Research on brand value based on analytic hierarchy process and fuzzy comprehensive evaluation

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Abstract. Based on the continuous deepening of brand strategy concepts in recent years, improving brand value has become a top priority. This article uses Xingtai wild jujube as an example to use the analytic hierarchy process to evaluate the brand value of Xingtai wild jujube from four aspects: product quality, brand support, product leadership, product profitability, and its subordinates 10 indicators; and use the fuzzy comprehensive evaluation method to calculate the evaluation score of Xingtai wild jujube, draw conclusions and make suggestions for the future development of Xingtai wild jujube.

1. Introduction
Xingtai is located in the south central part of Hebei Province, The western mountains of Xingtai City is the largest and best yielding area of sour dates in China today, with 33,300 hectares of wild sour dates and more than 4,000 hectares of artificial cultivation. In recent years, Xingtai has developed a scientific development strategy to synergize ecological environment and economic development, fully grasp the geographical advantages of the region, and promote the development of Xingtai's sour date industry with a market-oriented approach. The core issue in the development of the Xingtai sour date industry is to create a brand for this agricultural product. Product branding is the core competitiveness and an important symbol of agricultural modernization, and a strong brand represents a strong agriculture [1-3]. The construction of agricultural brands should be strengthened, and the construction of agricultural brands should be elevated to a height in terms of will, concept and strategy. The development of agricultural brands is conducive to driving agriculture to achieve scale, standardization, specialization and industrialization, which is conducive to improving agricultural efficiency, ensuring the quality and safety of agricultural products, enhancing market competitiveness, and promoting the concentration of agricultural production to advantageous regions and industrial structure [4]. From the perspective of brand development of agricultural products, in addition to the need to rely on the government, multimedia and other marketing channels to support the force also need to strive to improve the quality of products to expand the market share of products to improve the visibility of product brands and other factors. The degree of importance of each indicator factor on the construction of agricultural brands needs to be studied using AHP analysis.
2. AHP and construction of evaluation index system

2.1. AHP and Procedures
The basic principle of the AHP is to decompose the problem into different components according to the nature of the problem and the overall goal to be achieved, and according to the interrelationship between the factors and the affiliation relationship, the factors are aggregated and combined at different levels to form a multiple A hierarchical analysis structure, so that the problem is ultimately reduced to the determination of the relative importance of the lowest level (plans, measures, etc. for decision-making) relative to the highest level (the overall goal) or the order of relative superiority and inferiority.

2.2. Using the analytic hierarchy process to analyze the brand value of Xingtai Jujube as the following steps

2.2.1. Construction of an evaluation index system
Specifically, in the construction of the agricultural product brand evaluation index system taking Xingtai wild jujube as an example, the product quality, brand support, brand leadership, and brand profitability shall prevail [5], Analyze the influence weights of these four indicators relative to the decision-making goals, and then analyze ten sub-criteria such as nutritional quality, product quality, hygiene quality, government support, marketing channel investment, market share, product popularity, premium ability, development ability, and management ability The influence weights of indicators in the level on the criterion level and the influence weights on the decision-making goals comprehensively reflect the factors affecting brand value from a multi-dimensional perspective. The constructed Xingtai Jujube brand value evaluation index system is shown in the figure below:

![Figure 1. Xingtai Jujube Brand Value Evaluation Index System](image)

2.2.2. Construct a comparison matrix of factors affecting brand value and the weight of each indicator
After the hierarchical structure model is established, the indicators in the criterion layer are compared in pairs, and then the indicators in the sub-criteria layer are compared in pairs, and the matrix is defined in accordance with the 1-9 scaling method proposed by Professor Satie. Sexual judgment.

(1) According to expert advice, compare the four first-level indicators of product quality, brand support, brand leadership, and brand profitability, and assign weights and form the following judgment matrix:

\[
A = \begin{pmatrix}
1 & 5 & 2 & 2 \\
1/5 & 1 & 1/3 & 1/4 \\
1/2 & 3 & 1 & 1/2 \\
1/2 & 4 & 2 & 1
\end{pmatrix}
\]
The rows and columns in the matrix correspond to the four indicators of product quality, brand support, brand leadership, and brand profitability. The weights are obtained through pairwise comparison, that is, the ranking weights of the elements in the first intermediate layer to the decision goals [6]. Among the four indicators, product quality ranks first with a weight of 0.4393, brand profitability ranks second with a weight of 0.2944, brand leadership ranks third with a weight of 0.1925, and brand support ranks fourth. The proportion is 0.0738. The consistency ratio of the judgment matrix CR = 0.0212 < 0.1, passing the consistency test, the weight of the brand value evaluation is 1.00; $\lambda_{\text{max}} = 4.0566$.

