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Research Article

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Evaluation of Enteral Nutrient Flavor and Rating due to Differences in Form

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Abstract

Aims: It is necessary for medical staff to fully understand disparities in the comprehensive evaluation of enteral nutrients due to differences in their physical form. In this study, we compared the overall rating of each enteral nutrient with respect to form and examined the factors that influence their overall evaluation.

Methods: Sensory tests were conducted on 261 pharmaceutical students using the Sematic Differential method. Comparison of comprehensive evaluations for each form of enteral nutrient was carried out for liquids (room temperature, warm, cold), jelly (solid), and mousse (semi-solid) forms. Additionally, factors influencing the comprehensive evaluation of enteral nutrients were investigated using covariance structure analysis.

Results: Overall evaluation of each enteral nutrient form showed the jelly was rated highest (2.57 ± 1.49), followed by the warm liquid (2.53 ± 1.29), cold liquid (2.42 ± 1.20), room temperature liquid (2.26 ± 1.20), and the mousse (1.93 ± 1.07). From the result of factor analysis, four factors (flavor, richness, presence, and texture) were extracted. Covariance structure analysis of factors affecting the overall rating revealed that flavor had a significant influence (fitness index: GFI=0.908, AGFI=0.878, RMSEA=0.074, AIC=912.742).

Conclusion: Differences in the form of enteral nutrients affected the overall satisfaction of patients. It is important for medical staff, including pharmacists, to deepen their understanding of factors related to the overall rating of enteral nutrients in order to meet the needs of patients.

Keywords:

Enteral nutrition; Medication adherence; Flavor; Form of enteral nutrients; Therapeutic efficiency

Introduction

Recently, team-based medical care has been promoted in Japan in order to provide adequate, high-quality medical care to patients and their families. This approach encourages medical staff from each field to utilize their expertise and cooperate in the care of patients. In 2010, the medical reimbursement revision implemented the formation of Nutrition Support Teams (NST) made up of various specializations to manage hospitalized patient nutrition. At present, nutritional management and support of patients are mostly administered by NSTs. The two major principles of NSTs are to "avoid excessive nutrition" and "use the intestines as much as possible." Thus, enteral nutrients have become a necessity in nutritional management [1,2]. Since enteral nutrition emphasizes use of the digestive tract, it represents a physiological administration method relative to intravenous methods. Enteral nutrition is also gaining attention because it can improve the problem of high calorie infusion [3,4]. In addition, enteral nutrients are on the market as nutritional supplements for different pathologies [5] and are also being used for the nutritional management of patients with diabetes and cancer [6,7].

Previously, patient blood tests have been reported as being significantly improved by intake of enteral nutrients [8]. Provision of adequate nutrition to laboratory rats has also been shown to increase their body weight and restore the intestinal mucous membrane [9]. In Japan, enteral nutrients are available as medical and food products in various flavors and forms [10], including liquids, mousse, jellies, semi-solids, and solids. Though enteral nutrients are generally taken in liquid form, semi-solid enteral nutrients with thickening agents are useful for preventing aspiration pneumonitis due to gastro esophageal reflux [11].

It is thought that the physical state (liquid, solid, semi-solid) and overall rating of enteral nutrients influences patient medical adherence, nutritional status, and the effectiveness of the treatment. Hence, it is important for medical staff to fully understand the forms of enteral nutrients available and the factors that affect overall satisfaction ratings. In the present study, a sensory test was conducted using the Semantic Differential (SD) method [12] to compare the overall flavor evaluation (overall satisfaction level) of enteral nutrients with respect to differences in form. In addition, factors affecting the overall rating of enteral nutrients were further examined.

