

Comparison of Line Spread Test (LST) Results of Eight Different types of Thickeners Performed on Vegetable Menus (Salmon and Vegetable with Egg Sauce) that can be Crushed with Gums

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ABSTRACT

Japan is a super-aging society. Therefore, there is a shortage of welfare facilities that can accept elderly people for the number of elderly people who need long-term care. Then, in many cases, it is necessary to provide long-term care at home. One of the problems that caregivers have when they are at home is nursing care food. Creating three meals daily is physically, mentally, and economically burdensome for the caregiver. So, this research, we used a commercially available universal design food (UDF), and by combining it with a commercially available thickener, we aimed to create a nursing care food menu that can be created even at home. Among the universal design foods (UDF) on the market, the method is crushable with a tooth gums, salmon and vegetable egg sauce, (100g retort pack, sold for 190 Japanese yen (1.73 USD)). The nutritional value is 67kcal of energy, 4.1g of protein, 1.3g of lipid, 9.3g of carbohydrate, and 0.8g of salt equivalent per 100g. After that, the viscosity was examined 30 seconds and 5 minutes later, and a meal that was easy to swallow was prepared. A line spread test (LST) was performed to measure the viscosity of this food. The LST values were statistically compared. Using Excel Statistics 2010 (manufactured by SSRI) as the statistical software, if there is no significant difference after the F test in the comparison between 30 seconds and 5 minutes in each thickener, a parametric test, the student-t test, was performed. Using the test, if there was a significant difference in the F test, a nonparametric test, the Wilcoxon test, was performed. As a result, it was found that the viscosity of all eight types of thickeners decreased with time, but the A thickener (dextrin (in Japan)/Thickening polysaccharide Potassium chloride Sweetener (Sucralose)) was the most stable of the eight types. Since eating takes time, stability is required as much as possible. Thickener A had the best compatibility with the foods on the market this time in the future, we will continue to measure LST values for many foods and that can be used in ordinary households.

KEYWORDS: Line spread test (LST); Universal design food (UDF); Thickener; Crushed with gums

ABBREVIATIONS: LST: Line Spread Test; UDF: Universal Design Food

INTRODUCTION

Considering that the number of long-term cares at home will increase in the future, research on long-term care foods that can be made at home will become more important. Looking at the number of facilities for the elderly in Japan by type, according to the overview of the 2017 Social Welfare Facility Survey, the largest number is elderly homes by paid, and the number is 13,525, which

is charged with long-term care. The number included 3 types of homes for the elderly, long-term care nursing homes by paid, home-based nursing homes by paid, and healthy nursing homes by paid. The next most common is group homes for people with dementia, with 12,124 facilities, and the third most common is the low-cost, public nursing homes for the elderly with 7,891 facilities.

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However, looking at the number of people, the number of special elderly nursing homes was 540,000, which was the largest number of residents. From this, it is expected that the demand for long-term care food will increase more and more in the future.

Dietary protein supplementation is important to prevent sarcopenia [1,2] and frailty [3-9] in the nutritional status of the elderly. A thickened diet is required for safe dietary intake [10]. In the case of long-term care, a concentrated liquid diet may be used to prevent undernutrition. At that time, when the swallowing function is weakened, thickening is performed on foods and meals containing a large amount of water in order to avoid aspiration pneumonia [11-13]. Measuring viscosity before serving a meal is necessary for a safe meal serving [14-16].

PURPOSE

Therefore, in this study, aiming at a long-term care food that can be prepared at home, we started by using a commercially available product with uniform quality and adding viscosity to the food by adding a commercially available thickener to feed it. We aimed to create a long-term care food that is difficult to swallow and adheres to the swallowing pyramid advocated by the Swallowing

Rehabilitation Society. As already reported in previous studies, this study uses two types of thickeners, mainly dextrin (in Japan)/Thickening polysaccharide and Dietary fiber), and among multiple commercially available universal design food (three types) that do not need to be chewed. LST tests were performed using each of the three types of thickeners that can be crushed with the gums and three types that can be easily chewed, and results were obtained. Therefore, in this study, we used eight types of thickeners that can be obtained at nearby pharmacies at home and used a thickener for salmon and vegetable egg sauce, which are commercially available vegetables that can be crushed with gums. We decided to compare the viscosities of the above using the LST test.

