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Optimization Study on the Evaluation and Design of College Students' Dietary Recipes based on the Planning Model

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Abstract: In this paper, the optimal design and evaluation of college students' diet recipes were studied. Using the planning model method, a multi-objective optimization model was constructed with the goal of optimal protein and amino acid score and the most economical meal cost. Firstly, by establishing the objective function with protein amino acid score as the main index, combined with the principle of balanced diet optimization design, the daily diet of male university students and female university students was designed, and the dietary nutrition evaluation was carried out. Secondly, in order to pursue the economy of meal cost, an optimization model with cost minimization as the objective function was constructed, and the corresponding reasonable diet was obtained. Finally, to meet the needs of users to pursue nutrition and economy at the same time, a multi-objective optimization model was further constructed, which considered protein and amino acid scores and economy, and provided daily and weekly diet choices that were both nutritious and economical for college students.

Keywords: Diet Optimization; Nutrition Evaluation; Planning Model.

1. Introduction

In the fast pace and high pressure of modern life, the dietary health of college students is increasingly concerned. Reasonable collocation of meals not only contributes to the growth and development of college students, but also improves the efficiency of study and the quality of life. However, in the face of a wide variety of food choices, how to scientifically plan meals to achieve balanced nutrition and economic benefits has become a difficult problem for college students and their parents.

This paper aims to discuss the optimal design and evaluation of college students' dietary recipes based on the planning model [1-2]. Firstly, with the aim of maximizing protein and amino acid score and combining with the principle of balanced diet, an optimization model was constructed to design the daily diet to meet the nutritional needs of college students. Secondly, considering the meal cost economy, the optimization model with the most economical cost as the goal was built to meet the actual needs of different college students. On this basis, the two are combined to construct a multi-objective optimization model that considers protein and amino acid score and economy, to provide a nutritious and economical meal plan for college students. This study will provide theoretical support and practical guidance for college students to plan their meals scientifically and help to improve their dietary health level.

2. Establishment and Solution of Daily Diet Dietary Nutrition Evaluation Model

2.1. Construction of Optimal Model Aiming at the Optimal Protein Amino Acid Score

Based on the principle of optimal design of balanced diet and Amino Acid Score (AAS) and aiming at the maximum protein amino acid score, the optimal model was established to design the daily diet of male university students and female university students, respectively, and carry out dietary nutrition evaluation on the daily diet [3].

The formula for establishing the objective function model is as follows:

$$Max\ AAS = \frac{\sum(X_i * aa_i)}{\sum(X_i * aa_{std})} \times 100 \quad (1)$$

X_i is the food type, its randomness is very large, so according to the principle of balanced diet optimization design can establish the following constraints:

Since the constraints of male university students and female university students and the establishment of objective function ideas are basically the same, but there are different data in the principle of recipe optimization design, the following constraints are set according to the standard data of male university students.

Based on the actual daily energy intake of male university students and female university students and the intake target difference within ±10%; The inequality constraint conditions are established as follows:

$$0.9 \times E_{target} \leq \sum(X_i * E_i) \leq 1.1 \times E_{target} \quad (2)$$

As far as possible, the meal ratio can meet the breakfast 25%-35%, and the constraint conditions of lunch and dinner 30%-40% are:

$$0.25 \leq \frac{E_{i,1}}{E_{total}} \leq 0.35 \quad (3)$$

$$0.3 \leq \frac{E_{i,2}}{E_{total}} \leq 0.4 \quad (4)$$

$$0.3 \leq \frac{E_{i,3}}{E_{total}} \leq 0.4 \quad (5)$$

Based on the actual intake of male non-productive major nutrients calcium, iron, zinc, vitamin A, vitamin B_1, vitamin

B_2, as close as possible to the reference intake constraints are:

$$0.95 \times 800 \leq \sum_i (X_i * l_{Ca}) \leq 1.05 \times 800 \quad (6)$$

$$0.95 \times 12 \leq \sum_i (X_i * l_{Fe}) \leq 1.05 \times 12 \quad (7)$$

$$0.95 \times 12.5 \leq \sum_i (X_i * l_{Zn}) \leq 1.05 \times 12.5 \quad (8)$$

$$0.95 \times 800 \leq \sum_i (X_i * l_{VA}) \leq 1.05 \times 800 \quad (9)$$

$$0.95 \times 1.4 \leq \sum_i (X_i * l_{VB1}) \leq 1.05 \times 1.4 \quad (10)$$

$$0.95 \times 1.4 \leq \sum_i (X_i * l_{VB2}) \leq 1.05 \times 1.4 \quad (11)$$

Based on the percentage of productive nutrients in total energy, the constraints of 10%-15% protein, 20%-30% fat and 50%-65% carbohydrate should be met as follows:

$$0.1 \leq \frac{\sum_i (X_i * H_{p,i}) \times 4}{E_{total}} \leq 0.15 \quad (12)$$

$$0.2 \leq \frac{\sum_i (X_i * H_{f,i}) \times 9}{E_{total}} \leq 0.3 \quad (13)$$

$$0.5 \leq \frac{\sum_i (X_i * H_{c,i}) \times 4}{E_{total}} \leq 0.65 \quad (14)$$