Materials and Methods

Types of enteral nutrients

An enteral nutrient that is commonly used in Japan was used in the current sensory test survey (Figure 1). Elental® (Ajinomoto Pharmaceutical Co., Ltd., Tokyo, Japan), a component of pharmaceutical products, was used as the digestive nutrient. Enteral solution mixtures of Rakoru® NF (Otsuka Pharmaceutical Factory Co., Ltd., Tokushima, Japan) and Ensure® H (Abbott Japan Co., Ltd., Tokyo, Japan) were used as semi-digestive nutritional supplements. Mei Balance Mini® (Meiji Co., Ltd., Tokyo, Japan) was used as the food product. All nutritional supplements were coffee-flavored.

Liquid Elental® was prepared by dissolving Elental® powder in water to a concentration of 1 kcal/mL; all other liquid preparations had the same concentration (Ensure® H: 1.5 kcal/mL; Mei Balance Mini®: 1.6 kcal/mL; Rakoru® NF mixture: 1.0 kcal/mL). Liquids were dispensed at three different temperatures: room temperature, warm, and cold. To produce warm liquids, solutions were warmed using a water bath (Yazawa Chemicals Co., Ltd., Aichi, Japan) until they were about the same temperature as human skin (~37°C). To produce cold liquids, solutions were cooled in a refrigerator (5°C) for 1 h. For jellies (solid) and mousses (semi-solid), Elenta® was prepared from

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an exclusive jelly mix and a mousse base and used as a digestive nutrient, while Mei Balance Mini® Brick Jelly (1.6 kcal/bottle) was used as a semi-digestive nutrient. Mousses were also made by adding Tsururinko® (320 kcal/100 g; Clinico Co., Ltd., Tokyo, Japan) to thicken samples. The flavor of Elental® came from the attached exclusive flavor provided and by adding the recommended dose described in the product overview.

Implementation of sensory test using the SD method

Sensory tests were conducted on pharmaceutical students (261 people) using the SD method for rating impressions of a sample. A bipolar pair of adjectives are used and measured on a scale to determine which adjective expresses the sample more precisely [12]. Based on reports from Mukai et al. [13,14] on evaluation of adjective-pairs that express the characteristics of enteral nutrients, the following 18 word-pairs were selected for use in the present study (Figure 2): "familiarity," easy/difficult to familiarize with; "medicine," does/does not feel like a medicine; "richness," rich/not rich; "continuity," can/cannot drink every day; "aftertaste," weak/strong; "quality of taste," poor/good; "smells of milk," smelly/not smelly; "greasiness," greasy/not greasy; "drinking sensation," smooth/syrupy; "taste," delicious/bad; "strength of flavor," weak/strong; "ease of intake," easy/difficult; "peculiarity," no peculiarity/is peculiar; "texture," good/poor; "easy to get tired of," yes/no; "feels like a meal," does/does not; "swallowing sensation," poor/good; "overall rating," satisfied/not satisfied. A 5-point rating scale was used to evaluate the 18 word-pairs: 1="very much," 2="partially," 3="neither," 4="partially," 5="very much."

Data analysis

Comparison of the overall rating of difference nutrient forms was done by one-way analysis of variance (ANOVA). If a significant difference was found by 1-way ANOVA, the Games-Howell test was used as a post-hoc test to conduct multiple comparisons. The score for each item is shown as the mean ± standard deviation. To investigate the factors that affect the overall rating, factor analysis of the 17 pairs, excluding the overall rating, was conducted. Those with an eigenvalue of more than 1 under the maximum-likelihood method would be considered a common factor. Furthermore, in order to explain how the common factors derived from the factor analysis contribute to

