

Analytical Study on the Components of Health Products for Lowering Blood Glucose

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Abstract—Apriori algorithm was used to analyze 480 hypoglycemic health products for component association. Meanwhile, plain Bayesian algorithm was used to analyze the properties and flavors according to the *Chinese Pharmacopoeia* on the former basis. The results showed that chromium pyridinecarboxylate, magnesium stearate and Astragalus single ingredient played an important role on lowering blood glucose. The extracts of huangjing and mulberry leaf as well as coix seed and Chinese yam were highly correlated in the hypoglycemic health products. The ingredients of health products used to lower blood glucose are mainly pungent, warm and bitter medicines. This paper, can contribute to the research and application of health products and regulate the health products market according to the analysis of the valid ingredients of health products.

1 INTRODUCTION

People with hyperglycemia are generally middle-aged and even elder people after the age of 50. In recent years, the age trend of people with hyperglycemia is getting younger, and the number of young adults aged 30-35 suffering from hyperglycemia is gradually increasing. The reasons for this are as follows: Firstly, with the improvement of material life in China, the demand for food is getting higher and higher, and high-sugar and high-calorie food are popular among young people, so the number of people with hyperglycemia is also increasing and the age is getting younger and younger. Secondly, fasting is an important factor leading to high blood glucose [1]. Nowadays, at the fast-paced information age, young people have the diets hastily. Fasting has become a reason for young people to lose weight, which is also an important cause of high blood glucose.

Studies have shown that high blood glucose [2] can lead to various chronic complications in the organism, including diabetes, ischemic heart disease, cerebrovascular disease and chronic kidney disease, which will seriously affect human health. With the increasing awareness of health, it also promotes the development of health products market. In recent years, many hypoglycemic health products which have been favored by the public, have been introduced in the market for the prevention of diabetes and a series of complications [3]. From the perspective of TCM, hyperglycemia belongs to the category of achlorhydria, and people with hyperglycemia mainly have symptoms of polyphagia, polydipsia, polyuria, and loss of body mass. Chinese herbal medicines used for the health care of people with hyperglycemic need to be strictly reviewed and

conform to national standards. Different health products have different formulas with different combinations of corresponding ingredients. The Apriori algorithm can find the correlation between drug ingredients. Chinese herbal medicine can also reflect the importance among the health care products for lowering blood glucose., the ingredients can be screened and replaced by classifying the nature and taste of different health products through the plain Bayesian algorithm. And then, more valid health product formulas can be searched for to promote the development and application of health products.

2 DATA COLLECTION

For people with high blood glucose, many hypoglycemic health products have been developed and marketed. In this paper, we collected 480 kinds of health supplements that help to lower blood glucose in the current market from the State Drug Administration (<http://www.gov.cn>) through Internet technology, and analyzed the correlation between their ingredients by Apriori algorithm, so as to obtain the correlation of ingredients for treating high blood glucose, and provide data support for researching new and more efficient related drugs. Meanwhile, we collected the statistics of relevant ingredients by 2015 *The Chinese Pharmacopoeia* was also used to collect statistics on the properties and flavors of the relevant ingredients and to standardize their composition.

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3 HEALTH PRODUCT COMPOSITION CORRELATION

3.1. Introduction of Apriori algorithm

Apriori algorithm [4] is a type of correlation algorithm, Which is one of the top ten classical algorithms. It can correlate some common data, and then discover the hidden characteristics and extract more credible information. After the previous processing of the data in the data warehouse such as collection, scheduling and storage, the data is then classified in an intermediate layer by topic, and finally the required data is sorted out for data mining. The Apriori algorithm measures the impact of a certain set of elements on the event by the support degree. The confidence threshold [5], which can determine the confidence level of the results, is an important coefficient used to measure the correlation between sets.

The two item sets, frequent item set and the degree of support [6] are denoted as A and B, (A is not empty set, B can be empty set), R and support, and len denotes the count of these sets respectively. The interrelationships are shown in Equation (1).

$$\text{support}(A \rightarrow B) = \frac{\text{len}(A \rightarrow B)}{\text{len}(R)} \quad (1)$$

The confidence threshold can determine its trustworthiness [6]. For the sets with association rules, the

list RSS of support sets that meet the requirements is iterated, and the support set RS is iterated and the proportion of the i set in the i to t set is calculated for each pair that meets the conditions to obtain its confidence conf, and the interrelationship is shown in Equation (2).

$$\text{conf} = \frac{RS[i]}{RS[i-t]} \quad (2)$$

The entire iteration is controlled by the number of element occurrence frequency N, the minimum support min Support threshold of 0.01 and the minimum confidence min Conf [6] of 0.63 throughout the process, which in turn leads to the final result of the multi-value association.

