

Research on Fruit Recommendation Scheme Based on Delphi Hierarchical Analysis

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Abstract: With the rapid development of China's economy, the dietary quality of the population has improved significantly, but there is still a major problem of nutrient deficiency in the population intake. In this paper, a fruit recommendation scheme is proposed for the lack of minerals, vitamins and dietary fiber in the dietary structure of the fitness population in China. Based on the standard values of nutrient intake from fruits and vegetables by human body, the Delphi method is applied to determine the judgment indexes of recommended fruits for muscle building population and weight loss population, and then the hierarchical analysis of the ten most popular fruits in China under the indexes is carried out using yaahp platform, and finally the recommended comprehensive scores of the ten fruits are obtained. The results showed that the top five recommended fruits for both muscle building and weight loss were kiwi, cantaloupe, dates, mandarin oranges and pears, while kiwi was recommended for muscle building and cantaloupe for weight loss in order to achieve both nutrient supplementation and weight loss. The findings of this paper are of reference value for the nutritionally balanced diet of the fitness population and the selection of fruit consumption options for the general population.

Keywords: fitness population; Delphi method; hierarchical analysis; fruit recommendation

1 Introduction

Reasonable and balanced nutrition and proper physical activity are two important conditions for maintaining and promoting human health. For example, despite the time and intensity of fitness enthusiasts have reached the standard, but because of the nutrition and dietary mix is not reasonable, resulting in the desired fitness effect^[1], and physical fitness will consume a lot of micronutrients in the training process, fitness weight loss people in order to reduce weight effect is often accompanied by vitamins, dietary fiber and a variety of minerals intake inadequate phenomenon^[2]. The body will consume a lot of energy during the exercise process, along with the loss of water and trace elements, which will lead to endocrine disruption or dehydration without replenishment, and then the body's internal environment will change accordingly, affecting the normal acid-base balance of the body, and eventually the body will not be able to carry out metabolism^[3]. Therefore, micronutrient deficiencies and unbalanced nutritional intake can lead to a series of health problems, and the proposed effective fruit recommendation program can effectively improve the fruit intake of fitness people.

By analyzing the domestic and international literature, it can be seen that domestic scholar Wei Tanghong designed a fruit recommendation system using python language on the basis of collaborative filtering algorithm, and recommended fruits by analyzing users' historical purchase records to meet users' personalized needs^[4]. Xiao Qian, a scholar, designed a recommendation algorithm and finally realized a mixed recommendation system for fruit matching based on user behavior characteristics, and the results showed that it could effectively improve the quality of fruit matching recommendation^[5]. Gupta Garima, a foreign scholar, proposed a fruit recommendation system using a deep learning approach that takes into account the temporal dynamics of the fruit market, such as price fluctuations, fruit seasonality and quality changes that occur throughout the year, in order to improve the sales of retailers^[6]. A synthesis of the literature shows that none of the existing studies have proposed fruit recommendations based on nutritional composition for specific populations.

In this paper, to address the problem of nutrient deficiency in people with insufficient intake of fruits and vegetables, the judgment index of fruit recommendation is determined by Delphi method, which improves the objectivity and credibility of the index. The implementation of hierarchical analysis method using yaahp platform simplifies the calculation process and improves the calculation accuracy, and finally gives the fruit recommendation scheme for the fitness population with insufficient nutrient intake.

2 Modeling

2.1 Delphi hierarchical analysis

Delphi method is the expert survey method. Its general process is: after obtaining the opinions of experts on the issues to be predicted, the questions are organized and statistically recomposed, and then fed back to the experts to seek opinions again and make adjustments until a consensus is obtained. Through multiple information feedback, the final results can accurately reflect the basic views of experts and their understanding of the information, so the results have objectivity and high credibility.

The hierarchical analysis method is proposed to solve complex problems with multiple factors or decision problems combining qualitative and quantitative. The method is to combine quantitative data with qualitative data for decision criteria, followed by judging the relative importance among the measurement objectives through the expertise of experts and ensuring the consistency of importance among the objectives, thus giving the judgment matrix of each level and calculating the weight of each decision indicator, and using the indicator weights to find the order of merit of the evaluation scores of each solution, which can effectively find the optimal solution in those difficult to be solved by quantitative.

2.2 Selection of indicators for the fruit recommendation program

MAIGOO is a brand, knowledge, shopping guide, the essence of the core recommended by the majority of netizens and enterprises respected and loved by the industry portal. MAIGOO network based on the history of fruit cultivation, planting area and market circulation to obtain the top nine most popular fruits in China: apples, bananas, watermelon, citrus, peach, pear, kiwi, grape, date and Cantaloupe^[7]. Since it is difficult to ensure the consistency of judgment

with the judgment matrix order greater than nine in the hierarchical analysis method, In this paper, the top nine fruits in the MAIGOO ranking were selected for the study.

