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Abstract- We added four commercially available thickeners to white rice porridge with salty plum, which is popular in Japan, and compared the viscosity. Porridge containing water is useful even in the event of a disaster. In Japan, porridge is useful as a stockpile of food during disasters. Porridge is used as a meal of a wide range of age groups, from the elderly to infants. However, if porridge is made into a liquid using a mixer, etc., it becomes a food with a high risk of aspiration for people with impaired swallowing function. Therefore, it is necessary to add a thickener to the liquid porridge to increase its viscosity. In order to keep the consistency, the thickening agent should be changed according to the amount of nutrients contained in the porridge.

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Line Spread Test Results for Commercially Available the White Rice Porridge with Salted Plum - Including the Effect of Four Types of Thickening Agents Added After Blending -

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Abstract- We added four commercially available thickeners to white rice porridge with salty plum, which is popular in Japan, and compared the viscosity. Porridge containing water is useful even in the event of a disaster. In Japan, porridge is useful as a stockpile of food during disasters. Porridge is used as a meal of a wide range of age groups, from the elderly to infants. However, if porridge is made into a liquid using a mixer, etc., it becomes a food with a high risk of aspiration for people with impaired swallowing function. Therefore, it is necessary to add a thickener to the liquid porridge to increase its viscosity. In order to keep the consistency, the thickening agent should be changed according to the amount of nutrients contained in the porridge. As a result, viscosity was stable in the order of Thickener D(dextrin, Polysaccharide thickener, and calcium lactate), B(dextrin, xanthan gum, tri-sodium chloride, calcium lactate), A(dextrin, polysaccharide thickener, potassium chloride, sucralose as sweetener), and C(dextrin, water-soluble dietary fiber, xanthan gum as thickener). A thickener containing dextrin and calcium lactate was compatible with porridge and stabilized the viscosity. In order to prepare for disasters, it is necessary to stockpile thickeners suitable for porridge.

Keywords: commercial product, white rice porridge with salted plum, lin spread test (LST), thickener.

I. INTRODUCTION

In recent years, various disasters have occurred in Japan. In this case, disaster food that is stockpiled will be used. It is difficult to provide meals in a state

where lifelines are cut, and there is no water, gas, or electricity. At that time, porridge containing water is helpful. White rice porridge is widely available as nursing care food for the elderly and baby food for infants. However, porridge can cause aspiration pneumonia in people with impaired swallowing ability.

In order for people with impaired swallowing function to eat porridge safely, it is necessary to add a thickener suitable for the porridge. We reported that using porridge made by adding salted plum (umeboshi) to white rice, which is very popular in Japan, the viscosity measured by adding four types of thickening agents to porridge.

II. MATERIALS AND METHODS

The nutritional components of the white rice porridge with salted plum used in this experiment are shown in Table 1. The white rice porridge with salty plum used had 36.00 kcal, 0.6g of protein, 0.12g of Fat, 8.2g of carbohydrate, and 0.36-0.84g of sodium per 100g (displayed on the product packaging).

Table 1. Contents and nutritional value of commercial porridge

Contents	Nutrient contents (Per 100g)				
	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrates (g)	Sodium (m g)
White rice porridge with salted plum	36	0.6	0.12	8.2	0.36~0.84

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Table 2 shows the content and nutritional value of four commercially available thickeners. Main component of all thickeners was dextrin (displayed on the product packaging).

Table 2 Content and nutritional value of four types of thickeners

	Contents	Nutrient contents (Per 2g)					Sodium (mg)
		Energy (kcal)	Protein (g)	Fat (g)	Carbohydrates (g)		
					Sugar (g)	Dietary fiber (g)	
A	Dextrin, Polysaccharide thickener, potassium chloride, sweetener (Sucralose)	5.27	0.00	0.00	0.87	0.47	10.67
B	Dextrin, Xanthan gum, Trisodium chloride, Calcium lactate	4.00	0.00	0.00	1.00	0.70	3.00
C	Dextrin, Water-soluble dietary fiber, Thickener (Xanthan gum)	5.40	0.00	0.00	1.36	0.50	12.33
D	Dextrin, Polysaccharide thickener, Calcium lactate	0.53	0.03	0.00	0.91	0.83	24.00

a) *Sample (food with Thickener added) adjustment*

Samples were adjusted according to previous reports^{1,2,3,4}. Each of the three foods was prepared as follows.