(2) According to the expert advice, sort and judge the consistency of the sub-criteria level indicators of nutrition quality, commodity quality, and hygiene quality under the product quality criteria level to form the following matrix:

\[
B_1 = \begin{bmatrix}
1 & 1/2 & 1/4 \\
2 & 1 & 1/2 \\
4 & 2 & 1
\end{bmatrix}
\]

The indexes corresponding to the rows and columns in the matrix are nutritional quality, product quality, and hygiene quality. The weights are obtained by comparing two of the three indexes under the secondary product quality, and the weight of hygiene quality ranks first in product quality. Is 0.5714, the second-ranked product quality is 0.2857, and the third-ranked nutritional quality is 0.1429. The consistency ratio of the judgment matrix CR = 0.00 < 0.1, so the weight coefficient of the brand value evaluation through the consistency test is 0.4393, and $\lambda_{\text{max}} = 3.00$.

Same as above, according to the expert’s suggestion, the two indicators of marketing channel investment and government support under the three-level indicator of brand support are compared, and the two indicators are ranked and consistent to form the following matrix:

\[
B_2 = \begin{bmatrix}
1 & 1/4 \\
4 & 1
\end{bmatrix}
\]

Among the weights obtained by comparison, the weight of government support is 0.2, and the weight of marketing channel investment is 0.8. The consistency ratio of the judgment matrix CR = 0.00 < 0.1, passing the consistency test, the weight coefficient for brand value evaluation is 0.0738, and $\lambda_{\text{max}} = 2.00$.

In brand leadership, according to the suggestions given by experts, compare its index market share and product popularity to obtain the weight of the two indicators and the weight of the brand value. The result of the expert comparison and scoring forms the matrix as follows:

\[
B_3 = \begin{bmatrix}
1 & 2 \\
1/2 & 1
\end{bmatrix}
\]

The consistency ratio of the judgment matrix CR = 0.00 < 0.1, so through the consistency test, the weight coefficient for brand value evaluation is 0.1925, $\lambda_{\text{max}} = 2.00$.

Finally, the three sub-indexes in the profitability of the second-level brand profitability are compared and sorted by scoring and ranking of the premium capabilities, operating capabilities and development capabilities of the three sub-indexes.

\[
B_4 = \begin{bmatrix}
1 & 4 & 4 \\
1/4 & 1 & 1/2 \\
1/4 & 2 & 1
\end{bmatrix}
\]

The rows and columns of the judgment matrix are premium capacity, operating capacity, and development potential. The premium capacity has the highest weight of 0.6608, followed by development capacity of 0.2081, and finally operating capacity, which accounts for 0.1311. The
The consistency ratio of the judgment matrix is CR=0.0516<0.1. Through the consistency test, the weight coefficient for brand value evaluation is 0.2944, and $\lambda_{\text{max}}=2.00$.

**Table 1.** The sub-criteria layer's ranking weights for the decision goals obtained. The specific weight data is shown in the following table.

| Criterion-level indicators | Weights | Sub-criteria level indicators | Weights | The weight of the sub-level to the decision goal |
|----------------------------|---------|-------------------------------|---------|-----------------------------------------------|
| Nutritional quality        | 0.1429  | Commodity quality             | 0.2857  | 0.1255                                       |
| Hygienic quality           | 0.5714  | Hygienic quality governmental support | 0.2     | 0.0148                                       |
| Marketing channel investment | 0.8     |                                    |         | 0.0591                                       |
| Market share               | 0.667   | Product visibility             | 0.333   | 0.0642                                       |
| Premium ability            | 0.6608  | Premium ability                | 0.333   | 0.1945                                       |
| Management capacity        | 0.1311  | Development potential          | 0.2081  | 0.0613                                       |

It can be seen that for the research on the brand value of Xingtai Jujube, the influence of each index of the sub-criteria level on the decision-making goal is ranked as follows: hygiene quality, premium ability, market share, product quality, product awareness, Nutritional quality, development potential, investment in marketing channels, operational capabilities, and government support.

3. **Fuzzy comprehensive evaluation**

Fuzzy-level comprehensive evaluation method is a comprehensive evaluation method that combines fuzzy comprehensive evaluation method and analytic hierarchy process. It can analyze both quantitative indicators and qualitative indicators at the same time. Combine the fuzzy comprehensive rating method with the analytic hierarchy process, use the analytic hierarchy process to determine the weight, and then use the fuzzy comprehensive evaluation to transform the qualitative evaluation into the quantitative evaluation according to the membership theory of fuzzy mathematics to determine the evaluation effect.

