

# Multivariate Analysis Results on a Questionnaire Investigation for Rare Sugars

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## Abstract

The Rare Sugars exist naturally and have many kinds (more than 50). They have good effect for health such as prevention of increasing the blood-sugar level after eating, suppression of fat accumulation, suppression of increasing the blood pressure, and anti-oxidative effect etc. It is in the spotlight for many people especially for those who are in the metabolic syndrome. There are few related papers concerning the marketing research and its utilization of this matter. In this paper, a questionnaire investigation is executed in order to clarify consumers' current condition and their consciousness, and to seek the possibility of utilizing the Rare Sugars. Such multivariate analysis as Factor Analysis and Multi Correspondence Analysis are executed based on that. Some interesting and instructive results were obtained.

**Keywords:** the rare sugars, consumer, multivariate analysis, factor analysis, multi correspondence analysis

## 1. Introduction

The Rare Sugars' study has launched on 1980<sup>th</sup> by Professor Takeshi Izumori (Kagawa University). The way to the mass production was developed by the method of enzymatic reaction. The International Society of Rare Sugars was established in 2001. Local government of Kagawa Prefecture comes to assist this research activity on this big innovation newly born in Kagawa Prefecture. The Rare Sugars have advantage that a blood-sugar level does not increase so much after eating, in spite of it being a sugar. And it also holds the upturn of the blood pressure. Therefore it is expected as a new functional material for the prevention of metabolic syndrome.

By the way, one kind of the Rare Sugar D-psicose has the following characteristics.

- ① a sweetening made by the natural starch
- ② non calorie and its sweetness is 70% to those of sugar
- ③ organoleptic property of coolness and sharpness in taste

Many medical research papers are published on the Rare Sugars as follows.

Analysis of the function of D-psicose; Hossain et al., 2011, Hayashi et al., 2010, Iida et al., 2010

Analysis of the function of D-allose; Yamada et al., 2012, Kajikawa et al., 2010, Hirata et al., 2009

On the other hand, these are few papers analyzed by the viewpoint from consumers. The Rare Sugars is good for the health and is sold in the market as a sweetening, seasoning or functional ingredient for food.

In this paper, a questionnaire investigation is executed in order to clarify the recognition level among consumers and to pursue the future possibility of the Rare Sugars. Such multivariate analysis as Factor Analysis and Multi Correspondence Analysis are conducted. The following three main issues are set.

- A) Those who have interest in the Rare Sugars have also interest in health.
- B) Those who do not know the Rare Sugars feel anxiety for them.

C) Generally, female have much more interest in the Rare Sugars than male.

Then, 7 sub issues are set and hypothesis testing is executed.

The rest of this paper is organized as follows. In section 2, outline of the questionnaire investigation and its basic statistical results are exhibited. After that, multivariate analyses are performed in section 3, which is followed by the remarks of section 4.

**2. Outline and the Basic Statistical Results of the Questionnaire Research**

*2.1 Outline of the Questionnaire Research*

A questionnaire investigation is executed in order to clarify the recognition level among consumers and to pursue the future possibility of the Rare Sugars. The outline of the questionnaire research is as follows. The questionnaire sheet is attached in Appendix.

- (1) Scope of investigation : Students of Kagawa Junior College
- (2) Period : April – June 2015
- (3) Method : Leave until called for
- (4) Collection : Number of distribution 186  
 Number of collection 186 (collection rate 100.0%)  
 Valid answer 186

*2.2 Basic Statistical Results*

Now, we show the main summary results by single variable.

**(1) Basic characteristics of answerers**

Q32 Sex

	Frequency	%
Male	19	11
Female	154	89
Total	173	100

Q33 Age

	Frequency	%
-19	139	80.3
20-19	33	19.1
30-19	0	0
40-49	0	0
50-59	1	1
60-	0	0
Total	173	100

Q34 Occupation

	Frequency	%
Student	171	98.8
Officer	0	0
Company Employee	0	0
Clerk of Organization	0	0
Independents	0	0
Part timer	0	0
Housewife	1	0.6
Not Filled in	1	0.6
Total	173	100

Q25 Do you take interest in a diet?