The human body requires more than 40 nutrients, of which six categories are the most important and are known as the six macronutrients, namely protein, lipids, carbohydrates, vitamins, minerals and water. Of these, carbohydrates, fats and proteins are present and consumed in larger amounts in foods and are called macronutrients, while vitamins and minerals are required in only small amounts in a balanced diet and are therefore called micronutrients[8].

Fruits and vegetables are the most important agricultural products rich in nutrients, mainly providing minerals, vitamins, and dietary fiber for the human body, so the main nutrients that the human body gets from fruits are classified into three main categories: minerals, vitamins, and dietary fiber. According to the standard values of minerals and vitamins required by human body from fruits and vegetables, the total mineral composition consists of calcium, selenium, sodium, iron and zinc, and the vitamin assembly is divided into vitamin A, vitamin B, vitamin C and vitamin E.[9]. The raw data of protein, carbohydrate, fat and the three major nutrients are obtained according to the Chinese food composition table, 6th edition, book 1. Fruits with low and similar fat content are not counted as indicators of investigation in this paper. Integrating the main nutrients required by the human body and the special needs of fitness people, five nutrients of protein, carbohydrate, dietary fiber, minerals and vitamins in fruits are selected as the selection indicators of fruit recommendation scheme in this paper.

2.3 Hierarchical model of fruit recommendation scheme

In this paper, using the Delphi method and related literature, the five main nutrients in fruits, including protein, carbohydrate, dietary fiber, minerals, and vitamins, are used as the selection indexes of the fruit recommendation scheme in this paper, and the types of fruits to be studied in this paper are determined. Adding the Delphi method to the process of judging the importance between the objectives by experts in the hierarchical analysis can enhance the objectivity and credibility of the judgment matrix and avoid the disadvantage that experts only reflect the majority view. Based on the complexity of many fruit component categories and combination recommendation, this paper combines Delphi method and hierarchical analysis to study a reasonable fruit recommendation scheme, where hierarchical analysis uses yaahp software to calculate the results.

Yaahp is a Hierarchical Analysis Process assistant software that provides assistance in model construction, calculation and analysis for the decision making process using Hierarchical Analysis. Using yaahp, the task of multi-criteria decision analysis by hierarchical analysis can be easily accomplished. The flowchart for implementing the fruit recommendation scheme design in yaahp is shown in Figure 1.

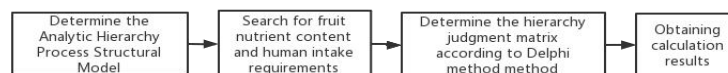


Figure 1. Flow Chart of Fruit Recommendation Scheme Design

3 Calculation of nutrient weights of fruits

The standard of daily intake of nutrients per capita for Chinese residents takes into account the amount of nutrients that a person takes in from all foods, while the nutrients taken in from fruits and vegetables only account for a small part of it, so to calculate the standard of the amount of nutrients that a person takes in from fruits and vegetables[7] , the total mineral composition of the recommended fruit index is divided into five parts: calcium, selenium, sodium, iron and zinc according to the mineral content in fruits. Vitamins are indispensable for maintaining the physiological functions of human metabolism, up to more than 30 kinds[9] . The total vitamin content in the recommended fruits is divided into four parts: vitamin A, vitamin B, vitamin C and vitamin E, according to the main vitamin content in fruits.

Since minerals and vitamins consist of several elements, this paper adopts a hierarchical analysis to calculate the weights of the total mineral and vitamin components in fruits.

3.1 Fruit weights based on mineral composition

The standard of per capita daily intake of nutrients for Chinese residents takes into account the amount of nutrients consumed from all foods, while the nutrients consumed from fruits and vegetables only account for a small part of it, so the standard of the amount of nutrients consumed from fruits and vegetables should be calculated. The adjustment coefficient indicates the human body's demand for minerals as a percentage of the intake from fruits and vegetables, and the higher the adjustment coefficient indicates that the human body takes in more mineral components from fruits and vegetables, and multiplied with the human mineral demand standard to get the standard of mineral intake from fruits and vegetables, see Table 1.[9]

Table 1. Human mineral intake standards from fruits and vegetables

Minerals	Adjustment factor	Human demand criteria	Standard intake from fruits and vegetables
Calcium	0.6	882.34	529.404
Iron	0.4	14.96	5.98284
Sodium	0.2	1983.04	396.6076
Zinc	0.2	15.4	3.08082
Selenium	0.1	46.45	4.64476

It is assumed that the intake of all minerals from fruits reaches the standard value of common intake of minerals in fruits and vegetables, then the higher the standard value of mineral intake in fruits and vegetables corresponds to the higher importance of the component. After normalizing the standard values of mineral intake from fruits and vegetables, the difference between two comparisons of minerals was obtained, and the difference was used to give a judgment matrix, and finally a scheme model was constructed in the yaahp platform and the final fruit score results were obtained, as shown in Figure 2.

