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Original Article

The effect of a mousse diet on mood and food intake in healthy young females

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ABSTRACT
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Objective: This study investigated whether a dysphagia diet, such as a mousse diet, caused low diet intake with a deterioration of psychological status.

Methods: Eleven healthy females were divided into two groups: normal and mousse diet. Subjects ate these diets three times a day for three consecutive days. The changes over time in diet intake, dietary assessment, appetite, craving for a specific taste, and mood status were compared between the two groups.

Results: At almost all evaluation points, the diet intake and dietary assessment values were higher in the normal diet group than in the mousse diet group. The anger-hostility and fatigue-inertia measures of mood status temporarily differed significantly between the two groups; anger-hostility increased in the mousse diet group, while fatigue-inertia decreased in the normal diet group ($p = 0.040$, $p = 0.041$). Positive effectors of diet intake amount were the taste of the diet and a craving for sweet-tasting items before the meals (partial regression coefficients 0.798 and 0.207, $p < 0.001$ and $p = 0.005$, respectively), while appetite, mood status, and a craving for other specific tastes before the meals did not have a considerable effect on diet intake.

Conclusions: These results demonstrate that a mousse diet is one of the causes of low diet intake and mood fluctuation.

Key words: deglutition, mousse diet, food intake, Profile of Mood States

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Introduction

Patients with dysphagia face a constant risk of aspiration pneumonia or choking to death from food [1]. To prevent these incidents, patients' swallowing functions are assessed through a physical examination, videofluorography or videoendoscopy, and specific diets are then provided, such as a dysphagia diet, based on swallowing ability. Patients' taste preferences relate to appetite; thus, dysphagia diets are matched to the dietary preferences reported by patients in order to enhance their appetite [2]. During simultaneous physical and swallowing rehabilitation, refusing food and loss of appetite are obstacles to various approaches to recover the swallowing function [3]. Patients with these symptoms tend to have difficulty withdrawing from tube feeding [3] or develop malnutrition. Generally, the causes of refusing food are aspontaneity and refusing needed care [4].

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Previous reports describe how short-term regulation of appetite and diet intake involves neural signals from the gastrointestinal tract [5]; nutrient blood levels [6]; gastrointestinal tract hormones, such as leptin and ghrelin [7]; and psychological factors [8, 9]. Conflicting reports provide evidence that psychological factors may both enhance and reduce appetite [10, 11]. Therefore, there are no firmly established theories about psychological effects on appetite, and it is still unclear how much impact the continuous intake of a dysphagia diet has on mood.

We conducted this study to validate the following hypothesis for healthy adults: a dysphagia diet, such as a mousse diet, plays a crucial role in appetite loss and/or low dietary intake due to changes in psychological status.

Methods

1. Subject selection

To evaluate the isolated impact of diet type on psychological status, it was important to eliminate possible external factors that could have influenced mood. Patients with dysphagia often have pre-existing psychological stress as a result of their disease [12]; therefore, the subjects for this study were selected from a healthy adult population. Eleven female students attending the Department of Food Science and Nutrition at S University in Tokyo between January 27 and February 28, 2014 were enrolled. All clinical information was collected after the subjects provided written informed consent. The study protocol was approved by the Institutional Review Board of the Ethics Committee of Toho University Ohashi Medical Center (Approval No. 14−43).

2. Protocol

Subjects were divided into the normal diet group and the mousse diet group by quasi-randomization, and were required to follow the specific protocol for their assigned group. Table 1 shows the daily nutritional content of the normal and mousse diets. The normal diet, which was purchased from N Foods, consisted of normal steamed rice as a staple food, supplemented with subsidiary items. The mousse diet, which was purchased from A Corporation, consisted of a staple food, a subsidiary item, and a dessert. The mousse texture was equivalent to code 1j as determined by the Japanese Society of Dysphagia Rehabilitation [13].

Table 1. Daily nutrient content of the normal and mousse diet.

	Normal diet	Mousse diet
Total calories (kcal)	992.6 ± 33.7	1014.0 ± 33.0
Water (g)	768.1 ± 53.2	753.1 ± 22.7
Protein (g)	34.3 ± 2.1	6.7 ± 1.4
Fat (g)	25.2 ± 1.3	32.1 ± 3.4
Carbohydrates (g)	145.7 ± 29.2	136.6 ± 7.3
Salt (g)	5.5 ± 0.2	3.5 ± 0.2

Each subject started eating their assigned diet 10 days before the expected date of their next menstrual cycle. Premenstrual syndrome has a wide variety of symptoms, including mood swings, breast tenderness, food cravings, irritability, and depression; we used this timeline in an attempt to reduce confounding due to premenstrual symptoms [14]. Each subject was given their diet meal for breakfast (6:00−8:00 a.m.), lunch (12:00−1:00 p.m.), and dinner (6:00−8:00 p.m.) for three consecutive days. If subjects felt hungry between meals, they were permitted to drink liquid supplements without caffeine, with energy content of 200 kilocalories per 125 ml. If a subject deviated from the assigned diet and ate undesignated foods, an experienced dietician calculated the total calorie content for these foods based on the declared records. The subjects were also permitted to freely drink liquids without sugar and caffeine to maintain hydration, and were also instructed not to exercise strenuously, not to stay awake late into the night, and not to share information regarding the study with one another before study completion. Defecation frequency from the previous day and body weight were recorded every morning.