	Frequency	%
Think it very much	65	38.0
Slightly think so	52	30.4
Cannot say either	24	14.0
Slightly do not think so	15	8.8
Do not think so	15	8.8
Total	171	100

Q26 Are you careful for the health?

	Frequency	%
Think it very much	21	12.2
Slightly think so	64	37.4
Cannot say either	65	38.0
Slightly do not think so	15	8.8
Do not think so	6	3.5
Total	171	100

As is shown in the above-mentioned table, female students take the majority, therefore 70% of them have interest in diet and nearly half of them are careful for the health.

(2) Summary result for the main items

A. Q1 Do you know the Rare Sugars?

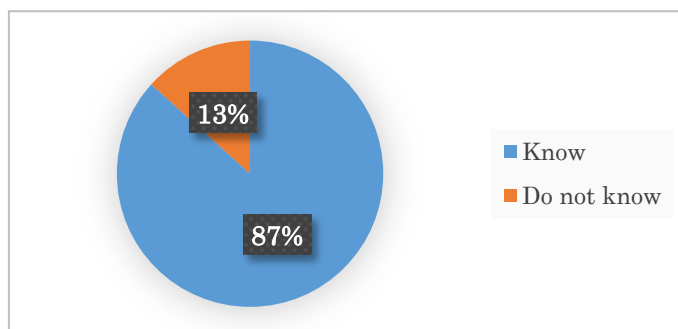


Figure 2.1 Q1 Do you know the Rare Sugars?

Nearly 90% of them knew the Rare Sugars.

B. Q6 Have you drunk or eaten the food in which the Rare Sugars are included?

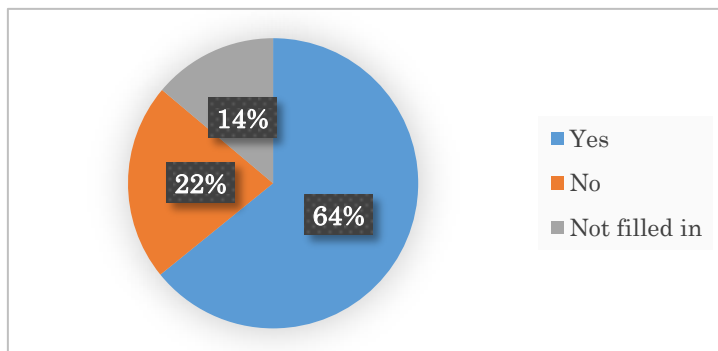


Figure 2.2 Q6 Have you drunk or eaten the food in which the Rare Sugars are included?

Nearly 2/3 of them answered that they have experienced the Rare Sugars.

C. Q7 Was the Rare Sugar effective after using it for more than one month?

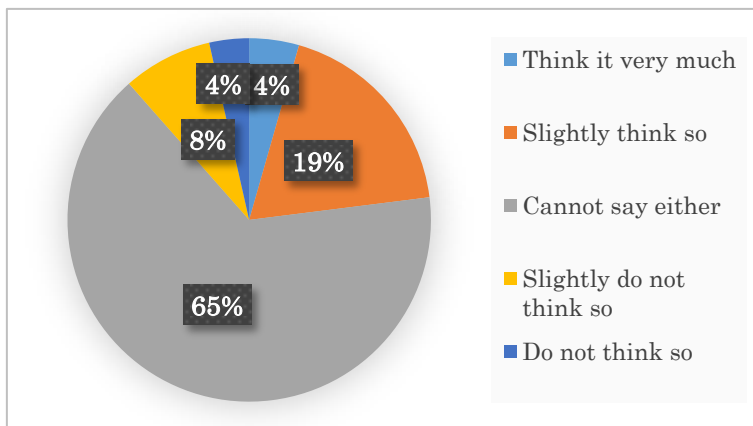


Figure 2.3 Q7 Was the Rare Sugar effective after using it for more than one month?

23% answered that the Rare Sugar was effective after using it for more than one month. On the contrary, 12 % said that it was not effective. While 2/3 have chosen “cannot say either”. They cannot grasp the distinct effect in the short time usage.

