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Abstract- In the event of a disaster, we will have to take stockpiled food. Retort porridge contains water and can be eaten directly from the container. However, there is a risk of aspiration for people with impaired swallowing function. As a result of the line spread test (LST), which was performed after homogenizing white rice porridge with sticky barley using a mixer, it was found that the viscosity was weak, and there was a risk of aspiration for people with weakened swallowing function. The thickness was added to white rice porridge with sticky barley by using four types of commercially available thickening agents that was made into a uniform liquid with a mixer. A line spread test (LST) was performed by adding 2 g of each thickening agent to 100g of liquid porridge. As a result, the viscosity of the liquid porridge was stabilized and thickened, and it became a state that could swallow more safely. In the line spread test, the thickness of the porridge was measured after 30 seconds, 5 minutes, 15 minutes, and 30 minutes.

Keywords: *commercial product, white rice porridge with sticky barley, lin spread test (LST), thickener.*

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Line Spread Test Results for Commercially Available the White Rice Porridge with Sticky Barley

Including the Effect of Four Types of Thickening Agents Added after Blending

Shoko Kondo ^α, Mayumi Hirabayashi ^σ & Naomi Katayama ^ρ

Abstract- In the event of a disaster, we will have to take stockpiled food. Retort porridge contains water and can be eaten directly from the container. However, there is a risk of aspiration for people with impaired swallowing function. As a result of the line spread test (LST), which was performed after homogenizing white rice porridge with sticky barley using a mixer, it was found that the viscosity was weak, and there was a risk of aspiration for people with weakened swallowing function. The thickness was added to white rice porridge with sticky barley by using four types of commercially available thickening agents that was made into a uniform liquid with a mixer. A line spread test (LST) was performed by adding 2 g of each thickening agent to 100g of liquid porridge. As a result, the viscosity of the liquid porridge was stabilized and thickened, and it became a state that could swallow more safely. In the line spread test, the thickness of the porridge was measured after 30 seconds, 5 minutes, 15 minutes, and 30 minutes. Thickeners containing dextrin, thickening polysaccharides, and calcium lactate showed the most stable thickening. In the future, we would like to investigate the viscosity of porridge containing more fat than white rice porridge with sticky barley. In addition, we would like to find a thickening agent suitable for liquefied porridge containing more fat.

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

I. INTRODUCTION

In a disaster, lifelines may be cut off, leaving water, gas, and electricity unusable. Cooking hot food can be difficult during a disaster. In times of disaster, it is

necessary to provide meals to people of all ages, from infants to the elderly. Therefore, we need to stockpile food that is suitable for more people. To provide all age groups with the variety of rice porridge that has been stockpiled in anticipation of situations without water, electricity, or gas, it is necessary to change the food form. We can make baby food for infants by using the porridge. We can make the white rice porridge into a uniform liquid with a battery-operated or charger-operated mixer. This liquid porridge is also a meal for the elderly with weak teeth. This liquid porridge poses a risk of aspiration in people with impaired swallowing ability. In this study, a commercially available thickening agent was used to add viscosity to the liquid porridge. Then, the viscosity of the thickener-added porridge was measured using the line spread test (LST). It was investigated whether the measured viscosity is a safe viscosity for people with impaired swallowing function.

II. MATERIALS AND METHODS

The nutritional components of the white rice porridge with sticky barley used in this experiment are shown in the Table 1. The white rice porridge with sticky barley used had 36.80 kcal, 0.68g of protein, 0.36g of fat, 7.68g of carbohydrate, and 0.01g 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 (mg)
White rice porridge with sticky barley	36.80	0.68	0.36	7.68	0.01

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Table 2 shows the content and nutritional value of the four commercially available thickeners used in this

experiment. The 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)					
	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrates (g)		Sodium (mg)
				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 2grams of thickener (A, B, C, and D) to the food (100g) after 30seconds, 5minutes, 15minutes, and 30minutes.

b) *Viscosity measurement method*

Using 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 room temperature of 24 degrees. Viscosity measurements by line spread test (LST) were performed three times 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 of therig (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 still standing for 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 the range of 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 the range of 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 the range of 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 processing 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.

decreased from extremely thick to moderately thick with time. When the white rice porridge with sticky barley was processed with a mixer so that it became a uniform liquid, the viscosity became mildly thick. However, when the thickener added to the liquid white rice porridge with sticky barley, the thickness remained highly dense.