The total energy of daily food intake was calculated based on the sum of kilocalories from the provided diets, liquids supplements, and undesignated food between the meals. Kilocalories from undesignated foods were added to the total for whichever assigned meal was closest in time.

The dietary assessment, which included presentation, smell, taste, aftertaste, and deliciousness of each diet was measured using the Visual Analogue Scale (VAS 1) [15]. Appetite, which included hunger, fullness, satisfaction, and prospective consumption, and cravings (salty, sweet, spicy, and greasy) were assessed with the appetite sensations questionnaire using VAS (VAS 2) [15]. Mood status was assessed using the Profile of Mood States (POMS) [16], which assesses the affect states using tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia, vigor-activity, and confusion-bewilderment scales; after the raw scores were corrected for age and gender, a standardized score (T-score) was calculated. The T-score for POMS compares the mood status of the experimental population with that normally expected in a healthy adult of the same gender and age. Decreases in tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia, and confusion-bewilderment scores were interpreted as improvements in physiological condition, while a decrease in the vigor-activity score signified a worsening of psychological condition. Abnormal results were defined as a score less than 40 for the vigor-activity scale or greater than 60 for the tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia, and confusion-bewilderment scales. Mental stress from life events and daily activity intensity over the three days were evaluated after dinner on the third day using the Holmes and Rahe stress scale [17] and the classification of activities of daily living [18]. VAS 2 and POMS scores were evaluated 30 minutes before meals, and VAS 1, VAS 2 and POMS were also evaluated 5 minutes after meals (Table 2).

3. Statistical analysis

Statistical analyses were performed using Statcel software version 3 (OMS Publishing Inc. Saitama, Japan) and the SPSS software package (IBM SPSS Statistics 22, Tokyo, Japan). Differences in quantitative variables between groups were evaluated using the Mann–Whitney *U* test. Within-group differences were evaluated using the Wilcoxon signed-rank test. The correlation of parameters in VAS and POMS was analyzed using Spearman's correlation. Multivariate multiple regression analysis was used to assess associations with food intake amount. Tests were deemed statistically significant if $p < 0.05$.

Results

1. Subject Characteristics (Table 3)

Eleven subjects (mean age ± standard deviation: 20.8 ± 0.3 years) were enrolled in the study; five and six subjects were randomized to the normal and mousse diet groups, respectively. One subject in the normal diet group underwent surgery during the study period and was excluded from the analysis. All other subjects completed the study protocol without any appreciable change in physical condition ($n = 4$ and $n = 6$ in normal and mousse dietary groups, respectively). There were no significant differences between the two groups in terms of age, body mass index, change in weight over the study period, frequency of defecation, mental stress from life events, or daily activity intensity during the study period ($p > 0.05$).

2. Diet and undesignated food intake between meals (Figure 1)

Total calorie intake was higher in the normal diet group than the mousse diet group at several evaluation time points: breakfast, lunch, and dinner on the first day ($p = 0.020$, $p = 0.010$, and $p = 0.014$, respectively); breakfast on the second day ($p = 0.010$); and breakfast on the third day ($p = 0.033$). Percentage of diet intake was higher in the normal diet group than the mousse diet group at almost all evaluation times (breakfast, lunch and dinner on the first day ($p = 0.017$, $p = 0.008$, and $p = 0.010$, respectively); breakfast, lunch, and

Table 2. Description of the study protocol.

	Upon waking	Breakfast			Lunch			Dinner		
		30 min pre-meal	6–8 a.m.	5 min post-meal	30 min pre-meal	12–1 p.m.	5 min post-meal	30 min pre-meal	6–8 p.m.	5 min post-meal
Day 1	BW, DF	VAS2 POMS	Intake	VAS1+2 POMS	VAS2 POMS	Intake	VAS1+2 POMS	VAS2 POMS	Intake	VAS1+2 POMS*
Day 2	BW, DF	VAS2 POMS	Intake	VAS1+2 POMS	VAS2 POMS	Intake	VAS1+2 POMS	VAS2 POMS	Intake	VAS1+2 POMS*
Day 3	BW, DF	VAS2 POMS	Intake	VAS1+2 POMS	VAS2 POMS	Intake	VAS1+2 POMS	VAS2 POMS	Intake	VAS1+2 POMS**

A.M., Ante meridiem; P.M., Post meridiem; BW, Measurement of body weight; DF, Recording of defecation frequency from the previous day; VAS1, Evaluation of dietary assessment using the Visual Analogue Scales 1; POMS, Evaluation of the Profile of Mood States; VAS2, Evaluation of appetite and desire using the Visual Analogue Scales 2; *, Recording of supplementary food and drink intake; **, Scoring of stressful life events and intensity of activities of daily living.