D. Q8 Do you want to try to eat or drink the food in which the Rare Sugar is included?

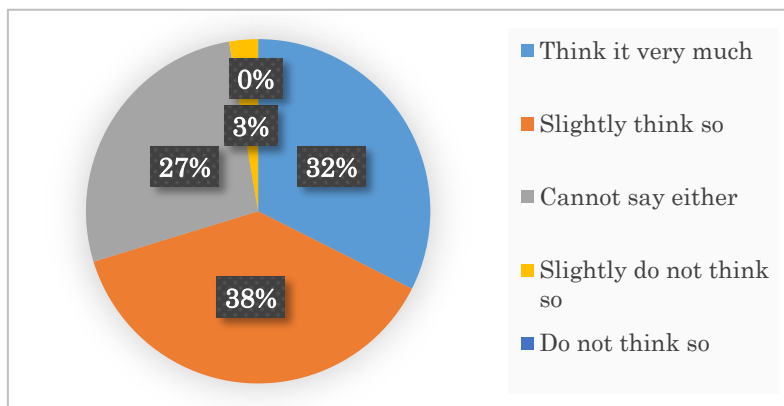


Figure 2.4 Q8 Do you want to try to eat or drink the food in which the Rare Sugar is included?

Nearly 70% of them answered that they want to eat or drink the food in which the Rare Sugar is included.

E. Q10-15 How do you want to use the Rare Sugar?

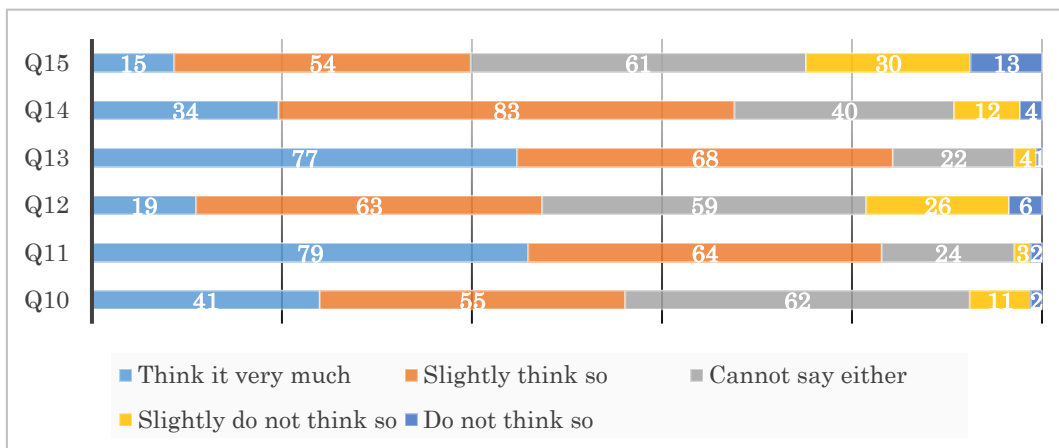


Figure 2.5 How do you want to use the Rare Sugar?

Consumers want to use the Rare Sugar in various aspects such as “as a supplement”, “can easily use it with a recipe”, “as a tool for treatment” and “in the cooking”.