MATERIALS AND METHODS

Commercially Available Thickener

Eight products commercially available in pharmacies were used as over-the-counter thickeners. Since it is a thickener, the nutritional components are shown in Table 1 & 2. All eight types of thickeners were dextrin-based thickeners. The price was in the price range that can be purchased by ordinary households (100g is within 1000 Japanese yen).

Table 1: Nutritional values of eight types of thickeners (per 100 grams).

Per 100g	Energy kcal	Protein g	Lipids g	Sugar g	Dietary Fiber g	Salt Equivalent g
A	263	0~10	0~10	64.3	23.5	1.4
B	261	0.7	0	46	37	2.4
C	292	0.5	0	60.5	23.8	3.9
D	270	0.5	0	67.5	21.9	2.5
E	290	0.5	0	59.6	24.9	3.7
F	230	0.3~1.0	0	54.9	34.3	4.7
G	288	0.4~1.7	0~0.3	54	33	4.5
H	230	0.3~1.0	0	60.5	34.3	4.7

Table 2: Ingredients of eight kinds of thickeners (per 100g).

Per 100g	Individual wrapping (price)g x wrapping = Yen	Per 100g Price Yen	Ingredients Name	Price (\$) 1\$ = 110¥
A	3g x 50 wrapping = 1274¥	849¥	dextrin (in Japan)/ Thickening polysaccharide, Potassium chloride, Sweetener (Sucralose)	11.6\$
B	1.5g x 50 wrapping = 728¥	971¥	dextrin (in Japan)/ Thickening polysaccharide, Potassium chloride	6.6\$
C	1.5g x 50wrapping = 537¥	716¥	dextrin (in Japan)/ Thickening polysaccharide, pH adjuster	4.9\$
D	3g x 50 wrapping= 1390¥	927¥	dextrin (in Japan), Xanthan gum, Calcium lactate, Trisodium citrate	12.6\$
E	2.5g x 50wrapping = 1130¥	904¥	dextrin (in Japan)/ Thickening polysaccharide, pH adjuster	10.3\$
F	3g x 50wrapping = 1490¥	993¥	dextrin (in Japan)/ Thickening polysaccharide, (CMC), Sodium gluconate, Magnesium chloride	13.5\$
G	2g x 30wrapping = 476¥	793¥	dextrin (in Japan)/ Thickening polysaccharide, Emulsifier	4.3\$
H	3g x 50wrapping = 1490¥	993¥	dextrin (in Japan)/ Thickening polysaccharide (CMC), Sodium gluconate, Magnesium chloride	13.5\$

Commercially Available Long-Term Care Food

One product forms the crushable by gums category of universal design foods on the market, salmon and vegetable egg sauce, was used. All are sold in 100g retort pouches for 190 Japanese Yen (1.73 USD).

The nutritional value was 67Kcal of energy, 4.1g protein, 1.3g of fat, 9.3g of carbohydrate, and 0.8g of salt equivalent per 100g.

Preparation of Sample (Food with Thickener)

One food was prepared into 5 samples. 1. The viscosity of the food itself was measured as it was without any modification. 2. The

food was crushed for 20 seconds using a mixer, pulverized into a liquid state, and the viscosity was measured. 3. The viscosity was measured after adding 1g of thickener (A,B,C,D,E,F,G,H) to the food (100g) ground for 20 seconds with a mixer and stirring for 5 minutes. 4. The viscosity was measured after adding 2g of thickener (A,B,C,D,E,F,G,H) to the food (100g) ground for 20 seconds with a mixer and stirring for 5 minutes. 5. The viscosity was measured after adding 3g of thickener (A,B,C,D,E,F,G,H) to the food (100g) ground for 20 seconds with a mixer and stirring for 5 minutes.

Viscosity Measurement Method

The viscosity of each sample was measured using line spread test (LST) starter kit manufactured by SARAYA. The measurement criteria are as follows. The viscosity was measured at room temperature of 24 °C. The test was repeated 3 times and the average value was calculated.