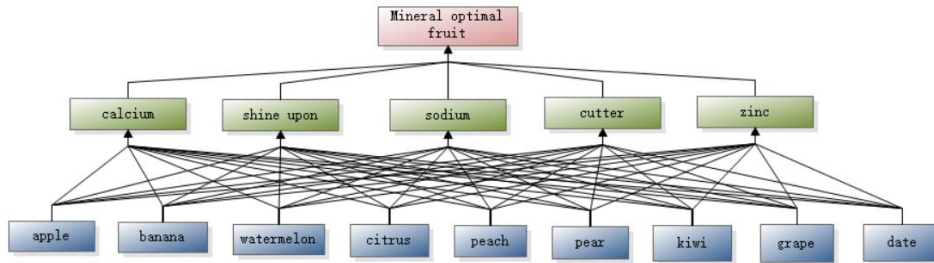


Figure 2. Fruit model of total mineral composition

3.2 Fruit weights based on vitamin composition

The higher the adjustment factor indicates that the human body's demand for vitamins in the proportion of intake of fruits and vegetables, the higher the adjustment factor indicates that the human body's intake of mineral components more from fruits and vegetables, multiplied with the human mineral demand standards to obtain the standard of mineral intake in fruits and vegetables, see Table 2.[9]

Table 2. Criteria for human vitamin intake from fruits and vegetables

Vitamins	Adjustment factor	Human demand criteria	Standard intake from fruits and vegetables
A	0.8	764.48	611.5808
B	0.5	1.315	0.66008
C	0.8	102.47	81.976
E	0.8	12.64	10.11104

Assuming that the intake of all vitamin components from fruits reaches the standard value of common vitamin intake in fruits and vegetables, the higher the standard value of vitamin intake in fruits and vegetables corresponds to a higher degree of importance, the standard value of vitamin intake from fruits and vegetables is normalized to obtain the difference between two comparisons of vitamins, and the difference gives the judgment matrix, and finally the program model is constructed in the yaahp platform and the final fruit The scoring results are shown in Figure 3.

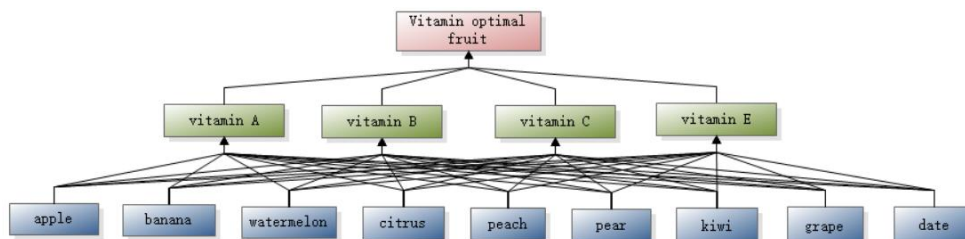


Figure 3. Fruit model of vitamin composition

4 based on the fitness crowd fruit recommendation program

Combining the content of protein, carbohydrates, dietary fiber in fruits and the total composition weights of minerals and vitamins of fruits obtained in Section 2, the nutrient composition data tables of ten fruits were derived as in Table 3.

Table 3. Nutritional composition data table of the ten most popular fruits

Fruit (100g)	Protein(g)	Carbohydrate(g)	Dietary fiber(g)	Mineral weights	Vitamin weights
Apple	0.4	13.7	1.7	0.0540	0.0708
Banana	1.4	22	1.2	0.0665	0.0676
Watermelon	0.5	6.8	0.2	0.0550	0.0858
Citrus	0.8	10.2	0.5	0.1632	0.2774
Peach	0.6	10.1	1	0.0565	0.0569
Pear	0.3	13.1	2.2	0.0552	0.0631
Kiwifruit	0.8	14.5	2.6	0.2917	0.1103
Grapes	0.4	10.3	1	0.0597	0.0637
Dates	1.1	30.5	1.9	0.1984	0.2045

Note: Mineral weight refers to the total weight of the five components of calcium, selenium, sodium, iron and zinc, and vitamin weight refers to the total weight of the four components of vitamin A, vitamin B, vitamin C and vitamin E.

Fruits and vegetables are the most important agricultural products rich in nutrients, mainly providing the body with minerals, vitamins, and dietary fiber[7], while the main sources of protein and carbohydrates are animal foods and cereals, so this paper gives higher weights to minerals, vitamins, and dietary fiber in fruits in the hierarchical analysis. The fitness purpose in the fitness population is roughly divided into muscle building and weight loss population, and the nutrients required for the two purposes are slightly different.