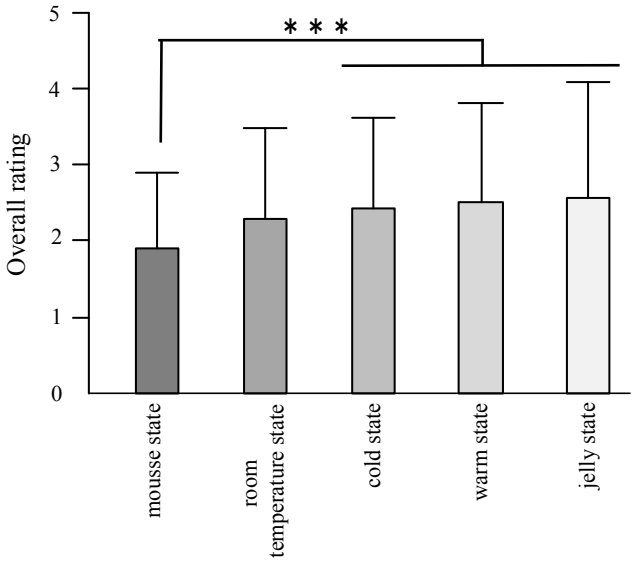

Figure 1: Comparison of overall ratings arising from difference in forms.

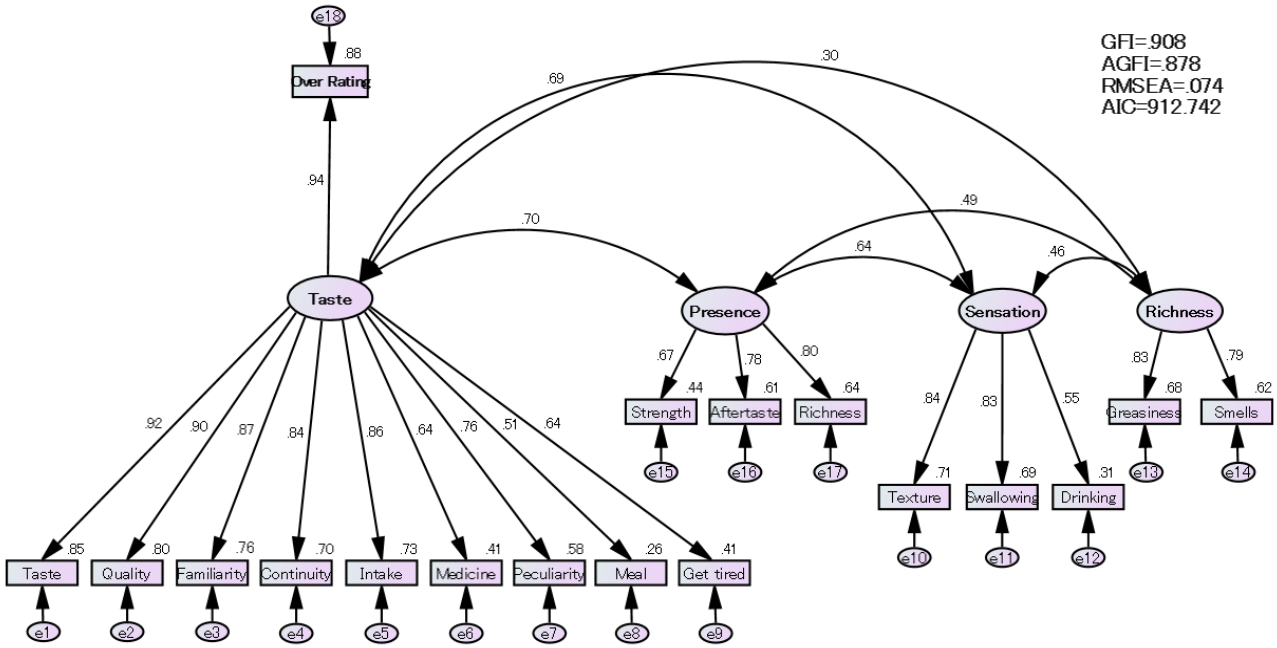

Figure 2: Path analysis model using mean values of all enteral nutrients.