According to the above constraints, the objective function is solved and the optimal solution is obtained. For the specific algorithm implementation, consider the use of particle swarm algorithm, define the particle swarm internal value, add constraints, to obtain the optimal solution, the obtained a reasonable recipe for male university students is shown in Table 1, the same for female university students.

Table 1. The optimal daily diet of male students with the maximum protein and amino acid score as the optimization target

Boiled Egg	1	Breakfast
Yogurt	2	
Fish ball soup	2	Lunch
Chicken stew with potatoes and carrots	1	
Braised cabbage with seaweed	1	
Dry fried croaker	1	
Casserole noodles	1	Dinner
Radish vermicelli soup	1	
Braised tofu with pollak	1	
Stir-fried meat lentils	1	
Sardines in Tomato sauce	1	
Braised Kelp cabbage tofu	3	

2.2. Build the Optimal Model with the Goal of the Most Economical Meal Cost

Based on the optimal design principle of balanced diet recipe and aiming at the most economical meal cost, an optimization model was established to design the daily diet of male university students and female university students, respectively, and carry out dietary nutrition evaluation on the daily diet.

Obviously, the most economical refers to the least cost of consumption. The following objective function is listed:

$$Min\ Cost = \sum_i (X_i * PR_i) \quad (15)$$

Other constraints are also established based on the principles of optimal design of balanced diet recipes.

Finally, a reasonable diet for male students is obtained, as shown in Table 2:

Table 2. Reasonable daily diet for male students with the optimal goal of the most economical meal cost

Mixed with shredded kelp	2	Breakfast
Steamed Sweet Potato	2	
Milk	2	
Braised tofu with cabbage	5	Lunch
Grapefruit	5	
Honeydew melon	3	
Braised kelp cabbage tofu	1.5	Dinner
Apples	5	

2.3. Multi-objective Optimization Model Construction Considering Protein Amino Acid Score and Economy

Based on the principles of optimal design of balanced diet recipes and amino acid score (AAS), an optimal model was established to design daily diet for male university students and female university students, respectively, and conduct dietary nutrition evaluation on daily diet [4-5].

That is, the formula can be satisfied:

$$\begin{aligned} Min\ Cost &= \sum_i (X_i * PR_i) \\ Max\ AAS &= \frac{\sum (X_i * aa_i)}{\sum (X_i * aa_{std`})} \times 100 \end{aligned} \quad (16)$$

Other constraints are the same as above, the objective function is established with the comprehensive score of total cost and amino acid score. Consider using the cross-iteration method to define the maximum number of iterations Max, cross probability CR, population size N and scaling factor CR. First, ensure that each individual meets the constraints, and then calculate the objective function value of each individual, that is, the comprehensive score. Each time a better individual score is obtained, the optimal value is updated, and the best score is finally obtained. Finally, we can get a set of specific combination schemes, including the energy ratio of three meals, the reasonable intake of each element, the total energy intake, the optimal amino acid score and the reasonable economic cost. Among them, a reasonable diet for male students is shown in Table 3:

Table 3. A reasonable daily diet for male students considering protein intake and economy

Boiled Egg	1	Breakfast
Rice porridge	5	
Cow's milk	3	
Sauteed mushrooms with rape	3.5	Lunch
Braised cabbage with seaweed	5	
Honeydew melon	1	
Banana	8	
Braised kelp cabbage tofu	1.5	Dinner
Grapefruit	5	

3. Establishment and Solution of Weekly Diet Nutrition Evaluation Model

Based on the principles of optimal design of balanced diet

recipe and amino acid score (AAS), the optimal model was established to design weekly diet for male university students and female university students (Monday to Sunday), and the evaluation and comparative analysis were carried out, with the goals of maximum protein amino acid score, most economical meal cost and considering protein amino acid score and economy, respectively. Currently, there is a multi-objective planning in the model, which needs to satisfy two objective functions at the same time. However, the condition of variety cannot be satisfied in practice. It shows that it is unreasonable to satisfy only two objective functions. Therefore, it is necessary to add weights to the two multi-objective programs and establish new objective functions on this model. The constraint conditions are established according to the principle of optimal design of balanced diet recipe.