Table 3. Subject characteristics.

	Normal diet group ($n = 4$)	Mousse diet group ($n = 6$)	*p*-Value
Gender, female (%)	100		—
Age (years)	20.5 ± 0.5	21.0 ± 0.6	0.221
Body mass index (kg/m^2)	21.0 ± 1.6	20.4 ± 1.4	0.669
Change in body weight (kg/3 days)	−0.7 ± 0.3	−0.6 ± 0.5	0.393
Defecation frequency (times/day)	0.6 ± 0.3	0.8 ± 0.2	0.393
Score of stressful life events (points/3 days)	15.0 ± 0.0	18.0 ± 7.3	0.669
Daily activity intensity (class)	I : II = 2 : 2	I : II = 2 : 4	0.617

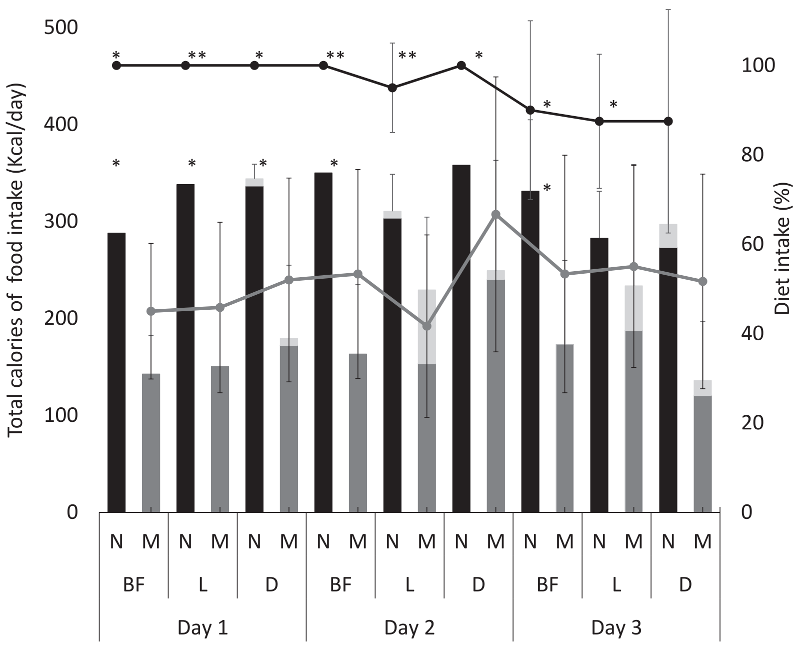

Figure 1. Total daily calorie intake and percentage of provided diet.
Abbreviations: N, Normal diet group: $n = 4$; M, Mousse diet group: $n = 6$; BF, breakfast; L, lunch; D, dinner.
Note: Bar-plot means for total daily calorie intake (i.e., provided diet, liquid supplements, and extra food between meals); the light gray bar on the black or dark gray bar indicates the amount of calories from extra food between meals. The line plot indicates the mean intake percentage of the provided diet (from 0−100%). * $p < 0.05$ and ** $p < 0.01$, Mann-Whitney *U* test for between-group comparisons.

dinner on the second day ($p = 0.007$, $p = 0.009$, and $p = 0.022$, respectively)) except for dinner on the third day (breakfast and lunch on the third day ($p = 0.030$ and $p = 0.048$, respectively)).

3. Dietary assessment (VAS 1), Appetite, and Cravings (VAS 2)

Total scores for the dietary assessments were higher in the normal diet group than the mousse diet group (Figure 2), because all parameter scores (presentation, smell, taste, aftertaste, and deliciousness) were significantly higher in the former group than in the latter group at almost all evaluation times (*p*-Values between 0.009 and 0.033) except for aftertaste at breakfast, deliciousness at lunch and taste at dinner on the third day (Supplemental data).

With regards to appetite, hunger in the normal diet group was higher than in the mousse diet group after lunch and dinner on the first day, and dinner on third day ($p = 0.042$, $p = 0.042$, and $p = 0.033$, respectively). Similarly, fullness was higher in the normal diet group after dinner on the first day ($p = 0.010$); satisfaction was higher in the normal diet group after lunch on the first day, after breakfast on the second day, and before dinner on the third day ($p = 0.033$, $p = 0.018$, and $p = 0.032$, respectively) (Figure 3A, B, and C). Cravings scores showed that the craving for salty-tasting items in the normal diet group was higher than for the mousse diet group only after dinner on the first day ($p = 0.025$). There were no significant differences between diet groups based on the craving for sweet, spicy, or greasy tasting items at any of the evaluation time points (Figure 3D, E, F, and G).