F. Q16-22 Anxiety in using the Rare Sugar

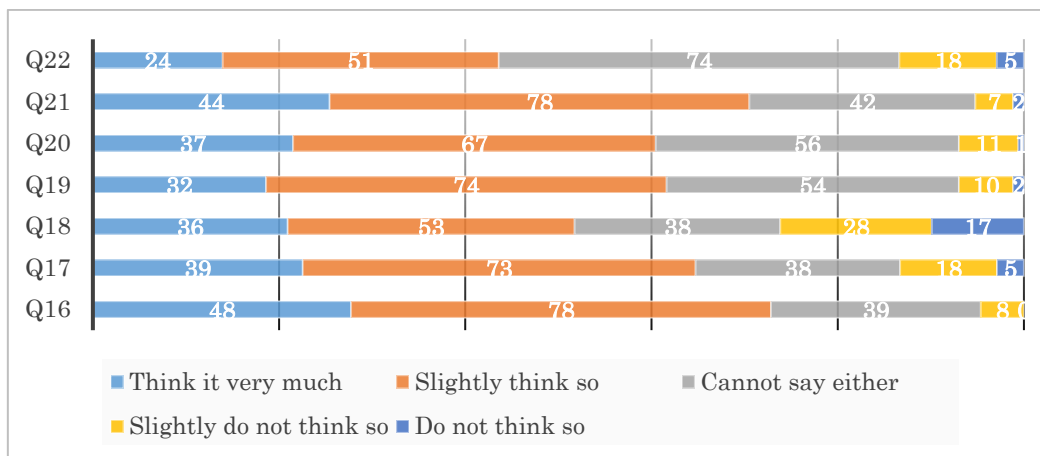


Figure 2.6 Q16-22 Anxiety in using the Rare Sugar

They feel anxiety in using the Rare Sugar because “Not so popular”, “Cannot find food in the shop”, “Seems to be expensive”, “Cannot have confidence that it is safe for anybody” and “Surrounding people do not use it so often”. These imply that the suppliers should dispatch much more information which removes the anxiety consumers hold.

**3. Multivariate Analysis**

**3.1 Factor Analysis**

Factor Analysis is executed. As for the extraction method of the factor, “Maximum-Likelihood Method” is adopted, and as for the rolling-method, “Promax Rotation which is accompanied by the normalization of Kaiser as orthogonal rotation” is adopted. Also, we confirmed the validity of the model in the KMO (Kaiser-Meyer-Olkin measure) specimen validity measure. When the value is more than 0.8, it is said meritorious, more than 0.7 middling, more than 0.6 mediocre. Bartlett’s test of sphericity is executed as well. If the score is less than 0.05, then it is said that there is a correlation among observation variables.

(1) Q10-15 :How do you want to use the Rare Sugar?

Factor Analysis is conducted on Q10 through Q15. KMO measure is 0.587 and Bartlett Score is 0.000.

We can confirm an appropriate common factor (Table 3.1).

Table 3.1 KMO measure and Bartlett Score

KMO measure		0.587
Bartlett sphericity test	Approximate $\chi^2$	154.202
	Degree of freedom	15
	Significance probability	0.000

From the Factor Matrix after Rotation (Table 3.2), we can extract two meaningful axes. Summary of the factor loading value is 40.615%. We can see that the first axis is the factor about “Using cooking” as the score for “Want to use in the cooking” and “Can easily use it if there is a recipe” are high. Second axis is the factor about “Collecting Information” as the score for “Want to know where I can buy it because I want to use it as a seasoning”, “Want to know how long I should use it in order to confirm the effectiveness” and “Want to know the hospital where the Rare Sugar is used as a tool for treatment” are high.

Table 3.2 Factor Matrix after Rotation (Pattern matrix)

	Factor		
	1	2	
Q10	.617		-.021
Q11	.887		-.095
Q12	.034		.641
Q13	.375		.351
Q14	.003		.576
Q15	-.132		.485

Figure 3.1 shows the Factor Plotting in Factor Space

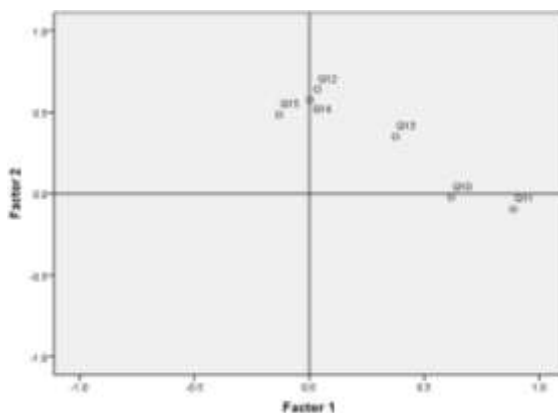


Figure 3.1 Factor Plotting in Factor Space

Correlation between two factors is 0.062 and we can assume that each factor is independent.

(2) Q10-15 without Q13: How do you want to use the Rare Sugar?

Factor loading value of Q13 was less than 0.4. Therefore, analysis is executed without Q13. KMO

measure is 0.546. It was nearly the same with before. Bartlett Score is 0.000. We can confirm an appropriate common factor (Table 3.3).