- 1) Place the sheet on a horizontal surface and place a ring with an inner diameter of 30 mm in the center of the concentric circles.
- 2) Add up to 1 tablespoon (20ml) of the thickening liquid to be measured and let stand for 30 seconds.
- 3) Lift the ring horizontally, and after 30 seconds, measure the spread distance of the solution at 1-6 points. Let the average value be the LST value.
- 4) After leaving it for 5 minutes, the spread distance of the solution was measured again at 6 points, and the average value was taken as LST.

Viscosity Criteria

There are three levels of classification by LST values. The first stage is a thin thickening with a viscosity that falls within 43-36mm

(50~150mPa•s). The property is that when you tilt the spoon, it runs down smoothly. The second stage is an intermediate thickening with a viscosity that falls within 36-32mm (150~300mPa•s). The property is that when you tilt the spoon, it flows like a pottage. The third stage is a thick thickening with viscosity that falls within 32-30 mm (300~500 mPa•s). Even if the spoon is tilted, the shape is kept moderate, and it is difficult to flow.

Statistical Processing

This study was statistically processed using statistical processing software, Excel 2010 (SSRI Co., Ltd.). The data to be compared were first tested for the normal distribution by F-test. For comparison between correlation data, paired Student-t test was used for normal distribution data. The Wilcoxon test was used for non-normally distributed data. For comparisons between uncorrelated data, the student-t test, which is not bear to the normal distribution, was used. The Mann-Whitney test was used for the non-normal distribution.

RESULTS

LST Test Results using 8 Types of Thickeners

The LST value obtained as it is without adjustment and the LST value obtained after 20 seconds in the mixer, with the salmon and vegetable egg sauce, which is a commercially available UDF that can be crushed with the gums, used this time. Table 3 shows the results of the LST values measured by adding 1g, 2g, and 3g of each of eight types of thickeners. For all thickeners, the LST value was higher after 5 minutes than after 30 seconds, but thickener A had the highest viscosity. Other than that, the thickeners F, B, D, H, E, G, and C had the highest viscosities in that order.

Table 3: LST results with eight thickeners (Crushable with gums: salmon and vegetable with egg sauce).

Thickener Name	Points 3X (6points)	No Modify		After Mixing		Add Thickener 1g		Add Thickener 2g		Add Thickener 3g	
		After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes
A	Average Value	28.6	31.3	33.4	35	15.5	16.6	13.6	14.6	12.1	13.1
	Standard Deviation	4.9	5.1	2.2	2.4	13.9	15	11.2	12.2	8.9	9.4
B	Average Value	30.3	33.1	33.8	35.3	27.4	28.7	21.7	23.4	20.8	21.7
	Standard Deviation	6	5	2.4	2.6	2.1	1.9	3.6	3.6	5.7	6.2
C	Average Value	28.5	31.1	31.3	32.7	31.2	33.7	24.3	26.6	20.3	21.7
	Standard Deviation	4.5	5.1	3	3.3	1.4	1.7	1.8	1.9	2.9	3.5
D	Average Value	26.8	29.7	32.6	34.3	28.7	31	28	30.8	20.1	22.3
	Standard Deviation	3.3	3.9	1.3	1.5	2.8	2.9	1.6	1.9	3.6	3.5
E	Average Value	28.1	31.3	34	35.7	29.5	32.2	28.1	31.1	22	23.4
	Standard Deviation	5.8	6.7	3	3.2	2.4	2.4	1.8	1.4	1.9	2.3

F	Average Value	29.2	317	33.6	35.1	26.3	28.3	23.4	24.7	19.7	20.7
	Standard Deviation	6.2	6.4	2.1	2.3	2.7	2.9	3.3	3.5	4.6	5.1
G	Average Value	27.7	30.1	33.8	35.5	30.3	32.8	21.6	23.1	20.1	22
	Standard Deviation	3.8	4.6	1.5	1.8	1.4	1.4	4.4	52	3.5	4.8
H	Average Value	29.9	31.9	34.9	36.3	28.4	30.4	21.8	22.6	21.7	22.7
	Standard Deviation	4.4	3.8	2.4	2.4	2.1	2.1	4.3	4.6	2.8	3.2

Statistical Processing Results of LST Test using 8 Types of Thickeners

Comparison of LST values after 30 seconds and 5 minutes in salmon and vegetable egg sauce that can be crushed with gums UDF on the market before adding thickeners: The LST values of salmon and vegetable egg sauce that can be crushed with the gums were statistically compared. The variance between

the two groups was examined by F-test. As a result, it was shown that there was no statistically significant difference in any case. Whether the LST value changed after 30 seconds to 5 minutes was investigated using a paired Student-t test. The results are shown in Table 4. In each case, the LST value was statistically significantly higher after 5 minutes than after 30 seconds. It was shown that the viscosity changed over time.