4. Profile of Mood States assessment

Scores for the tension-anxiety, depression-dejection, vigor-activity, fatigue-inertia, and confusion-bewilderment scales increased from pre- to post-meal in the normal diet group ($p = 0.001$, $p = 0.012$, $p = 0.001$, $p < 0.001$, and $p < 0.001$, respectively), while the anger-hostility score did not change remarkably. On the contrary, in the mousse diet group, only the anger-hostility scale scores significantly decreased from pre- to post-meal ($p = 0.007$); the other mood scale scores did not change remarkably (Figure 4A, B, C, D, E, and F). Comparisons between the diet groups showed higher scores for the anger-hostility scale after lunch on the second day ($p = 0.040$) and higher fatigue-inertia scale scores after dinner on the third day ($p = 0.041$) in the mousse diet group compared to the normal diet group (Figure 5C and E); there were no significant differences in the other mood scale scores at any evaluation time point

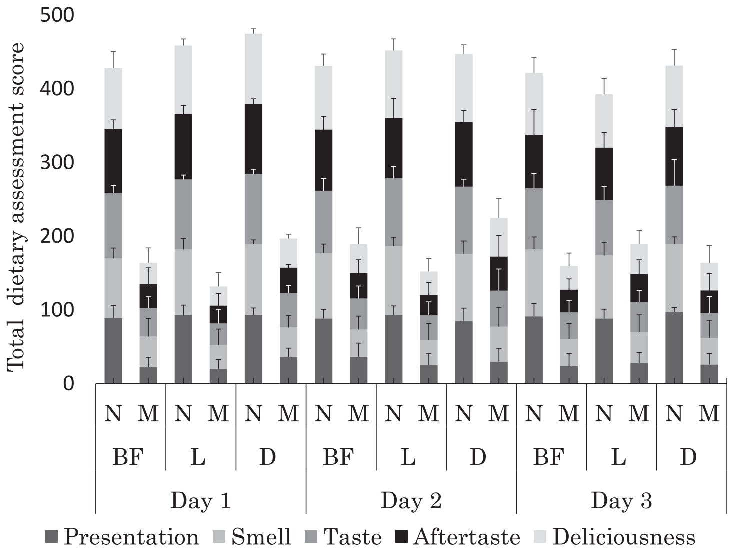

Figure 2. Dietary assessment assessed with Visual Analogue Scales 1. Abbreviations: N, Normal diet group: $n = 4$; M, Mousse diet group: $n = 6$; BF, breakfast; L, lunch; D, dinner.
Note: Data is presented as mean ± standard deviation of scores. Cumulative bar plot is the sum of the mean values of each dietary assessment parameter score.

(Figure 5A, B, D, and F). The mood states within each group did not change significantly between the initial and final evaluation points.

5. Multivariate regression to determine major factors affecting diet intake

A total of 88 diet intake points were recorded for the 10 subjects. Six significant and independent parameters were selected for the multivariate analysis from univariate regression analysis: taste, hunger, craving for sweet- and salty-tasting items, vigor-activity and confusion-bewilderment. A multivariate regression analysis revealed that the taste of the diet and a craving for sweet-tasting items before the meal had significant positive effects on diet intake (partial regression coefficient (r) = 0.798, $p < 0.001$ and $r = 0.207$, $p = 0.005$, respectively), while hunger, craving for salty-tasting items, vigor-activity and confusion-bewilderment did not have considerable effects on diet intake ($r = 0.142$, $p = 0.184$; $r = -0.092$, $p = 0.393$; $r = -0.086$, $p = 0.750$; $r = -0.578$, $p = 0.112$, respectively). Additionally, deliciousness was correlated with aftertaste ($r = 0.958$, $p < 0.001$), taste ($r = 0.932$, $p < 0.001$), smell ($r = 0.852$, $p < 0.001$), and presentation ($r = 0.791$, $p < 0.001$) from VAS 2.

Discussion

This quasi-randomized controlled study investigated the impact of a mousse diet on diet intake and psychological status in healthy adult females. The results can be summarized as follows: (i) The diet intake and dietary assessment values were higher in the normal diet group than the mousse diet group; (ii) the anger-hostility and fatigue-inertia scores of the mousse diet group were temporarily higher than those of the normal diet group, while the fluctuation in mood status in both groups remained within the normal range throughout the study period; and (iii) the factors determining diet intake amount were the taste of the diet and a craving for sweet-tasting items before the meals.

