Study of Dietary Variety

— A New Strategy using the Fuzzy Cluster Analysis based on the New Ordination Method —

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ABSTRACT

The aim of this study was to clarify the dietary variety of a junior college student, deeply related with eating habits or food preferences. The author tried a new strategy using the fuzzy cluster analysis based on the new ordination method, which can express ambiguity by the membership function. The membership function expresses the degree to which foods belong to each cluster. Foods with the largest membership function in each cluster show the characteristic intake pattern for the cluster. In this study, the fuzzy cluster analysis identified four dietary groups characterized by food intake patterns. Oils, fruits, seeds and sugars had large membership functions, which means that they show the characteristic intake pattern for the student's diet. Vegetables except green and yellow ones and milk had small membership functions and could not be clustered clearly into any food group. Therefore, their intake patterns are considered to be ambiguous. These results suggest that the fuzzy cluster analysis based on the new ordination method was effectively applied to clarification of the tendency and intake pattern of foods from ambiguous dietary data with large and irregular fluctuations.

1. INTRODUCTION

Recently, dietary surveys have been conducted to ascertain the adequacy of food and nutrient intake because of concern about their role in the prevention of lifestyle-related diseases. However, a number of reports have shown that food intake data obtained from these surveys are difficult to analyze and ascertain features of the diet. [1 6)]

The main cause of this difficulty is the ambiguous and irregular variability in amount of food intake, which is attributed to the dietary variety related to individual eating habits or food preferences. In this study, a new strategy was tried using the fuzzy cluster analysis based on the new ordination method [7,8)], which could express ambiguity with the membership function and, consequently, could correctly clarify the features of food intake patterns.

2. SUBJECTS and METHODS

The subjects were 79 female junior college students aged 19-20 years. Each subject recorded the amount and kinds of foods and beverages consumed during the three-days study period in 2001-2002. These dietary records were checked by trained dieticians and the average intake of each food per day was then calculated.

DATA ANALYSIS

A strategy for analyzing the biotic community data devised by Dr. Shinagawa was applied to the data analysis because of the advantages that the method gives results less affected by noises[9,10], and resulting characteristic food intake patterns were examined.

3. RESULTS and DISCUSSION

The ordination of subjects and foods on the axis Ⅰ×Ⅱ plane is shown in Figs. 1 and 2, respectively.[11] The third eigenvalue and its cumulative ratio were 8.79 and 62.3%, respectively. Using components relative to AXIS Ⅰ to Ⅲ, for more information to be reserved, the fuzzy cluster analysis was applied to partition both subjects and foods into 4 clusters characterized by food intake patterns. In order to exhibit the characteristic intake pattern, weighted averages were calculated for subject groups A-D for each food intake with squared membership function of the subject group over all subjects and then centered and normalized by the simple average and standard deviation, respectively. [8,12] The results are shown in Fig. 3.

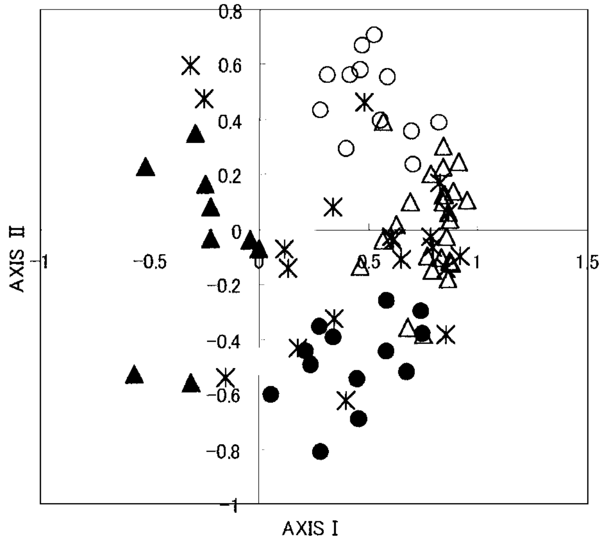

Fig.1 Ordination of 79 subjects onto the axis Ⅰ × Ⅱ plane.
Symbols represent subjects with high membership function more than 0.5 of the group derived from fuzzy *c* -means method, as follows.
○ A, ● B, △ C, ▲ D
Star marks (∗) represent subjects with low membership function below 0.5.