Table 4: Crushable with gums: salmon and vegetable with egg. Statistical comparison of LST values after 30 seconds and 5 minutes.

Test	No Modify		After Mixing	
	After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes
F Test	0.23		0.335	
Pair-t test	0.0001**		0.0001**	
F Test	0.244		0.332	
Pair-t test	0.0001**		0.0001**	
F Test	0.214		0.322	
Pair-t test	0.0001**		0.0001**	

Statistical results after 30 seconds and 5 minutes in LST values performed using 8 types of thickeners: Eight types of thickeners added to a commercially available UDF, salmon and vegetable egg sauce that can be crushed with gums The LST values at that time were statistically compared. F-test was performed 30 seconds and 5 minutes after the addition of 1g, 2g, and 3g of thickener, respectively, to examine the dispersion between the two

groups. Since the F-test was not statistically significant in all cases, the paired Student-t test was used to compare the LST values after 30 seconds and 5 minutes. The results are shown in Table 5. For all thickeners, the LST value was higher after 5 minutes than after 30 seconds, regardless of the number of grams of thickener added. It was shown that the viscosity became weaker with time.

Table 5: Statistical comparison of LST values after 30 seconds and 5 minutes using different types of thickeners.

Thickeners	Test	Add Thickener 1g		Add Thickener 2g		Add Thickener 3g	
		After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes	After 30 Seconds	After 5 Minutes
A	F Test	0.493		0.364		0.401	
	Pair-t test	0.0001**		0.003*		0.001*	
B	F Test	0.349		0.499		0.364	
	Pair-t test	0.0001**		0.004**		0.003**	
C	F Test	0.244		0.401		0.235	
	Pair-t test	0.0001**		0.0001**		0.0001**	
D	F Test	0.474		0.24		0.433	
	Pair-t test	0.0001**		0.0001**		0.0001*	
E	F Test	0.5		0.144		0.224	
	Pair-t test	0.0001**		0.0001**		0.0001**	
F	F Test	0.377		0.403		0.315	
	Pair-t test	0.0001**		0.0001**		0.002**	

G	F Test	0.439	0.245	0.086
	Pair-t test	0.009**	0.009**	0.001**
H	F Test	0.5	0.391	0.289
	Pair-t test	0.0001**	0.0001**	0.048*

Statistical comparison results of LST value after 30 seconds at each thickener amount using 8 kinds of thickeners: Next, then after 30 seconds between each thickener amount at 8 kinds of thickeners The LST values were statistically compared. There was no statistical difference in the LST values of thickener A and

thickener H when 2g of thickener was added and when 3g was added. However, the LST value of the other 5 types of thickeners was smaller when 3g was added than when 2g was added. That is, it was found that the viscosity was strong (Table 6).

Table 6: Statistical comparison of LST values after 30 seconds between thickeners supplemented with eight thickeners.

Thickeners	Test	After 30 Seconds		After 30 Seconds		After 30 Seconds	
		Add Thickener 1g	Add Thickener 2g	Add Thickener 1g	Add Thickener 3g	Add Thickener 2g	Add Thickener 3g
A	F Test	0.132		0.301		0.277	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.271	
B	F Test	0.0014*		0.0001**		0.031*	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.182	
C	F Test	0.179		0.002**		0.021*	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.0001**	
D	F Test	0.013*		0.158		0.001*	
	Pair-t test Wilcoxon	0.452		0.0001**		0.0001**	
E	F Test	0.114		0.172		0.387	
	Pair-t test Wilcoxon	0.045**		0.0001**		0.0001**	
F	F Test	0.199		0.015*		0.093	
	Pair-t test Wilcoxon	0.001**		0.0001**		0.009**	
G	F Test	0.0001**		0.0001**		0.156	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.267	
H	F Test	0.002*		0.135		0.031*	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.787	