Oba et al. broadly divided the factors determining deliciousness into six categories: chemical factors, such as taste and smell of the food; physical factors, such as presentation; texture and temperature of food; individual physiological factors, such as gender, age, health status, and hunger; psychological factors, such as emotional state; and environmental factors, such as career, religion, and dietary history [19]. In our study, taste and deliciousness were treated as equivalent items in VAS and the subjects assessed them at the same timing. Consequently, the scores for these factors were strongly correlated.

On the other hand, there were no significant differences in the craving for specific tasting items between the two groups at almost all evaluation points. One reason might be that the subjects were provided with a variety of subsidiary items at each meal during the study period.

As for the relationship between diet intake and various intrinsic and extrinsic factors, taste and a craving for sweet-tasting items was correlated with diet intake, while appetite and mood status before the meals was not. A study by Takahashi et al. revealed that appetite, people eating at the same table, health condition, and mood significantly influenced diet intake in healthy

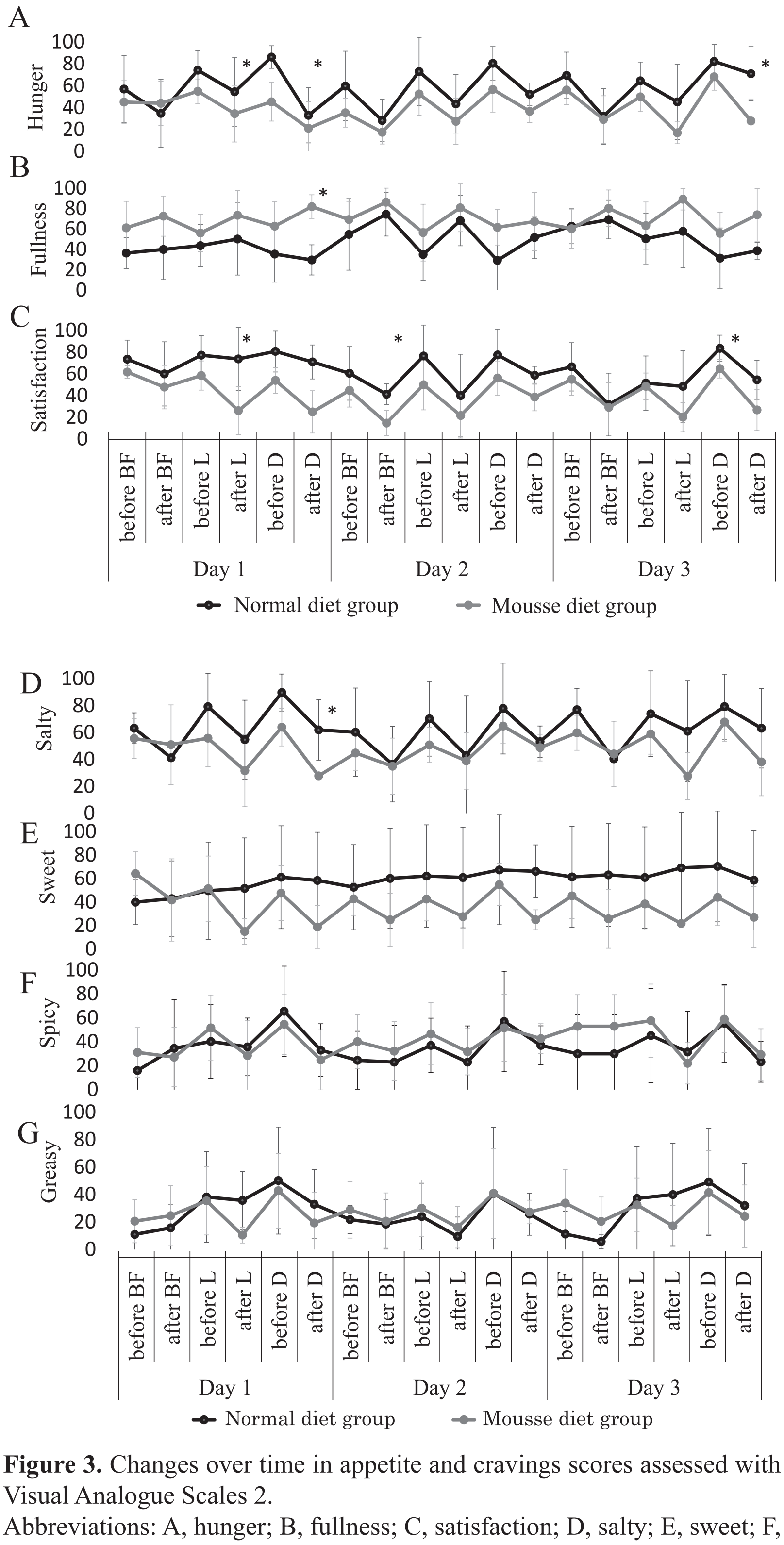

Figure 3. Changes over time in appetite and cravings scores assessed with Visual Analogue Scales 2.