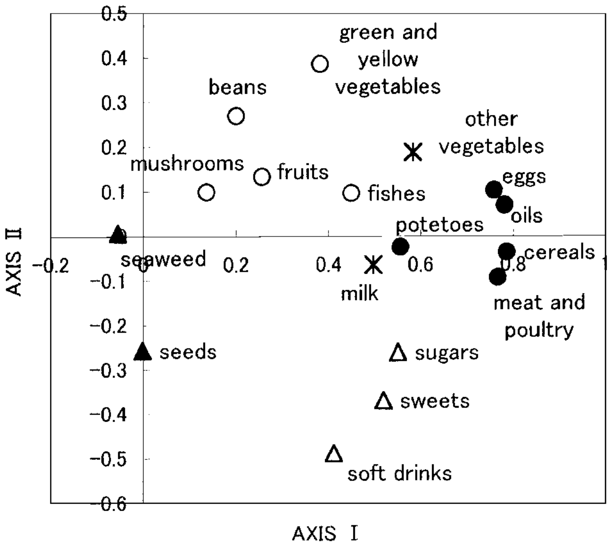

Fig.2 Ordination of 17 foods onto the axis Ⅰ × Ⅱ plane.
Symbols represent foods with high membership function more than 0.5 of the group derived from fuzzy *c* -means method, as follows.
○ 1, ● 2, △ 3, ▲ 4
Star marks (∗) represent foods with low membership function below 0.5.