3.2. Analysis of results

Among the 480 kinds of health products collected from the State Drug Administration and collated by data warehouse technology that help lower blood glucose, the data with frequencies greater than 10 appearances in the cell number collection were obtained by Apriori algorithm. The most ingredients are chromium picolinate, which appeared 123 times. The second and the third followed by magnesium stearate 103 times and astragalus 100 times respectively, and the frequencies in many flavors of medicines all reached 0.2. Other detailed data are shown in Table 1.

Table 1 Table of components with frequencies over 10 times

Name	Number	Frequency
Chromium picolinate	123	0.25625
Magnesium stearate	103	0.21458
Astragalus	100	0.20833
Bitter melon extract	74	0.15417
Mulberry leaves	73	0.15208
Yam	72	0.15
Ginseng	30	0.075
Microcrystalline cellulose	29	0.06667
Purified water	29	0.06667
Beeswax	25	0.06458
Yellow Essence	23	0.0625
Jade Bamboo	23	0.0625
Kudzu root	70	0.14583
Propolis	69	0.14375
Bitter melon	67	0.13958
Mulberry leaf extract	59	0.12292
Starch	58	0.12083
Goji berries	48	0.1
Gelatin	48	0.1
Glycerin	47	0.09792
Astragalus Extract	37	0.09167
American Ginseng	23	0.0625
Pueraria Mirifica Extract	18	0.06042
Zhi Mu	18	0.06042
Chromium yeast	14	0.05208
Titanium Dioxide	13	0.05208
American Ginseng Extract	13	0.05

Chromium-rich yeast	12	0.04792
Macrocephalus	12	0.04792
Ligustrum	11	0.04792
Salvia miltiorrhiza	10	0.04167

The above data were obtained by Apriori algorithm, in which 32 ingredients appeared with a frequency greater than or equal to 10. It can be obviously seen that the ingredients of chromium picolinate, magnesium stearate and astragalus play a positive therapeutic effect on the treatment of hyperglycemia.

The frequency and confidence level of occurrence of the association component [7] are often used as a measure to determine whether the joint component is effective. Through the association rule of Apriori algorithm, the set

with more than two components that occur more than 10 times is screened out as the association component of blood glucose reduction. Then, the frequency and confidence are compared and determined, and finally the set with the highest frequency of occurrence is identified and the confidence is compared. After calculation, the frequency of occurrence and confidence among the association components were presented in the form of a table, as shown in Table 2.

Table 2 Correlation table for sets with more than two components

Ex-items	Back items	Support Level (%)	Confidence (%)
Fenugreek	Astragalus	1.46	100
Flos Lobata Extract	Mulberry leaf extract	1.87	89.9
Job's Tears	Yam	1.46	87.43
Yam extract	Bitter melon extract	1.04	83.2
Ground Bark	Yam	1.46	78.07
Panax Ginseng Extract	Bitter melon extract	1.04	71.23
Radix et Rhizoma Dioscorea	Astragalus	1.04	71.23
Fenugreek	Bitter melon	1.04	71.23
Radix Rehmanniae Praeparata	Astragalus	1.04	71.23
Radix Rehmanniae Praeparata	kudzu root	1.04	71.23
Fenugreek	Astragalus, bitter melon	1.04	71.23
Raw Groundnut	Kudzu root	2.5	66.67

It can be concluded that fenugreek and astragalus with a confidence level of 100% and a frequency of 1.46% are the most reliable in treating hyperglycemia through Apriori algorithm. The extracts of huangjing and mulberry leaf have a confidence level of 89.9% and a frequency of 1.87%, and coix seed and Chinese yam was 87.43% and 1.46% respectively. As can be seen from Table 2, fenugreek and astragalus, the extracts of huangjing and mulberry leaf, and coix seed + Chinese yam are often used in combination to lower blood glucose in hypoglycemic health products. Classification by medicinal properties.

3.3. Introduction to the plain Bayesian algorithm

The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled. The plain Bayesian [8] algorithm is an algorithm used for classification. As one of the top ten classical algorithms, it is usually applied to classify unknown events based on known conditions. The classification can obtain the optimal classification results.

The data analysis by the plain Bayesian algorithm is the core with frequency of the events classification, which consists of two steps, training and classification. After training the data, the frequency of each component is calculated and the probability of each component is compared, and the component with the highest probability is the component that belongs to that thing.