Abbreviations: A, hunger; B, fullness; C, satisfaction; D, salty; E, sweet; F, spicy; G, greasy; BF, breakfast; L, lunch; D, dinner.

Note: Data is presented as mean ± standard deviation of scores. Normal diet group: $n = 4$; Mousse diet group: $n = 6$. *** $p < 0.001$, Mann-Whitney U test for between-group comparisons.

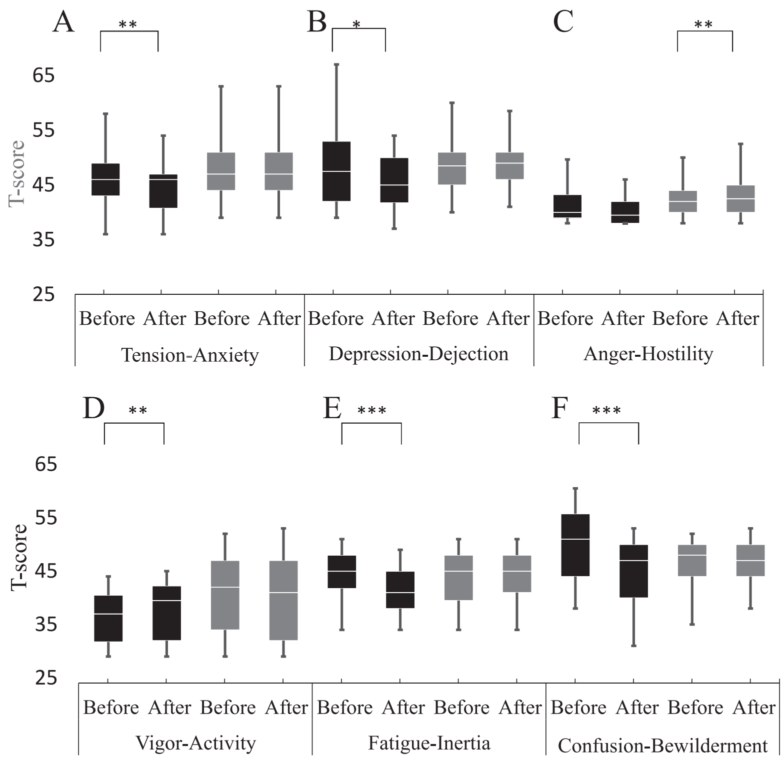

Figure 4. Change in mood assessed with the Profile of Mood States before and after diet consumption.
Abbreviations: A, tension-anxiety; B, depression-dejection; C, anger-hostility; D, vigor-activity; E, fatigue-inertia; F, confusion-bewilderment.
Note: Boxes represent the interquartile range (IQR) from the 25th to 75th percentile, while the horizontal white line in the box represents the median value; the whiskers extend to the most extreme data point within 1.5 times the IQR. *$p < 0.05$, ** $p < 0.01$ and *** $p < 0.001$, Wilcoxon signed-rank test for within-group comparisons.

adults [20]. These results contradict the results in our study, but there are several potential reasons for this: (i) Dietary intake was impacted more by the taste of the diet than by the individual's appetite; (ii) there were no differences in appetite before the meal between the two groups; (iii) the previous study included subjects who felt sick at the time of entry into the study, while our subjects' moods were normal at the start and remained within a clinically normal range throughout the study period.

A significant difference in anger-hostility scores was observed between the groups. Ben-Zur H. et al. reported that three basic aspects of harmful events affect anger: the extent of damage caused by the event, the causes of the damaging act, and the likelihood of damage occurrence [21]. In our study, increases in anger-hostility most likely arose from psychological damage caused by eating a tasteless diet and being deprived of the freedom to choose a diet. Furthermore, these differences were observed after consumption of the mousse diet, but disappeared by the next meal. A previous study indicated that anger or intense emotions fade over time, although the degree of change during the calming process is correlated with the strength of the anger or intense emotion at onset [22]. We thought this rapid elimination was largely a result of normal anger-hostility scores and normal mood status at the baseline. Yukawa et al. described that the degree of anger correlates positively with only psychological damage, whereas depression correlates with both psychological and physical damage [23]. However, there were no significant differences in depression-dejection scores between the two groups in our study.

