In such an application, caregivers could input the infant's age and nutritional requirements, and the system would automatically analyze the dataset, predict suitable foods, and provide ranked recommendations in real time. Such intelligent recommendation systems are increasingly used in AI-based decision-support applications [8].

The recommendation module serves not only as a decision-support mechanism but also as a nutritional guidance tool for parents. By recommending foods based on multiple nutritional parameters, the system supports balanced diet planning for infants and helps reduce the risk of improper feeding practices [6].

From a deployment perspective, the framework can be integrated into digital health or parenting support platforms where users can access personalized food recommendations. Conversational AI technologies, such as chatbot systems, can further enhance interaction between users and the recommendation system [11]. The system could also be extended to incorporate additional features such as allergen detection, dietary restrictions, and nutritional tracking.

B . Chatbot Interaction Results

The developed chatbot was evaluated through multiple interaction scenarios to demonstrate its ability to provide accurate responses and handle different types of user queries. The results show that the system successfully processes user inputs and generates appropriate responses based on the detected intent.

In the first scenario, when the user sends a greeting message, the chatbot responds with a welcome message and asks for the baby's age to personalize future recommendations. This interaction demonstrates the chatbot's ability to initiate conversational engagement and collect essential contextual information required for nutritional guidance.

In the second scenario, the user asks whether a 3-month-old baby can consume a banana. The chatbot correctly identifies the baby's age and informs the user that solid foods are not recommended before six months. Instead, it advises continuing breastfeeding or formula feeding, which aligns with international infant feeding recommendations [6].

Another scenario demonstrates the chatbot's ability to provide age-appropriate food suggestions. When the user asks about feeding options for a 6-month-old baby, the chatbot recommends suitable complementary foods such as mashed banana, sweet potato puree, and rice porridge. These recommendations are consistent with complementary feeding guidelines suggested by global health organisations [3].

The system also effectively handles medical concern detection. When a user reports symptoms such as fever and vomiting in an infant, the chatbot immediately identifies the query as a potential medical issue and generates a safety warning message advising the user to contact a paediatrician or emergency services. This safety-first approach ensures that the chatbot does not provide potentially harmful medical advice.

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Furthermore, the chatbot successfully supports appointment scheduling by providing users with a consultation booking link through the scheduling platform. Once the user selects a suitable time slot, the system confirms the appointment and sends a meeting invitation.

Overall, the experimental interactions demonstrate that the chatbot can effectively handle multiple types of queries, including greetings, nutritional guidance, medical alerts, and appointment booking. The integration of safety checks, conversational AI, and automated scheduling improves the reliability and usability of the system for parents seeking infant nutrition support.

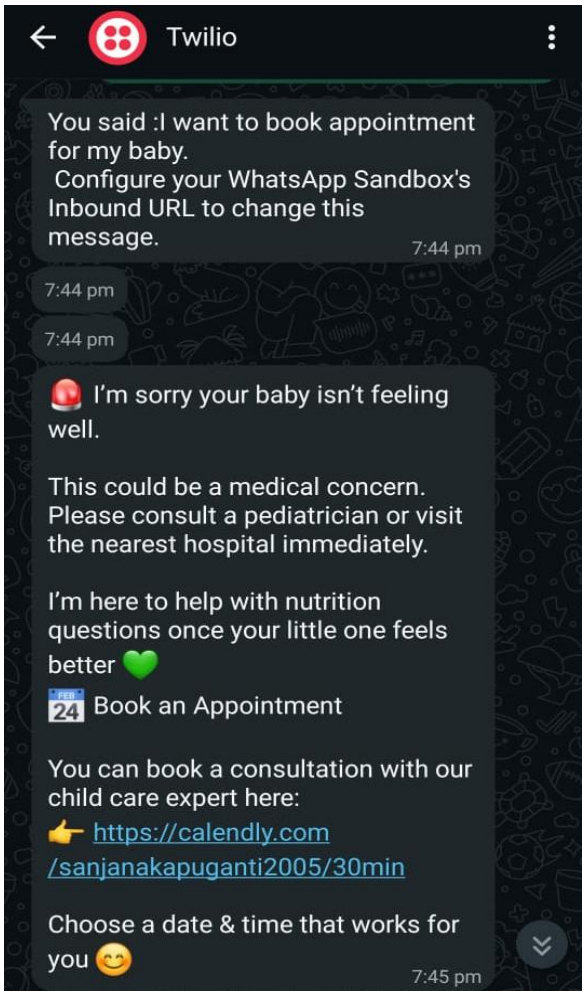

Fig. 3. Appointment Booking Link Generated For Consultation.

VI. Conclusion

This work presents a data-driven baby food recommendation chatbot designed to assist parents and caregivers in selecting appropriate complementary foods for infants.

The system integrates important nutritional attributes such as age suitability, food texture, calorie content, protein levels, and allergen information to recommend safe and nutritious food options for babies. A machine learning approach using the **CatBoost classification model** was employed to predict food suitability based on these features, enabling accurate and personalized recommendations.

The chatbot framework allows users to interact with the system easily and receive instant guidance on suitable foods for infants at different developmental stages. By combining predictive modelling with an interactive chatbot interface, the system provides practical support for caregivers who may not have immediate access to paediatric nutrition guidance.

Fig. 4. Complementary Food Recommendations Generated For A 6-Month-Old Infant

Furthermore, the proposed model promotes healthy complementary feeding practices by considering nutritional value and potential allergens, thereby reducing risks and supporting balanced infant development. The system can also serve as an educational tool by providing preparation tips and feeding recommendations, helping parents make informed dietary choices for their children

VII. Scope For Further Research

The proposed baby food recommendation chatbot can be further improved with several enhancements to increase accessibility, usability, and functionality. One potential improvement is the integration of a voice interaction feature, allowing users to speak their queries instead of typing. This would make the system more convenient for parents and caregivers who may prefer hands-free interaction while caring for infants.

Another important enhancement is multilingual support. Currently, many users may face language barriers when using technology-based health tools. By adding support for regional languages such as Hindi and Telugu, the chatbot can become more inclusive and accessible to a wider population, especially in rural and regional areas.

Additionally, future versions of the system could include real-time voice translation, enabling the chatbot to automatically translate user queries and responses into the preferred language. This would improve communication and ensure that caregivers clearly understand feeding recommendations.

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