Taste was comprised of the following nine evaluation pairs: Taste, Quality of taste (Quality), Familiarity, Continuity, Ease of intake (Intake), feel like medicine (Medicine), Peculiarity, Feels like a meal (Meal), and easy to get tired of (Get tired). Presence was comprised of the following three evaluation pairs: Strength of taste (Strength), Aftertaste, and Richness. Sensation of dosage was comprised of the following three evaluation pairs: Texture, Swallowing sensation (Swallowing), and drinking sensation (Drinking). Richness was comprised of the following two evaluation pairs: Greasiness and Smells of milk (Smells).

the overall rating, a correlation analysis between the common factors and overall rating was conducted. Based on the results obtained, a confirmatory factor analysis was done using the covariance structure analysis. The significance level for all tests was set to P=0.05. IBM® SPSS statistics® 22 (SPSS, Japan) was used for one-way ANOVA, multiple comparison, and factor analysis. IBM® SPSS Amos® 22 was used for covariance structure analysis.

Results

Aggregate results of each evaluation word-pair

In the sensory test survey, the mean ± standard deviation of the 18 items was tabulated, and the score distribution was confirmed (Table 1). There was bias in some of the scores. However, all of the items were determined to include important content contributing to the overall rating of each enteral nutrient. Thus, all items were analyzed.

Comparison of overall ratings of different enteral nutrient forms

The mean overall rating for room temperature (n=274), warm (n=249), and cold (n=233) liquids was 2.26 ± 1.20, 2.53 ± 1.29, and 2.42 ± 1.20, respectively. The mean overall rating for the mousse (n=119) and jelly (n=124) was 1.93 ± 1.07 and 2.57 ± 1.49, respectively. Thus, the jelly received the highest overall rating, followed by the warm liquid, cold liquid, room temperature liquid, and the mousse. A significant difference (P<0.001, 1-way ANOVA) was found when comparing the difference in overall ratings arising from the enteral nutrient form, and the Game-Howell test for multiple comparisons showed that the mousse had a significantly lower rating than the jelly, warm liquid, and cold liquid (P<0.001).

Using factor analysis to extract factors related to the overall rating

Among the surveyed word-pairs in the sensory test, factor analysis using the maximum likelihood method was done on 17 ratings (excluding the overall rating). From the attenuation state of the eigenvalue and the level of probability of explanation, a 4-factor structure was adopted. Then, factor analysis was conducted again using the maximum likelihood method (Promax Rotation), and factor loading was standardized to 0.35. The final factor analysis results for each nutrient after Promax Rotation are shown in Table 2. The explanation provided by the four factors after factor extraction was 63.20% out of the total explanation for the entire distribution of the 17 evaluation pairs.

The first factor was named "Taste" and was comprised of the following nine evaluation pairs: taste, quality of taste, familiarity, continuity, ease of intake, feels like a medicine, peculiarity, feels like a meal, and easy to get tired of. The second factor was named "Presence" and consisted of three pairs: strength of taste, aftertaste, and richness. The third factor was named "Sensation of dosage" and consisted of three pairs: texture, drinking sensation, and swallowing sensation. The fourth factor was "Richness" and consisted of two pairs: greasiness and smells of milk (Table 3).

Table 1: List of enteral nutrients.

Category		Product Name	Flavor
Semi digestive nutrient	Medical product	Rakoru NF®	Coffee, Milk, Banana, Corn
		EnsureH®	Coffee, Vanilla, Banana, Melon, Black Sugar
	Food product	Mei Balance Mini®	Coffee, Strawberry, Yogurt, Green Tea, Corn Soup, Chocolate, Caramel, Banana
Digestive nutrient (nutrient composite)	Medical product	Elental®	Coffee, Pineapple, Yogurt, Plum, Green Apple, Grapefruit, Mango, Orange, consommé, Tomato and Fruits

All nutrients were coffee-flavored

Table 2: Evaluation word-pairs used in the SD method.