On the other hand, many inpatients who are suffering from dysphagia experience various stresses caused by their poor physical condition, concern about financial burden, and change in living environment [24], and their mood status tends to be at the upper limit of normal or abnormal. With an abnormal mood status, dietary changes could act as a trigger for increased anger or hostility. Anger that is not calmed is often outwardly expressed as aggressive behavior and blame shifting to others. On the contrary, anger can sometimes be contained in the mind or relieved by an indirect emotional expression rather than effusive language and behavior [25]. Since both restraining and effusion of

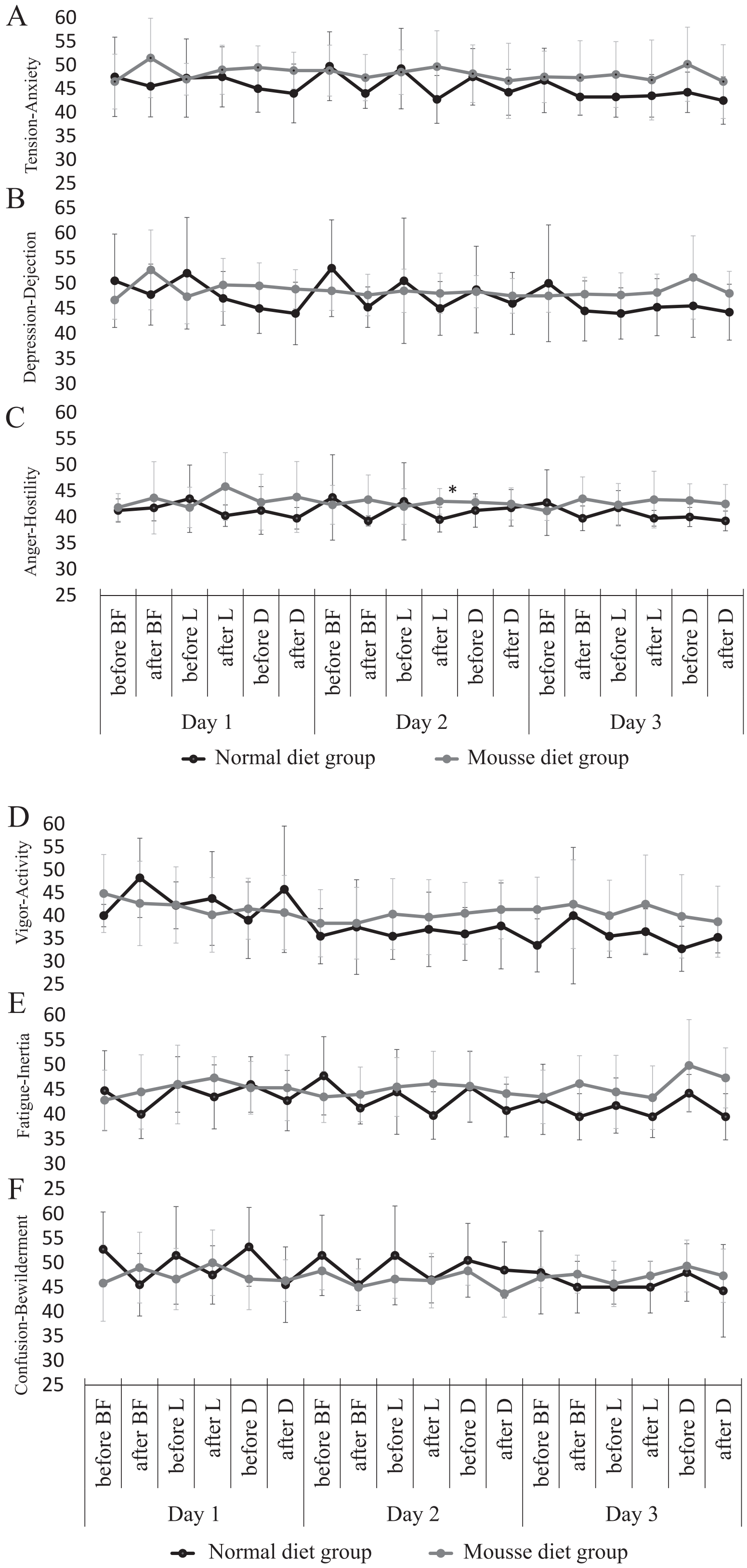

Figure 5. Changes over time in mood assessed with the Profile of Mood States. Abbreviations: A, tension-anxiety; B, depression-dejection; C, anger-hostility; D, vigor-activity; E, fatigue-inertia; F, confusion-bewilderment; BF, breakfast; L, lunch; D, dinner.

Note: Data represents mean ± standard deviation of the T-scores. Normal diet group: *n* = 4; Mousse diet group: *n* = 6. * $p < 0.05$, Mann-Whitney *U* test for between-group comparisons.

anger are considered to be risk factors for cardiovascular disease [26, 27], it is important to reduce situations that incite anger in patients.