- 1) The viscosity of the food product was measured without any modification (homogenize with a mixer) after 30seconds, 5minutes, 15minutes, and 30minutes.
- 2) The viscosity of the food product was measured with modification (homogenize with a mixer) after 30seconds, 5minutes, 15minutes, and 30minutes.
- 3) The viscosity was measured on the food product with modification (homogenize with a mixer) after adding 2 grams of thickener (A, B, C, and D) to the food (100g) after 30seconds, 5minutes, 15minutes, and 30minutes.

b) *Viscosity measurement method*

Using the Line Spread Test Start Kit (LST) manufactured by SARAYA, the viscosity of each food was measured. The measurement procedure is as follows. The line spread test (LST) was performed in a room with a room temperature of 24 degrees. Viscosity measurements by line spread test (LST) were performed three repetitions using the same sample. Data was obtained by averaging the viscosity results of three repeated measurements. The measurement method was according to Line Spread Test Start Kit (LST) manufactured by SARAYA.

1. Place the sheet on a level surface. Place a ring with an inner diameter of 30mm in the center of the concentric circles.

2. Add the liquid to be measured to the total thickness in the ring (capacity is 20ml) and let stand for 30 seconds.
3. Lift the ring vertically, and after 30 seconds, measure the spread distance of the solution. Six points on the outermost circumference of the sample spread concentrically were measured, and the average value was calculated as the result of LST values.
4. After 5 minutes, the spread of the samples is measured again at 6 points, and the average value is recorded as the LST value.

c) *Criteria for viscosity*

There are three levels of classification by LST value⁵. The first stage is mildly thick with a viscosity that falls within 43mm to 36mm (50-150 mPa · s). As for the properties, when the spoon is tilted, it flows down quickly². The second stage is moderately thick with a viscosity that falls within 36mm to 32mm (150-300 mPa · s). As for the properties, when you tilt the spoon, it flows to the surface². The third stage is highly thick with a viscosity that falls within 32mm to 30mm (300-500 mPa · s). Even if the spoon is tilted, the shape is maintained to some extent, and does not flow easily⁵.

d) *Statistical processing*

This study was statistically processed using statistical software (Excel 2010: SSRI Co., Ltd). The data to be compared were first tested for normal distribution by F-test. For comparisons between correlated data, the paired Student-t test was used for normally distributed data. Wilcoxon test was used for non-normally distributed data.

III. RESULTS

Table 3 shows the line spread test results. The viscosity of white rice porridge with salted plum decreased from moderately thick to mildly thick with time. When the white rice porridge with salty plum was processed with a mixer so that it became a uniform liquid, the viscosity became mildly thick. When

thickeners B and D were added to the liquid white rice porridge with salty plum, the viscosity remained highly dense. But, when thickener A and C were added to the liquid white rice porridge with salty plum, the viscosity decreased from highly dense to moderately dense with time.

Table 3. Viscosity measurement results of four types of thickeners for salted plum rice porridge using the line spread test

	After 30 seconds	After 5 minutes	After 15 minutes	After 30 minutes
No adjustment	35.6 ± 3.4	37.4 ± 3.7	37.6 ± 3.8	38.9 ± 3.7
Mixer processing (MP)	44.8 ± 3.0	48.6 ± 6.4	47.5 ± 4.7	47.3 ± 4.8
MP with Thickener A (Toromicria)	30.0 ± 3.5	31.3 ± 3.9	31.1 ± 3.8	31.4 ± 4.6
MP with Thickener B (Tururinko)	28.4 ± 1.7	29.7 ± 1.9	29.9 ± 1.9	30.2 ± 2.0
MP with Thickener C (Toromifaiver)	30.3 ± 2.8	30.9 ± 2.0	31.0 ± 1.9	32.8 ± 3.3
MP with Thickener D (Neohaitoromi-ru)	23.7 ± 3.4	24.1 ± 3.9	24.7 ± 4.0	25.3 ± 4.3

a) Statistical processing results

The line spread test results and statistical processing results are shown in Table 4-9. Except for the sample with Thickener A, C, and D, the viscosity was statistically significantly weakened from 30 seconds to 5

minutes after putting the white rice porridge with salty plum on the viscometer plate under other conditions. However, except for the sample with Thickener C, the viscosities of the white rice porridge with salted plum with thickener were highly dense.