		Very much	Partially	Normal	Partially	Very much	Normal
Familiarity	Difficult to familiarize	1	2	3	4	5	Easy to familiarize
Does it feel like medicine	Does not feel like medicine	1	2	3	4	5	Feels like medicine
Richness	Rich	1	2	3	4	5	Not rich
Continuity	Cannot drink everyday	1	2	3	4	5	Can drink everyday
Aftertaste	Strong aftertaste	1	2	3	4	5	Weak aftertaste
Quality of taste	Poor quality	1	2	3	4	5	Good quality
Smells of milk	Smelly	1	2	3	4	5	Not smelly
Greasiness	Greasy	1	2	3	4	5	Not greasy
Drinking sensation	Syrupy	1	2	3	4	5	Smooth
Taste	Tastes bad	1	2	3	4	5	Delicious
Strength of taste	Strong	1	2	3	4	5	Weak
Ease of intake	Easy to eat	1	2	3	4	5	Difficult to eat
Peculiarity	Peculiar	1	2	3	4	5	Not peculiar
Texture	Poor texture	1	2	3	4	5	Good texture
Is it easy to get tired of	Easy to get tired of	1	2	3	4	5	Difficult to get tired of
Feeling as a meal	Does not feel like a meal	1	2	3	4	5	Feels like a meal
Swallowing sensation	Poor	1	2	3	4	5	Good
Overall rating	Not satisfied	1	2	3	4	5	Satisfied

Correlation between the four factors related to the overall rating and comprehensive evaluation

The mean score of the 4 factors extracted by the factor analysis was tabulated, and the correlation between each factor, as well as the comprehensive evaluation, was obtained. The mean ± standard deviation score for each factor was 2.38 ± 1.00 for taste, 2.06 ± 0.89 for presence, 2.62 ± 1.06 for sensation of dosage, and 2.80 ± 1.25 for richness. When calculating Cronbach's α to test for internal consistency, sufficient values of α=0.929 for taste, α=0.790 for presence, α=0.782 for sensation of dosage, and α=0.788 for richness were obtained.

Correlation analysis of the 4 factors and overall rating showed a strong positive correlation between taste and overall rating (r=0.907, P<0.001). While the correlations between taste and presence (r=0.643, P<0.001), taste and sensation of dosage (r=0.568, P<0.001), presence and sensation of dosage (r=0.523, P=0.001), presence and overall rating (r=0.557, P<0.001), sensation of dosage and overall rating (r=0.528, P<0.001), sensation of dosage and richness (r=0.387, P<0.001), richness and overall rating (r=0.245, P<0.001) were weak, they were nonetheless positive.

Investigation of factors affecting overall rating

The mean value obtained by adding the total nutrient value for each examiner regardless of enteral nutrient forms was used for pathway analysis by covariance structure analysis. When the analysis was conducted assuming all four factors influenced the overall rating (Table 2), only taste displayed a significant pathway. Therefore, taste was connected to the overall rating, while the other three factors (presence, sensation of dosage, and richness) are thought to correlate with taste. The second analysis was the final model (best fit index: GFI=0.908, AGFI=0.878, RMSEA=0.074, AIC=912.742).

Discussion

The present study showed that the overall rating of the enteral nutrient dosage sensation (satisfactory/unsatisfactory) depended on its physical form (liquid, solid, semi-solid). Comparison of the overall rating arising from the difference in enteral nutrient form showed the mousse was rated lowest (1.93; P<0.001), being significantly lower than all other forms except the room temperature liquid. Accordingly, nutrient dosage form rankings from highest to lowest were as follows: jelly, warm liquid, cold liquid, room temperature liquid, and mousse. This was most likely because the jelly felt more like a dessert when eaten, conferring it a high rating for being the easiest to consume. The semi-liquid mousse, on the other hand, is a less familiar form of food eaten by these subjects in an average daily meal, making it more difficult to consume and causing the low rating. In addition, although there was no significant difference between the three liquid dosage forms, both the warmer and colder liquids tended to have higher ratings than the room temperature liquid. Thus, when enteral nutrients are orally administered, the jelly form was considered the best for maintaining good patient adherence to the nutrient regimen. The results from multiple comparison tests conducted using the Games-Howell method showed that the mousse had a significantly lower impact on the overall rating. By changing the form/texture of foods, it is possible to provide safer meals that do not lead to problems swallowing, especially for patients with dysphagia or similar illnesses that want to eat using their mouth. Furthermore, it the nutrient dosage must be taken in mousse form, it is necessary to listen to the patient's requests in order to improve their adherence to the dosage.