Several limitations of our study bear mention. First, there were a small number of female subjects, which limits the generalization of our results. Therefore, further studies involving more male and female subjects and/or dysphagic patients are needed. Second, we were unable to measure gastrointestinal hormones, such as leptin and ghrelin, which are important factors in appetite control. Third, we cannot deny that the differences in not only the diet's form but also the taste between the diets affected the results of multiple regression analysis. Despite these limitations, the results demonstrated that the mousse diet has the potential for deleterious effects on anger-hostility and diet intake through the diet's physical and chemical properties.

Conclusion

The mousse diet can trigger low food intake with mood fluctuation. This suggests that a change in the diet form in response to recovery of swallowing function may help improve patients' appetite.

Author Contributions

SK, EI, TK, RH, TS, FS, and DY conceived and designed the study. SK, EI, MW, and NK analyzed the data. SK, MM, and YO contributed materials and analysis tools. SK, EI, MM, and TF wrote the paper.

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Supplemental data

		Presentation	*p*-Value	Smell	*p*-Value	Taste	*p*-Value	Aftertaste	*p*-Value	Deliciousness	*p*-Value
	breakfast	89.0 ± 16.7 vs. 22.1 ± 13.6	0.011*	80.7 ± 14.1 vs. 41.6 ± 24.9	0.019*	88.5 ± 10.4 vs. 38.6 ± 15.3	0.011*	87.0 ± 12.6 vs. 32.7 ± 21.9	0.010*	82.7 ± 22.4 vs. 28.7 ± 20.3	0.019*
Day 1	lunch	92.7 ± 13.6 vs. 22.2 ± 12.6	0.010*	41.6 ± 24.8 vs. 32.3 ± 21.7	0.019*	38.6 ± 15.3 vs. 29.3 ± 19.2	0.010*	32.6 ± 21.9 vs. 24.3 ± 16.5	0.011*	28.6 ± 20.3 vs. 25.8 ± 18.7	0.010*
	dinner	93.5 ± 9.1 vs. 20.0 ± 12.4	0.010*	95.7 ± 5.7 vs. 40.3 ± 16.0	0.010*	95.5 ± 6.1 vs. 46.7 ± 10.5	0.010*	95.0 ± 6.6 vs. 34.7 ± 4.1	0.009**	95.0 ± 6.6 vs. 39.3 ± 6.0	0.010*
	breakfast	88.5 ± 12.4 vs. 35.8 ± 18.3	0.011*	88.5 ± 16.0 vs. 36.6 ± 18.3	0.011*	84.7 ± 10.5 vs. 42.2 ± 17.0	0.011*	83.0 ± 4.1 vs. 34.5 ± 18.0	0.011*	86.5 ± 6.0 vs. 39.3 ± 22.0	0.011*
Day 2	lunch	93.2 ± 12.2 vs. 36.7 ± 15.4	0.010*	93.2 ± 12.2 vs. 34,3 ± 22.3	0.010*	92.0 ± 16.0 vs. 33.2 ± 18.3	0.009**	82.0 ± 26.4 vs. 28.0 ± 16.5	0.018*	91.5 ± 15.7 vs. 31.5 ± 17.5	0.010*
	dinner	84.7 ± 17.7 vs. 25.2 ± 18.8	0.010*	91.2 ± 17.5 vs. 47.3 ± 26.4	0.023*	91.2 ± 10.2 vs. 48.8 ± 29.4	0.032*	87.7 ± 15.8 vs. 46.3 ± 28.7	0.032*	92.2 ± 12.4 vs. 52.2 ± 26.7	0.019*
	breakfast	91.2 ± 17.5 vs. 30.0 ± 16.8	0.010*	91.0 ± 16.7 vs. 36.5 ± 20.6	0.010*	82.7 ± 20.0 vs. 35.8 ± 16.4	0.010*	72.7 ± 33.9 vs. 31.0 ± 14.4	0.054	83.7 ± 20.6 vs. 31.8 ± 17.6	0.010*
Day 3	lunch	88.5 ± 12.6 vs. 24.3 ± 13.8	0.011*	85.2 ± 17.4 vs. 41.7 ± 23.5	0.025*	75.5 ± 18.4 vs. 40.5 ± 16.0	0.033*	71.0 ± 20.5 vs. 38.3 ± 19.4	0.033*	72.2 ± 21.5 vs. 41.2 ± 17.8	0.069
	dinner	97.0 ± 6.0 vs. 28.2 ± 14.7	0.010*	92.5 ± 9.63 vs. 36.0 ± 24.0	0.010*	79.0 ± 35.6 vs. 34.0 ± 22.0	0.087	80.0 ± 23.2 vs. 30.5 ± 22.7	0.032*	83.0 ± 21.8 vs. 37.3 ± 23.5	0.033*

*$p < 0.05$ and **$p < 0.01$, Mann-Whitney U test between normal diet and mousse diet.