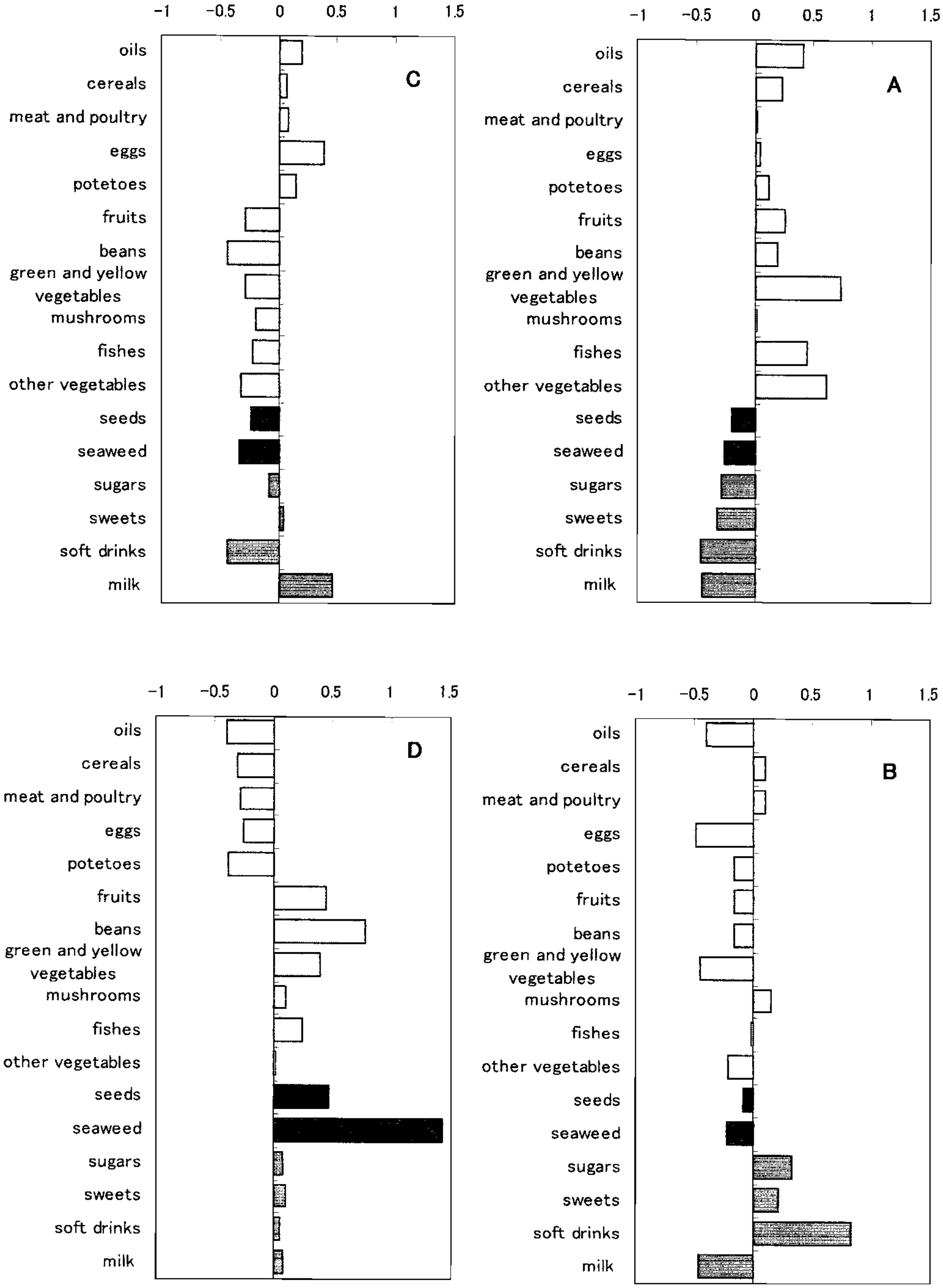

Fig.3 Food intake patterns of 4 dietary groups.
0=Mean, ±1=SD
4 food groups are the same as shown in Table 1.

Food group 1 Food group 2
Food group 3 Food group 4

The number of students with a membership function greater than 0.5 in group A was 12 of 79. They consumed more foods in food group 2 than the other subjects, especially vegetables. The number of students with a membership function greater than 0.5 in group B was 13. They consumed more foods in food group 4 than the other subjects, especially soft drinks. The number of students with a membership function greater than 0.5 in group C was 25. They consumed slightly more eggs and milk than the simple average over all subjects. The number of students with a membership function greater than 0.5 in group D was 9. The seaweed intake was remarkably high in that group. The number of students with a membership function lower than 0.5 in all subject groups was 20, demonstrating ambiguous food intake patterns for these students.

Table 1 shows each of the 4 (1, 2, 3, 4) food group classifications and the membership functions for each food. The membership function indicates the degree to which each food belongs to each food group, and a food with a large membership function is located near the center of the food group in the ordination space. It can be said, therefore, that this is the food showing the characteristic variety pattern in the student's diet.

Table 1. Fuzzy clustering of foods

Food groups	Foods	membership function
1	oils	0.943
	cereals	0.942
	meat and poultry	0.811
	eggs	0.785
	potetoes	0.576
	other vegetables	**0.407**
2	fruits	0.927
	beans	0.897
	green and yellow vegetables	0.752
	mushrooms	0.730
	fishes	0.620
	other vegetables	**0.414**
3	seeds	0.867
	seaweed	0.863
4	sugars	0.931
	sweets	0.915
	soft drinks	0.578
	milk	**0.331**

Oils, fruits, seeds and sugars had a large membership function in each food group (Table 1), which indicates that these foods had characteristic variety patterns for each group in the student's diet. The intake patterns of foods with a low membership function (less than 0.5) were so ambiguous that they couldn't be classified clearly into any food group. Therefore, vegetables except green and yellow one (other vegetables) and milk with a low membership function (less than 0.5) demonstrated ambiguous intake patterns in the student's diet.

In particular, milk had a low membership function indicating irregular fluctuation of the amount and frequency of intake or a biased intake to only a few students. Other vegetables were classified into both food groups 1 and 2 by the even and low membership function indicating an ambiguous intake pattern between both groups.

Moreover, the combination of foods with a large membership function in the same food group suggests the characteristic intake combination in the student's diet. So, the combination of oils and cereals in group 1 and the combination of sugars and sweets in group 4 were considered to be the characteristic intake combinations reflecting the student's eating habits. These results suggest that the fuzzy cluster analysis based on the new ordination method was effective in clarifying the tendency of dietary variety data to fluctuate ambiguously and irregularly.

In the future, the author aims to develop a new analysis method to clarify lifestyle factors that are deeply related to the features of the food intake pattern for each group obtained by the new strategy used here.

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