Table 4. Line spread test (LST) measurement results of salted plum rice porridge

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ±Standard deviation	35.6±3.4	37.4±3.7	37.4±3.7	37.6±3.8	37.6±3.8	38.9±3.7
F test	P=0.370		P=0.465		P=0.456	
Paired Student t-test	P=0.0001**		P=0.083		P=0.127	
Wilcoxon test						

Table 5. Line spread test (LST) measurement results of salted plum rice porridge after mixer processing (MP)

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ±Standard deviation	44.8±3.0	48.6±6.4	48.6±6.4	47.5±4.7	47.5±4.7	47.2±4.8
F test	P=0.001**		P=0.104		P=0.460	
Paired Student t-test	P=0.0001**		P=0.283		P=0.331	
Wilcoxon test	P=0.0001**					

Table 6. Line spread test (LST) measurement results of salted plum rice porridge after mixer processing (MP) with Thickener A

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ±Standard deviation	30.0±3.5	31.3±3.5	31.3±3.5	31.1±3.8	31.1±3.8	31.4±4.6
F test	P=0.335		P=0.471		P=0.217	
Paired Student t-test	P=0.264		P=0.659		P=0.469	
Wilcoxon test						

Table 7. Line spread test (LST) measurement results of salted plum rice porridge after mixer processing (MP) with Thickener B

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ±Standard dev	28.4±1.7	29.7±1.9	29.7±1.9	29.9±1.9	29.9±1.9	30.2±2.0
F test	P=0.364		P=0.455		P=0.447	
Paired Student t-test	P=0.0001**		P=0.104		P=0.020*	
Wilcoxon test						

Table 8. Line spread test (LST) measurement results of salted plum rice porridge after mixer processing (MP) with Thickener C

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ±Standard dev	30.3±2.8	30.9±2.0	30.9±2.0	31.0±1.9	31.0±1.9	32.8±3.3
F test	P=0.075		P=0.477		P=0.015*	
Paired Student t-test	P=0.305		P=0.4505			
Wilcoxon test					P=0.070	

Table 9. Line spread test (LST) measurement results of salted plum rice porridge after mixer processing (MP) with Thickener D

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ± Standard dev	23.7 ± 3.4	24.1 ± 3.9	24.1 ± 3.9	24.7 ± 4.0	24.7 ± 4.0	25.3 ± 4.3
F test	P=0.276		P=0.468		P=0.381	
Paired Student t-test	P=0.088		P=0.066		P=0.243	
Wilcoxon test						

IV. DISCUSSIONS

By adding a commercial Thickener D (including dextrin, calcium lactate, and polysaccharide) to the white rice porridge with salty plum, the viscosity was the highest and was stable. Adding Thickener D (including dextrin, calcium lactate, and polysaccharide) to white rice porridge made it more viscous and stable⁶. Adding Thickener B (including dextrin, calcium lactate, xanthan gum, and tri-sodium chloride) and Thickener D made to white rice porridge with sticky barley (rich in fat) it more viscous and stable⁷. Adding Thickener B (including dextrin, calcium lactate, xanthan gum, and tri-sodium chloride) and Thickener D to white rice porridge with salmon (rich in protein) made it more viscous and stable⁸. As previously reported on the relationship between ease of swallowing and food viscosity^{9,10}, low viscosity also increases the likelihood of aspiration. In the case of porridge containing fat and protein, adding Thickener D (including dextrin, calcium lactate, and polysaccharide) stabilized the viscosity.

V. CONCLUSION

We liquefied white rice porridge with salty plums, popular in Japan, and added four commercially available thickeners to measure the viscosity. As a result, thickener D (including dextrin, calcium lactate, and polysaccharide) was the most viscous and stable when it was added to the porridge. For people with various swallowing functions, stockpiling a thickener that stabilizes the viscosity of the porridge to be stockpiled is necessary in case of a disaster.

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