4.1 Fruit recommendation program based on muscle building population

For muscle building people, studies have shown that a 4:1 ratio of carbohydrates to protein after exercise is more effective in promoting body synthesis[10]. Fruits are not the main source of protein and carbohydrates required by fitness people, but mainly provide minerals, vitamins and dietary fiber for the body[7], so the weight of minerals, vitamins and dietary fiber in the fruit recommendation scheme for muscle building people is the largest, and they have the same weight between two, followed by carbohydrates and finally protein. This gives the hierarchical model of fruit recommendation scheme for muscle building population, as shown in Figure 4.

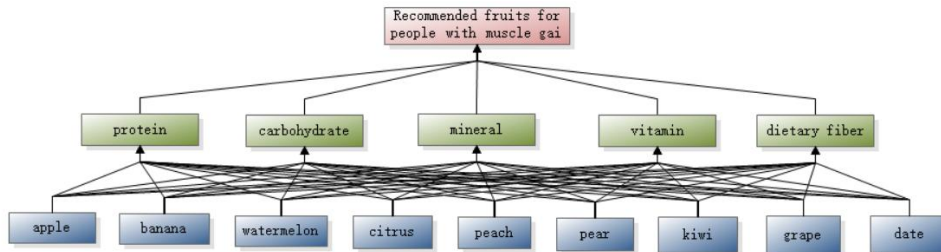


Figure 4. Hierarchical model of fruit recommendation scheme for muscle building population

4.2 Fruit recommendation scheme based on weight loss population

For people on a diet, moderate exercise and strict control of energy intake are necessary to achieve weight loss, so people on a diet with a lean body should choose fruits with low sugar content to eat[11] . Without controlling calorie intake, people on high protein diets can consume fewer calories than people on normal diets to achieve a certain weight loss effect[12] . Therefore, the weight of sugar content in the fruit recommendation scheme for weight loss people is the highest, followed by minerals, vitamins and dietary fiber, and the weight between them is the same, then protein, and finally carbohydrates, thus giving a hierarchical model of fruit recommendation scheme for weight loss people, as shown in Figure 5.

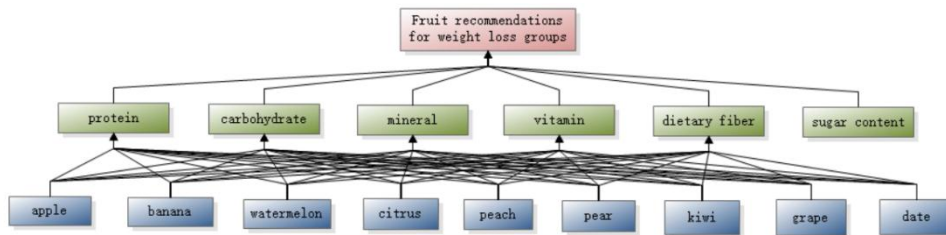


Figure 5. Hierarchical model of fruit recommendation scheme for weight-loss people

The raw data of protein, carbohydrate, dietary fiber and sugar content of each fruit were normalized, and the differences between the fruits were compared two by two, combined with Table 3 to implement the hierarchical analysis method through Yaahp platform and derive the fruit recommendation weights Table 4.

Table 4. Recommended weights of fruits for muscle building and weight loss population

Recommended fruits for muscle gainers	Recommended weights of fruits for muscle gainers	Recommended fruits for weight loss people	Recommended weights of fruits for weight loss people
Kiwifruit	0.2267	Kiwifruit	0.1847
Dates	0.2123	Citrus	0.1443
Citrus	0.1484	Dates	0.1289
Pear	0.1006	Pear	0.1091
Apple	0.0783	Watermelon	0.0986

Banana	0.0819	Apple	0.0935
Grapes	0.0540	Peach	0.0865
Peach	0.0528	Grapes	0.0864
Watermelon	0.0449	Banana	0.0679

As can be seen from Table 4, regardless of whether the fitness purpose is muscle building or weight loss, the top five recommended fruit weights to meet the nutritional needs of the fitness population are kiwi, cantaloupe, dates, citrus and pears, while kiwi is preferred for muscle building population to supplement nutrients and cantaloupe is preferred for weight loss population to achieve both nutrient supplementation and weight loss.

5 Conclusion

In this paper, based on the standard values of nutrient intake in fruits and vegetables, the Delphi method was applied to determine the indicators for judging the recommended fruits, and then the yaahp was used to conduct hierarchical analysis on the ten most popular fruits in China under the indicators, and finally the recommended weights of different fruits were calculated. The results showed that the top five recommended fruit weights to meet the nutritional needs of the fitness population, whether for muscle building or weight loss, were kiwi, cantaloupe, dates, mandarin oranges and pears, while kiwi was preferred for muscle building to supplement nutrients and cantaloupe was preferred for weight loss to achieve both nutrient supplementation and weight loss.

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