III. RESULTS

Table 3 shows the line spread test results. The viscosity of white rice porridge with sticky barley

Table 3. Viscosity measurement results of four types of thickeners for sticky barley porridge using the line spread test

	After 30 seconds	After 5 minutes	After 15 minutes	After 30 minutes
No adjustment	30.7 ± 4.6	33.1 ± 3.9	35.3 ± 4.4	34.2 ± 4.1
Mixer processing (MP)	45.3 ± 2.4	50.5 ± 5.5	51.6 ± 6.5	51.8 ± 6.6
MP with Thickener A (Toromicria)	24.1 ± 3.8	27.5 ± 5.4	27.2 ± 4.7	27.7 ± 5.3
MP with Thickener B (Tururinko)	24.7 ± 4.6	26.0 ± 5.2	26.7 ± 5.4	28.1 ± 5.6
MP with Thickener C (Toromifaiver)	25.3 ± 4.3	27.1 ± 4.1	26.7 ± 3.9	24.2 ± 3.8
MP with Thickener D (Neohaitoromi-ru)	22.1 ± 4.8	24.0 ± 5.8	24.7 ± 6.1	25.1 ± 6.1

a) *Statistical processing results*

The line spread test results and statistical processing results are shown in Table 4-9. Except for the white rice porridge with sticky barley with thickener C, the viscosity was statistically significantly weakened from 30 seconds to 5 minutes. The white rice porridge with sticky barley that has been homogenized in a mixer,

which porridge with thickener B, and which porridge with thickener D, the viscosity was statistically significantly weakened from 30 seconds to 5 minutes, from 5 minutes to 15 minutes, and 15 minutes to 30minutes. However, all the viscosities of the white rice porridge with sticky barley with Thickener were highly thick.

Table 4. Line spread test (LST) measurement results of sticky barley rice porridge

	After 30 seconds	After 5 minutes	After 5 minutes	After 15 minutes	After 15 minutes	After 30 minutes
Average value ± Standard deviation	30.7 ± 4.6	33.1 ± 3.9	33.1 ± 3.9	35.3 ± 4.4	35.3 ± 4.4	34.2 ± 4.1
F test	P=0.244		P=0.207		P=0.387	
Paired Student t-test	P=0.020*		P=0.067		P=0.190	
Wilcoxon test						

Table 5. Line spread test (LST) measurement results of sticky barley 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	45.3 ± 2.4	50.5 ± 5.5	50.5 ± 5.5	51.6 ± 6.5	51.6 ± 6.5	51.8 ± 6.6
F test	P=0.001**		P=0.245		P=0.452	
Paired Student t-test	P=0.001**		p=0.001**		p=0.042*	
Wilcoxon test						

Table 6. Line spread test (LST) measurement results of sticky barley 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	24.1 ± 3.8	27.5 ± 5.4	27.5 ± 5.4	27.2 ± 4.7	27.2 ± 4.7	27.7 ± 5.3
F test	P=0.077		P=0.298		P=0.329	
Paired Student t-test	p=0.001**		p=0.714		p=0.291	
Wilcoxon test						

Table 7. Line spread test (LST) measurement results of sticky barley 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 deviation	24.7 ± 4.6	26.0 ± 5.2	26.0 ± 5.2	26.7 ± 5.4	26.7 ± 5.4	28.1 ± 5.6
F test	P=0.295		P=0.430		P=0.447	
Paired Student t-test	p=0.001**		p=0.0001**		p=0.044*	
Wilcoxon test						

Table 8. Line spread test (LST) measurement results of sticky barley 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 deviation	25.3 ± 4.3	27.1 ± 4.1	27.1 ± 4.1	26.7 ± 3.9	26.7 ± 3.9	27.2 ± 3.8
F test	P=0.434		P=0.415		P=0.430	
Paired Student t-test	p=0.260		p=0.609		p=0.002**	
Wilcoxon test						

Table 9. Line spread test (LST) measurement results of sticky barley 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 \pm Standard deviation	22.1 \pm 4.8	24.0 \pm 5.8	24.0 \pm 5.8	24.7 \pm 6.1	24.7 \pm 6.1	25.1 \pm 6.1
F test		P=0.212		P=0.419		P=0.477
Paired Student t-test		p=0.013*		p=0.0001**		p=0.002**
Wilcoxon test						

IV. DISCUSSIONS

The viscosity of white rice porridge with sticky barley which included more fat than white rice porridge was measured viscosity by using line spread test. The white rice porridge with sticky barley that was made into a uniform liquid porridge with a mixer had a weak viscosity and a thin thickness. Therefore, liquid porridge had a risk of aspiration for people with weakened swallowing function^{6,7}. Consequently, it is necessary to add a thickener to the liquid porridge. All of the four types of thickeners used in this study were able to increase the viscosity of the liquid porridge. In particular, thickeners included dextrin, polysaccharide thickener, and calcium lactate exhibited good viscosity stability over time. The thickening effect of the thickening agent varied depending on the type and amount of nutrients contained in the porridge. We would like to conduct further research on suitable thickeners that maintain stable viscosity using porridge with different nutrients.

V. CONCLUSION

The viscosity of white rice porridge containing sticky barley was investigated using the line spread test (LST). The uniform liquid of white rice porridge with sticky barley is made using a mixer, the food has a low viscosity and is highly likely to be aspirated by people with weakened swallowing function. The safety eating of liquid porridge, it is necessary to add a thickening agent to the liquid porridge. A thickener included dextrin, polysaccharide thickener, calcium lactate was suitable for the liquid porridge of white rice with sticky barley.

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