Factor analysis of 17 evaluation word-pairs (excluding overall rating) resulted in the extraction of four factors (taste, presence, sensation of dosage, and richness). Hence, in order to examine their influence on the lower end of the scale and on the overall rating, pathway analysis using covariance structure analysis was conducted using all of the enteral nutrient dosages without separating by form. The final model showed that the taste pathway had a significantly positive path on the overall rating and indicated that richness, presence, and texture were correlated to taste. From these results, it can be inferred that it is important to consider taste in order to improve the overall rating of enteral nutrients.

As this study was limited to only university pharmaceutical students as testing subjects, it is possible that it does not accurately reflect the preference of the age group(s) that enteral nutrients are

Table 3: Factor analysis results of sensory testing of enteral nutrients (Factor pattern after Promax Rotation).

	I	II	III	IV
Taste	**0.925**	0.03	-0.160	0.004
Quality of taste	**0.874**	0.049	0.020	0.00
Familiarity	**0.844**	0.051	0.017	0.110
Continuity	**0.770**	0.108	0.030	-0.003
Ease of intake	**0.752**	0.068	0.167	0.003
Does it feel like medicine	**0.596**	-0.016	0.087	0.060
Peculiarity	**0.552**	0.414	0.049	0.000
Feeling as a meal	**0.442**	0.160	-0.034	0.031
Is it easy to get tired of	**0.404**	0.334	0.135	0.034
Strength of taste	0.033	**0.674**	-0.116	0.021
Aftertaste	0.221	**0.652**	0.021	0.046
Richness	0.293	**0.507**	0.083	0.133
Texture	0.288	-0.024	**0.695**	0.039
Swallowing sensation	0.261	0.063	**0.632**	0.025
Drinking sensation	-0.114	0.186	**0.57**	0.087
Greasiness	0.03	-0.015	0.020	**0.991**
Smells of milk	0.016	0.128	0.080	**0.587**
Maximum likelihood method using Promax Rotation Factor loading was set to >0.35				

actually prescribed to. However, the results from covariance structure analysis showed that taste strongly influenced the overall rating of all enteral nutrients. Thus, it is believed that regardless of age, taste is a factor that directly influences the overall rating of enteral nutrients. Additionally, the current survey was conducted with all nutrients being coffee-flavored to more accurately compare differences between the physical forms of oral dosages. Although the order of the overall ratings might change between the different forms depending on other flavors, present results showed there was a significant difference in the overall evaluation based on physical form. Many studies have been conducted on the taste of medicines [15,16], and it is expected that further flavors will be developed in future. Hence, it is importance to properly understand the taste of each form.

The results of the present study demonstrate that enteral nutrient dosage forms (liquid, semi-solids, solids) and taste factors are strongly connected to their overall rating and satisfaction. It is important for medical staff, including pharmacists, to deepen their understanding of factors related to the overall rating of enteral nutrients and instructions on dosage. In addition to the swallowing ability of patients, it is important to consider patient preferences in order to provide them with the appropriate enteral nutrients and improve adherence to medical treatments.

Conclusion

Differences in the form of enteral nutrients influence their overall rating. In addition, the overall rating is strongly connected to taste. It is important for medical staff, including pharmacists, to deepen their understanding of factors related to the overall rating and to provide the appropriate form of enteral nutrient preferred by patients to suit swallowing ability and improve adherence to treatment.

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