The specific evaluation steps are as follows:
1. Establish a set of factors for fuzzy evaluation:
   The factor set $U$ is divided into four subsets according to attributes: product quality, brand support, brand leadership, and brand profitability $\{U_1, U_2, U_3, U_4\}$.
2. Make a first-level judgment
   (a) Construct a fuzzy evaluation matrix: $A=\{0.45,0.29,0.19,0.07\}$
   $A_1=\{0.14,0.29,0.57\}$  $A_2=\{0.2,0.8\}$  $A_3=\{0.67,0.33\}$  $A_4=\{0.66,0.13,0.21\}$
   (b) Establish the index comment set $V=\{V_1,V_2,V_3,V_4\}=\{\text{strong, stronger, medium, weak}\}$
(c) Judge each index in U1-U4 according to the standard value and comment set of the above-mentioned evaluation index system, obtain the fuzzy evaluation matrix, and conduct the first-level comprehensive evaluation

\[
R_1 = \begin{pmatrix}
0.33 & 0.32 & 0.25 & 0.10 \\
0.27 & 0.35 & 0.31 & 0.07 \\
0.32 & 0.30 & 0.32 & 0.06 \\
\end{pmatrix}
\]

\[
R_2 = \begin{pmatrix}
0.15 & 0.2 & 0.25 & 0.4 \\
0.10 & 0.15 & 0.25 & 0.5 \\
\end{pmatrix}
\]

\[
R_3 = \begin{pmatrix}
0.3 & 0.3 & 0.2 & 0.2 \\
0.1 & 0.1 & 0.3 & 0.5 \\
\end{pmatrix}
\]

\[
R_4 = \begin{pmatrix}
0.2 & 0.2 & 0.25 & 0.35 \\
0.3 & 0.3 & 0.27 & 0.13 \\
0.35 & 0.34 & 0.24 & 0.07 \\
\end{pmatrix}
\]

\[
B_1 = A_1 \times R_1 = (0.30, 0.32, 0.31, 0.07) \\
B_2 = A_2 \times R_2 = (0.14, 0.14, 0.28, 0.44) \\
B_3 = A_3 \times R_3 = (0.13, 0.18, 0.25, 0.43) \\
B_4 = A_4 \times R_4 = (0.24, 0.24, 0.25, 0.27)
\]

Perform a secondary comprehensive evaluation of the brand

\[
B = A \times R = \begin{pmatrix}
0.30 & 0.32 & 0.31 & 0.07 \\
0.14 & 0.14 & 0.28 & 0.44 \\
0.13 & 0.18 & 0.25 & 0.43 \\
0.24 & 0.24 & 0.25 & 0.27 \\
\end{pmatrix}
\]

In the corresponding comment set V={V1,V2,V3,V4}={strong, strong, medium, weak}, assign specific scores to each comment set, 4, 3, 2, and 1, respectively, and get the final fraction

\[
F = B \times (4, 3, 2, 1)^T = (0.22, 0.23, 0.29, 0.07) \times (4, 3, 2, 1)^T = 2.41
\]

\[
F_1 = B_1 \times (4, 3, 2, 1)^T = 2.85 \\
F_2 = B_2 \times (4, 3, 2, 1)^T = 1.98 \\
F_3 = B_3 \times (4, 3, 2, 1)^T = 1.99 \\
F_4 = B_4 \times (4, 3, 2, 1)^T = 2.45
\]
Using FUZZY software for data input and result export, the brand evaluation score of 2.41 can be obtained by assigning values of 4, 3, 2, and 1 to the rubric set, and the result corresponds to a medium to high rubric set. The scores of four indicators affecting brand value, namely product quality, brand support, brand leadership and brand profitability, are 2.85, 1.98, 1.99 and 2.45 respectively. From the scores of these four indicators, we can see that product quality has the highest score, which means that Xingtai sour dates are outstanding in terms of nutritional value and quality of products, so we can make use of the advantages of this aspect to shape the value of the brand and create special agricultural products. The brand has the next highest profitability score, indicating that the potential upside is relatively large and the development potential is strong. To improve the business capability of the company, the level of overall competitiveness of the product will be further enhanced. The product support and leadership of Xingtai sour dates are weak, especially in marketing channel investment, market share and visibility, so efforts should be made to develop the market to improve visibility and enhance the leadership of the product.

4. Conclusions
In recent years, the county government has attached a great importance to the development of the sour date industry, and although farmers are encouraged to plant sour dates to expand the sour date planting area, the development of the sour date industry is not sufficiently standardized, and the sales channels are narrow. Therefore, from the above analysis of the advantages and disadvantages of Xingtai jujube industry development, in order to implement brand construction, the strategic implementation of brand strategy needs to be constructed, to continue to strengthen the government's support for Xingtai jujube industry, to accelerate the construction of infrastructure, to integrate resources, to guide the elements to the jujube industry, to bring advantages for the development of jujube, to develop industry policies to promote the development of industry with the government's leading role, under the government's guidance. The government has also taken the lead in promoting the brand of Xingtai jujube online and offline to raise the awareness of Xingtai jujube and make it a special industry out of Xingtai. At the same time, we attract capital and technology to improve the production technology of jujube, breed excellent varieties, expand the planting area of high-quality jujube to increase the production of jujube, establish the quality tracing system, realize the green development of jujube, make jujube from planting to sales fully monitorable, controllable and traceable, extend the industrial chain to deep processing of jujube, make the product present multi-level, accelerate the integrated development of production, processing and marketing, in order to expand the market share of Xingtai jujube. The market share of Xingtai jujube products can be increased to improve the recognition of brand products.

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