A is noted as a event and B is the probability of each component of the event occurring in the whole process, and the relationship involved is shown in Equation (3).

$$P(B|A) = \frac{P(AB)}{P(A)} \quad (3)$$

In the data sample, it is divided into many samples, B₁, B₂, ..., and B_n, and each sample occurs with probability P(B₁), P(B₂), ..., and P(B_n), where P(B_i) > 0. The event A can be seen as an E event. P(A) is the full probability of the data sample [9], and the relationship between them is shown in Equation (4).

$$P(A) = P(A|B_1)P(B_1) + P(A|B_2)P(B_2) + \dots + P(A|B_n)P(B_n) \quad (4)$$

The full probability formula is designed to decompose a complex event into multiple simple events, and then after combining the individual events, the Bayesian formula can be obtained according to the full probability formula as shown in Equation (5).

$$P(B_i|A) = \frac{P(A|B_i)P(B_i)}{P(A)} \quad (5)$$

The principle of the plain Bayesian algorithm is to take the probability of occurrence of each small partitioned

sample in the sample data, and then take the most possible one as the target value.

3.4. Analysis of the five flavors of paired medicine components

The five flavors of TCM are pungency, sweetness, acid, bitterness, salty mildness [10]. The five flavors can mainly reflect the characteristics of the herbs in the configuration of medicines. The basic effects of the five flavors are summarized in the *Internal Classic* [11]. pungency is characterized by dispersion; acid, astringent; sweetness, moderation; bitterness, hardness; salty, softy. When making compatibility of medicines, we master the characteristics of the five flavors corresponding to the herbs can comprehensively and accurately grasp the special effects of the medicines. Since different flavors have a great influence on the configuration of drugs, this paper analyzes the five flavors among the ingredients of hypoglycemic medicines by researching of them. According to the 2015 *Chinese Pharmacopoeia* [12], we selected 424 medicines with herbal ingredients among the 480 collected blood glucose reduction products. regulated the medicine ingredients, and collated the five flavors of relevant medicine ingredients, including 99 Chinese herbal ingredients such as astragalus and mulberry leaf. According to these herbal ingredients, the five flavors of these ingredients were collected, in which those with relevant flavors were 1 and those not present were empty events. According to the frequency of occurrence of each ingredient and the presence or absence of related tastes was used as the weight of tastes, as shown in Figure 3. The weights corresponding to pungency, sweetness, acid, bitterness, salty mildness were 174, 839, 34, 561, 6 and 21, respectively.

Table 3 The weighting chart of some drugs by taste

	pungent	sweet	sour	bitter	salty	light
A	0.1034	0.0930	0.0000	0.2371	0.0000	0.0000
B	0.0000	0.0703	0.0294	0.2478	0.0000	0.0000
C	0.3966	0.0822	0.0000	0.1230	0.0000	0.0000
D	0.3966	0.3254	0.0000	0.3048	0.0000	0.0952
E	0.0057	0.0012	0.0000	0.1319	0.0000	0.0000
F	0.0000	0.0858	0.0000	0.2602	0.0000	0.0000
G	0.0000	0.0012	0.0000	0.0018	0.0000	0.0000
H	0.4023	0.2324	0.0000	0.0036	0.0000	0.0000
I	0.0000	0.1716	0.0294	0.1319	0.1667	0.0000
J	0.0000	0.2050	0.0000	0.1283	0.0000	0.0000
K	0.0000	0.0810	0.0000	0.0535	0.0000	0.0000
L	0.4023	0.3456	0.0294	0.1283	0.0000	0.0000

Herbal ingredients of every kinds of health products have a corresponding flavor. The five flavors of every kinds of health products were calculated according to the plain Bayesian algorithm. the flavor with the greatest frequency was taken as the flavor of the health product after the calculation, and finally all the health products were counted.

According to the classification of each health product by plain Bayesian algorithm, the frequency of pungency is 118 and the probability is 27.8%; sweetness, 48and 11.3%; acid, 51 and 12.0%; bitterness, 129 and 30.4%; salty, 26

and 6.1%; mildness, 52and 12.3%. they are as shown in Table 3.

4 CONCLUSIONS

As the pace of life accelerates and work pressure increases, more and more people have developed a high glucose and high calorie diet, which has led to an increasing number of people with hyperglycemia. As the health consciousness of people increasing, various kinds of health supplements are then pushed to the market. We analyzed 480 kinds of

hypoglycemic supplements and found that chromium pyridinecarboxylate, magnesium stearate and astragalus are the most common single ingredients. The combinations of fenugreek and astragalus, the extract of Huangjing and mulberry leaf, as well as coix seeds + Chinese yam were used most frequently to lower blood glucose. The conclusion can help manufacturers to improve the formulation of health products, develop new health food products and promote them to the market. The aim is to achieve the effective prevention of hyperglycemia.

After analyzing the herbal ingredients of hypoglycemic supplements, it was found that pungent warm and bitter medicines accounted for more than half of the total. According to these studies, it can be found that pungent warm and bitter medicines play an important role in lowering blood glucose.

Through the research of the paper, we hope to provide better theoretical support for the development and application of hypoglycemic health products, help the people with hyperglycemic, regulate the health products market which hope to promote the development of medical health care.

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