Table 3.3. KMO measure and Bartlett Score

KMO measure		0.546
Bartlett sphericity test	Approximate $\chi^2$	112.190
	Degree of freedom	10
	Significance probability	0.000

From the Factor Matrix after Rotation (Table 3.4), we can extract two meaningful axes. Summary of factor loading value is 45.907%.The meaning of both axes is nearly the same with before. We can see that the first axis is the factor about “Using cooking” as the score for “Want to use in the cooking” and “Can easily use it if there is a recipe” are high. Second axis is the factor about “Collecting Information” as the score for “Want to know where I can get information because I want to use it as a supplement”, “Want to know how long I should use it in order to confirm the effectiveness” and “Want to know the hospital where the Rare Sugar is used as a tool for treatment” are high.

Table 3.4 Factor Matrix after Rotation (Pattern matrix)

	Factor		
	1	2	
Q10	.551		.033
Q11	.998		-.015
Q12	.056		.572
Q14	.042		.574
Q15	-.078		.573

Figure 3.2 shows the Factor Plotting in Factor Space

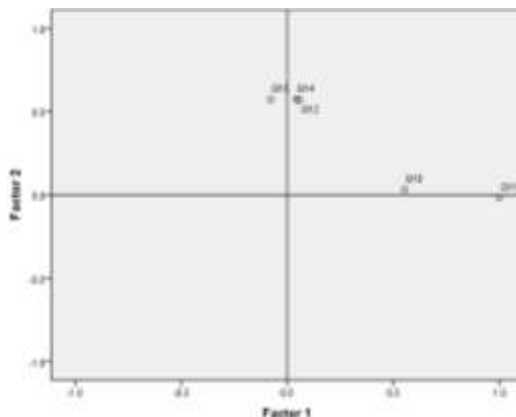


Figure 3.2 Factor Plotting in Factor Space

Correlation between two factors is  $-0.076$  and we can guess that each factor is independent.

### 3.2 Multi Correspondence Analysis

Now, we execute the Multi Correspondence Analysis. We made two way of analysis as follows.

- Q10-15 How do you want to use the Rare Sugar?
- Q16-22 Anxiety in using the Rare Sugar

#### (1) Q10-15: How do you want to use the Rare Sugar?

We can observe the following result from Figure 3.3. From the data, an eigenvalue of Dimension 1 axis is  $0.427$  and those of Dimension 2 is  $0.351$ .

We can extract 4 clusters. We can assume that the first cluster (Right Upper ) shows“ collecting information in use” ( “want to know where I can get information because I want to use it as a supplement”, “can easily use it if there is a recipe”). The second one (Lower Right) would mean “corresponding place in usage” (“want to know the hospital where the Rare Sugar is used as a tool for treatment”, “want to know where I can buy it because I want to use it as a seasoning”).

The third and fourth one are independent items (“want to use it in the cooking” and “want to know how long I should use it in order to confirm the effectiveness”). These mean “arrangement of surroundings” and “means to get information”.

Thereby we can guess that the horizontal axis is an axis about “collecting information” and the vertical axis is that of “attitude in usage”.

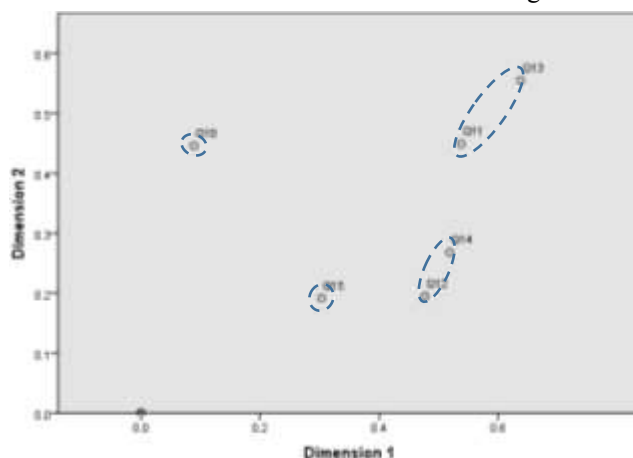


Figure 3.3 Multi Correspondence Analysis for Q10-15

#### (2) Q16-22: Anxiety in using the Rare Sugar

We can observe the following result from Figure 3.4. From the data, an eigenvalue of Dimension 1 axis is  $0.583$  and those of Dimension 2 is  $0.414$ .