Statistical comparison results of LST value after 5 minutes between each thickener amount using 8 kinds of thickeners: Similarly, 5 minutes after addition of each thickener amount in 8 kinds of thickeners The LST values were statistically compared. There was no statistical difference in the LST values of the

thickeners D and G when 1g of the thickener was added and when 2g of the thickener was added. However, it was found that the LST value of the other 6 types of thickeners was smaller when 2g was added than when 1g was added, that is, the viscosity was stronger (Table 7).

Table 7: Statistical comparison of LST values after 5 minutes between thickeners supplemented with eight thickeners.

Thickeners	Test	After 30 Seconds		After 30 Seconds		After 30 Seconds	
		Add Thickener 1g	Add Thickener 2g	Add Thickener 1g	Add Thickener 3g	Add Thickener 2g	Add Thickener 3g
A	F Test	0.227		0.227		0.498	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.31	
B	F Test	0.0001**		0.0001**		0.031*	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.078	
C	F Test	0.34		0.002**		0.007**	
	Pair-t test Wilcoxon	0.0001**		0.0001**		0.0001**	

D	F Test	0.051	0.22	0.009**
	Pair-t test Wilcoxon	0.84	0.0001**	0.0001**
E	F Test	0.013	0.424	0.020*
	Pair-t test Wilcoxon	0.187	0.0001**	0.0001**
F	F Test	0.219	0.011**	0.05
	Pair-t test Wilcoxon	0.002**	0.0001**	0.009**
G	F Test	0.0001**	0.0001**	0.373
	Pair-t test Wilcoxon	0.0001**	0.0001**	0.534
H	F Test	0.001*	0.050*	0.056
	Pair-t test Wilcoxon	0.0001**	0.0001**	0.901

In addition, there was no statistically significant difference in the thickeners A, B, G, and H between the case where 2g of the thickener was added and the case where 3g of the thickener was added. However, it can be seen that the LST value of the other four types of thickeners is smaller when 3g is added than when 2g is added, that is, the viscosity is stronger. Statistical comparison results of 1g and 3g additions of 8 types of thickeners showed that the LST value was smaller; that is, the viscosity was stronger when 3g was added than when all 1g was added.

Statistical comparison results 30 seconds after LST after addition of 1g of 8 types of thickeners (multiple comparison by Schaffer method; lateral direction): Table 8 shows the statistical comparison results after 30 seconds of LST after adding 1g of 8 types of thickeners. It was found that the thickeners C, E, and G had a significantly higher LST value and a lower viscosity than the thickener A.

Table 8: Statistical comparison of LST values 30 seconds after 1g of each thickener was added. (Multiple comparison by Scheffe's method: Horizontal direction, Established higher).

	A	B	C	D	E	F	G	H
A	-----	0.987	0.0001**	0.278	0.031	1.000	0.001**	0.463
B	0.987	-----	0.001**	0.855	0.329	0.954	0.042*	0.954
C	0.0001**	0.001**	-----	0.166	0.668	0.0001**	0.985	0.077
D	0.278	0.855	0.166	-----	0.993	0.186	0.743	1.000
E	0.031*	0.329	0.668	0.993	-----	0.014*	0.993	0.96
F	1.000	0.954	0.0001**	0.166	0.014*	-----	0.0001**	0.311
G	0.001**	0.042*	0.985	0.743	0.993	0.0001**	-----	0.545
H	0.436	0.954	0.077	1.000	0.96	0.311	0.545	-----

Statistical comparison results 5 minutes after LST after addition of 1g of 8 types of thickeners (multiple comparison by Schaffer method; lateral direction): Table 9 shows the statistical comparison results after 5 minutes of LST after adding 1g of 8

types of thickeners. It was found that the thickeners C, D, E, and G had a significantly higher LST value and a lower viscosity than the thickener A.

Table 9: Statistical comparison of LST values 5 minutes after 1g of each thickener was added. (Multiple comparison by Scheffe's method: Horizontal direction, Established higher).