A new objective function is established, based on the precondition of the highest and most economical amino acid score for the protein, and the (16) must be satisfied. In addition to satisfying the above conditions, there are different values for nutrition and economy in practice. Therefore, we need to add a weight β to it. Here is how to create the objective function:

$$Min\ Z = Cost \times \beta - AAS \times (1 - \beta) \tag{17}$$

Model interpretation: The higher the weight, the better. In this model, there are opposite characteristics of amino acid score and economic cost. That is, we hope that the amino acid score is high and do not want high consumption. Therefore, the $\text{Cost} \times \beta$ is expected to be smaller. And $\text{AAS} \times (1 - \beta)$ is more promising. Currently, $-\text{AAS} \times (1 - \beta)$ is the smallest. So, the objective function is set to Z. The minimum value of the objective function can satisfy the above conditions. Meet the conditions and be realistic.

The solution can obtain a reasonable weekly male diet as shown in Table 4:

Table 4. Reasonable weekly diet for male students based on multi-objective planning

Monday	
Breakfast	Millet porridge (1 part) Boiled egg (1 part) Churros (1 part)
Lunch	Rice (4 servings) Braised pork (1 serving) Ground three fresh vegetables (1 serving) Mixed fungus (1 serving)
Dinner	Casserole noodles (1 serving) Steamed buns (1 serving)
Tuesday	
Breakfast	Millet porridge (1 part) Fried eggs (1 part) Yogurt (1 part)
lunch	Rice (4 servings) Stir-fried beef (1 serving) Moo shu persimmon (1 serving) Mixed spinach (1 serving)
Dinner	Chicken cutlet noodles (1 serving) With spinach (1 serving)
Wednesday	
Breakfast	Pumpkin porridge (1 serving) Rolls (1 serving) Soy milk (1 serving)
Lunch	Rice (4 servings) Kung pao diced Chicken (1 serving) Egg and persimmon soup (1 serving) Mixed with dry tofu (1 serving)
Dinner	Spinach mixed (2 servings) Steamed buns (1 serving)
Thursday	
Breakfast	Millet porridge (1 part) Fried egg (1 part) steamed bun (1 part)
Lunch	Rice (4 servings) Grilled ribs (1 serving) Stir-fried three shreds (1 serving) Mixed tofu (1 serving)
dinner	Mixed Wood fungus (1 serving) Egg cake (1 serving)
Friday	
Breakfast	Millet porridge (1 part) Fried eggs (1 part) Yogurt (1 part)
Lunch	Rice (4 servings) Stir-fried beef (1 serving) Mixed fungus (2 servings) Moo shu persimmon (1 serving)
Dinner	Chicken chop noodles (1 serving) with shredded kelp (1 serving)
Saturday	
Breakfast	Milk (1 part) millet porridge (1 part) Rice (4 parts) Fried eggs (1 part)
Lunch	Kung pao diced Chicken (4 servings) Mixed with dry tofu (2 servings) Moo Shu persimmon (2 servings)
Dinner	Mixed Wood fungus (1 serving) Braised pork (1 serving)
Sunday	
Breakfast	Chicken cutlet noodles (1 serving) Fried eggs (1 serving) Soy milk (1 serving)
Lunch	Rice (4 servings) Ground three fresh vegetables (1 servings) Mixed with wood fungus (2 servings) Braised pork (1 servings)
Dinner	Spinach mixed (1 serving) Steamed buns (1 serving)

4. Conclusion

The purpose of this paper is to optimize the design and evaluation of college students' dietary recipes through the planning model to ensure the balance of dietary nutrition and economy. Based on the principles of balanced diet and amino acid scoring, an optimization model aiming at maximizing protein amino acid scoring was constructed, and a reasonable daily and weekly diet was designed for male and female students respectively considering the economic cost. By setting the constraint conditions of energy intake, meal ratio and major nutrient intake, the model ensured the sufficiency and balance of dietary nutrients and considered the intake of non-productive nutrients. In addition, the paper also discusses the application of multi-objective programming in the optimal design of dietary recipes. By introducing two objective functions of weight balance protein amino acid score and economic cost, the individualized meal planning is realized.

Through solving the model, a reasonable and economical meal plan is obtained, including a variety of ingredients and dishes, which reflects the diversity of diet and the consideration of nutrition collocation. These recipes not only help to improve the nutrition and health level of college students, but also provide a strong guarantee for the prevention of malnutrition.

To sum up, the study of this paper is of great significance for guiding college students to eat a reasonable diet and

prevent malnutrition and provides a useful reference for further research in related fields.

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