We can extract 4 clusters. We can assume that the first cluster (Right Upper ) shows“ anxiety in usage” (“it seems to be expensive”, “cannot have confidence that it is safe for anybody”, “surrounding people do not use it so often”, “cannot find food in the shop”).

The second, third and fourth one are independent items (“cannot grasp the concrete effect”, “cannot guess how I should use the Rare Sugar to what kind of cooking” and “It is not so popular”).

These are the “vague question points”.

Therefore we can guess that the horizontal axis is an axis about “anxiety” and the vertical axis is that of “question points”.

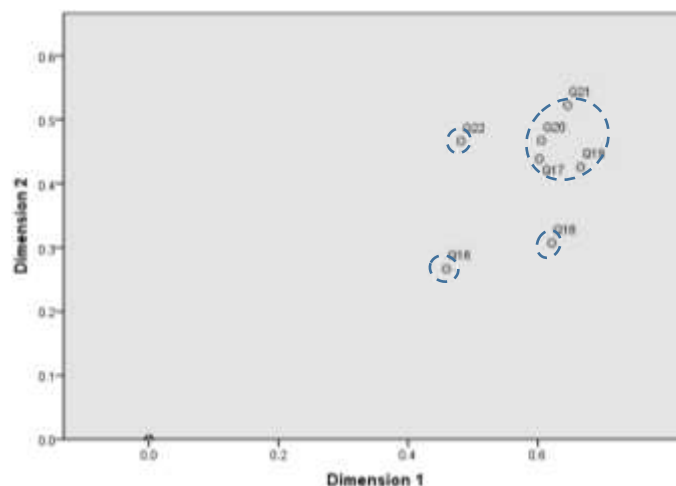


Figure 3.4 Multi Correspondence Analysis for Q16-22

#### 4. Remarks

In the Factor Analysis, we made the analysis on Q10-15 “How do you want to use the Rare Sugar?” and extracted two such meaningful axes as: “Use in cooking” and “Collecting Information”. On the other hand the analysis of Q10-15 without Q13 had a similar result.

In the Multi Corresponding Analysis, 4 clusters could be confirmed in the Q10-15 “How do you want to use the Rare Sugar?” analysis. From the analysis result, we can guess that that the horizontal axis is an axis about “collecting information” and the vertical axis is that of “attitude in usage”.

We could also confirm 4 clusters in the Q16-22 “Anxiety in using the Rare Sugar” analysis. From the analysis result, we can assume that the horizontal axis is an axis about “anxiety” and the vertical axis is that of question points”.

#### 5. Conclusion

The Rare Sugars exist naturally and have many kinds (more than 50). They have good effect for health such as prevention of increasing the blood - sugar level after eating, suppression of fat accumulation, suppression of increasing the blood pressure, and anti-oxidative effect etc. It is in the spotlight for many people especially for those who are in the metabolic syndrome. There are few related papers concerning the marketing research and its utilization of this matter. In this paper, a questionnaire investigation was executed in order to clarify consumers’ current condition and their consciousness, and to seek the possibility of utilizing the Rare Sugars. Such multivariate analysis as Factor Analysis and Multi Correspondence Analysis were executed based on that.

Main findings are as follows.

In the Factor Analysis, we made the analysis on Q10-15 “How do you want to use the Rare Sugar?” and extracted two such meaningful axes as: “Use in cooking” and “Collecting Information”. On the other hand the analysis of Q10-15 without Q13 had a similar result. Thus, it is required for the manufacturers/Retailers to provide the suitable information to consumers.

In the Multi Correspondence Analysis, 4 clusters could be confirmed in the Q10-15 “How do you want to use the Rare Sugar?” analysis. From the analysis result, we could guess that that the horizontal axis was an axis about “collecting information” and the vertical axis was that of “attitude in usage”.

We could also confirm 4 clusters in the Q16-22 “Anxiety in using the Rare Sugar” analysis. From the analysis result, we could assume that the horizontal axis was an axis about “anxiety” and the vertical axis was that of question points”. From this analysis, collecting information and attitude in usage are required in using Rare Sugar. Cheapness, safety, many achievement of usage, many kinds of products are required in terms of anxiety.

The effectiveness of this method should be examined in various cases.

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