	A	B	C	D	E	F	G	H
A	-----	0.982	0.0001**	0.014*	0.0001**	0.999	0.0001**	0.088
B	0.982	-----	0.0001**	0.232	0.005**	1.000	0.0001**	0.6
C	0.0001**	0.0001**	-----	0.088	0.760	0.0001**	0.98	0.014*
D	0.014*	0.232	0.088	-----	0.937	0.103	0.609	0.999
E	0.0001**	0.005**	0.760	0.937	-----	0.001*	0.999	0.648
F	0.999	1.000	0.0001**	0.103	0.001**	-----	0.0001**	0.370
G	0.0001**	0.0001**	0.980	0.608	0.999	0.0001**	-----	0.238
H	0.088	0.6	0.014**	0.999	0.648	0.370	0.238	-----

Statistical comparison results 30 seconds after LST after addition of 2g of 8 types of thickeners (multiple comparison by Schaffer method; lateral direction): Table 10 shows the statistical comparison results after 30 seconds of LST after adding

2g of 8 types of thickeners. It was found that the thickeners D and E had a significantly higher LST value and a lower viscosity than the thickener A.

Table 10: Statistical comparison of LST values 30 seconds after 2g of each thickener was added. (Multiple comparison by Scheffe's method: Horizontal direction, Established higher).

	A	B	C	D	E	F	G	H
A	-----	0.999	0.799	0.0001**	0.0001**	0.991	0.999	0.999
B	0.999	-----	0.516	0.0001**	0.0001**	0.913	1.000	1.000
C	0.799	0.516	-----	0.76	0.067	0.998	0.456	0.546
D	0.0001**	0.0001**	0.076	-----	1.000	0.007**	0.0001**	0.0001**
E	0.0001**	0.0001**	0.067	1.000	-----	0.006**	0.0001**	0.0001**
F	0.991	0.913	0.998	0.007**	0.006**	-----	0.881	0.927
G	1.000	1.000	0.456	0.0001**	0.0001**	0.881	-----	1.000
H	1.000	1.000	0.545	0.0001**	0.0001**	0.927	1.000	-----

Statistical comparison results 5 minutes after LST after addition of 2g of 8 types of thickeners (multiple comparison by Schaffer method; lateral direction): Table 11 shows the statistical comparison results after 5 minutes of LST after adding

2g of 8 types of thickeners. It was found that the thickeners D and E had a significantly higher LST value and a lower viscosity than the thickener A.

Table 11: Statistical comparison of LST values 5 minutes after 2g of each thickener was added. (Multiple comparison by Scheffe's method: Horizontal direction, Established higher).

	A	B	C	D	E	F	G	H
A	-----	1.000	0.121	0.0001**	0.0001**	0.874	1.000	1.000
B	1.000	-----	1.344	0.0001**	0.0001**	0.985	1.000	0.999
C	0.121	0.344	-----	0.043*	0.022*	0.905	0.197	0.079
D	0.0001**	0.0001**	0.043*	-----	1.000	0.0001**	0.0001**	0.0001**
E	0.0001**	0.0001**	0.022*	1.000	-----	0.0001**	0.0001**	0.0001**
F	0.874	0.985	0.905	0.0001**	0.0001**	-----	0.942	0.796
G	1.000	1.000	0.197	0.0001**	0.0001**	0.942	-----	1.000
H	1.000	0.999	0.079	0.0001**	0.0001**	0.796	1.000	-----

Statistical comparison results 30 seconds after LST after addition of 3g of 8 types of thickeners (multiple comparison by Schaffer method; lateral direction): Table 12 shows the

statistical comparison results after 30 seconds of LST after adding 3g of 8 types of thickeners. All were not statistically significant.

Table 12: Statistical comparison of LST values 30 seconds after 3g of each thickener was added. (Multiple comparison by Scheffe's method: Horizontal direction, Established higher).

	A	B	C	D	E	F	G	H
A	-----	1.000	0.995	0.983	1.000	0.936	0.987	1.000
B	1.000	-----	1.000	1.000	0.995	0.995	1.000	0.999
C	0.995	1.000	-----	1.000	0.962	1.000	1.000	0.990
D	0.983	1.000	1.000	-----	0.914	1.000	1.000	0.968
E	1.000	0.995	0.962	0.914	-----	0.800	0.926	1.000
F	0.936	0.995	1.000	1.000	0.800	-----	1.000	0.901
G	0.987	1.000	1.000	1.000	0.926	1.000	-----	0.974
H	1.000	0.999	0.990	0.968	1.000	0.901	0.974	-----

Statistical comparison results 5 minutes after LST after addition of 3g of 8 types of thickeners (multiple comparison by Schaffer method; lateral direction): Table 13 shows the

statistical comparison results after 5 minutes of LST after adding 3g of 8 types of thickeners. All were not statistically significant.

Table 13: Statistical comparison of LST values 5 minutes after 3g of each thickener was added. (Multiple comparison by Scheffe's method: Horizontal direction, Established higher).

	A	B	C	D	E	F	G	H
A	-----	1.000	1.000	1.000	0.995	0.994	1.000	1.000
B	1.000	-----	1.000	1.000	0.997	0.999	1.000	0.999
C	1.000	1.000	-----	1.000	0.981	0.999	1.000	0.999
D	1.000	1.000	1.000	-----	0.998	0.984	1.000	1.000
E	0.995	0.997	0.981	0.998	-----	0.771	0.994	1.000
F	0.994	0.999	0.999	0.984	0.771	-----	0.995	0.939
G	1.000	1.000	1.000	1.000	0.994	0.995	-----	1.000
H	1.000	0.999	0.999	1.000	1.000	0.939	1.000	-----

DISCUSSION

Using 8 types of thickeners, add 1g, 2g, and 3g of thickeners to the salmon and vegetable egg sauces, which are the vegetable menus in the category that can be crushed with toothpaste, which is a commercially available universal design food. And compared the LST. As a result, there was a tendency for the LST value to be higher and the viscosity to be lower after 30 seconds and 5 minutes for the KST value of each thickener. Some thickeners were statistically significantly less viscous. In addition, the larger the amount of thickener added, the lower the LST value and the higher the viscosity. It was statistically significantly higher depending on the thickener. In addition, eight types of thickeners were compared using multiple comparisons by Scheffe's method. As a result, it was shown that the thickener A was statistically significantly highly viscous regardless of whether 1g was added or 2g was added. However, when 3g of the thickener was added, there was no difference in viscosity between the eight types of thickeners.

In order to provide a safe and secure meal, the viscosity must be stable. For that purpose, the combination of diet or food and thickener is important. It was found that the thickener A in this food has a more stable viscosity than other thickeners. However, in foods, when there is a lot of water, a lot of protein, and a lot of carbohydrates, it is necessary to select and use a suitable thickener properly.

In addition, although the viscosity was measured at room temperature (around 30 degrees Celsius) this time, it is necessary to select a thickener suitable for the meal depending on the temperature at the time of serving, and it may be necessary to further change the addition amount. Temperature is related to deliciousness, but depending on the swallowing function of the eater, it may be provided at a temperature lower than body temperature (around 10 degrees) to prevent burns in the oral cavity and esophagus. This is because the swallowing reflex is unlikely to occur at the same temperature as body temperature.

In order to prevent sarcopenia [1,2] and frailty [3-9] due to malnutrition and to prevent aspiration pneumonia, it is necessary to add viscosity to drinks [10-13] and liquid meals [14-16], using a thickener. I would like to continue my research and consider combinations of thickeners that are suitable for foods.

CONCLUSION

Comparing the viscosities of thickeners with the same amount added to foods, the difference in viscosity becomes clear when the amount added is smaller, so it is necessary to consider compatibility with foods. All of the eight types of thickeners used this time are

mainly composed of dextrin, but depending on the combination of other food materials, they were added to the same commercially available universal design food, but in multiple thickeners. Since there is a statistically significant difference in the LST value, it is necessary to confirm the LST value when providing it to the eating target.

This time, the LST value was measured at room temperature (around 20 degrees), but if the temperature is kept above 60 degrees when serving meals, the viscosity of the food value may change, so it is necessary to change the temperature for comparison. I think. It is a future task.

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