



Line Spread Test (LST) Results for Commercially Available Universal Design Foods (UDF: Can be Crushed with the Tongue; “Daikon Radish with Minced Chicken Sauce” and “Sweet Potato and Bean Paste”) – Combination Results of Two Types of UDF and Eight Types of Thickeners

Sahoko Ito¹, Shoko Kondo², Mayumi Hirabayashi³ and Naomi Katayama^{1,4*}

¹Nagoya Women's University, Graduate School of Human Life Science, Naguoya City, Aichi, Japan

²Watanabe Hospital, Noma, Mihama Town, Aichi, Japan

³Aichi Prefecture Blue Bird Medical Rehabilitation Center, Ichinoiya City, Aichi, Japan

⁴Nagoya Women's University, Department of Health and Nutrition Nagoya City, Aichi, Japan

*Corresponding Author: Naomi Katayama, Nagoya Women's University, Graduate School of Human Life Science, Naguoya City, Aichi, Japan.

DOI: 10.31080/ASMS.2023.07.1649

Received: July 31, 2023

Published: August 04, 2023

© All rights are reserved by Naomi Katayama, et al.

Abstract

Japan is a super-aged society. As a result, more and more families are providing nursing care at home. The problem of food, which is a burden on the family in home care, is an issue that should be resolved as soon as possible. Therefore, in this study, we measured and compared the viscosity of meals prepared by adding eight types of thickening available universal design food (UDF: can be crushed with the tongue) using a line spread test (LST). Based on these results, we discussed the adjustment of nursing care food that is easy to swallow. UDF (can be crushed with the tongue: “Daikon radish with minced chicken sauce” and “Sweet potato and Bean paste”) were used. After adding 1 g, 2 g, and 3 g of each of the eight types of thickeners to commercially available shrimp gratin, a line spread test (LST) was performed using a superficial thickness measuring plate (manufactured by Saraya Co., Ltd.). “Sweet potato and Bean paste” had a high carbohydrate content, and became pasty even after the mixer treatment, and had sufficient viscosity, eliminating the need for a thickener. However, UDF (“Daikon radish with minced chicken sauce”), which has a high water content, had low viscosity after the mixer treatment, and it was necessary to add a thickener. Addition of 3 g of any of the eight types of thickeners to UDF (“Daikon radish with minced chicken sauce”) gave a viscosity that was easy to swallow. Eight kinds of thickeners are commercially available products containing xanthan gum. In the future, it will be necessary to investigate the effects of thickeners on universal design foods (UDF) that can be crushed with the tongue and have different nutritional values.

Keywords: Nursing Care Food; Universal Design Food; Line Spread Test; Thickener

Introduction

It is speculated that the need for nursing care food will increase in Japan, which will become an increasingly aged society in the future. To prevent aspiration pneumonia, it is necessary to provide safe and delicious nursing care food [1,2]. In a previous study, Shyoko Kondo [3,4], Mayumi Hirabayashi [5,6], and Sahoko Ito [7] reported the results of a line spread test on a commercially available universal design food (UDF) that does not require chewing, can be crushed with the gums, and can be chewed quickly. This study, we decided to compare the difference on viscosity of eight types of thickening agents added to UDF with high water content and UDF with high

carbohydrate content. A thickness measuring plate manufactured by Saraya Co., Ltd. was used for the viscosity. The standard value of viscosity was 23-32 mm, which is easy to swallow.

Materials and Methods

“Daikon radish with minced chicken sauce” and “Sweet potato and Bean paste”, which are a universal design food (UDF: 100g per one retort pouch) available on the market, was labeled as being crushable with the tongue. Is the nutritional value of “Daikon radish with minced chicken sauce” and “Sweet potato and Bean paste”, labeled as crushable with the tongue shown in Table 1.

Product name	Energy	Protein	Fat	Carbohydrates (g)		Sodium	Calcium
	(kcal)	(g)	(g)	Sugar (g)	Dietary fiber (g)	(mg)	(g)
Daikon radish with minced chicken sauce	27	1.1	0.3	3.8	2.5	0.5	107
Sweet potato and Bean paste	72	1	0.8	14.6	1.3	0.2	97

Table 1: Nutritional value of commercial UDF (cruch with tongue).

Furthermore, after adding 1 g, 2 g, and 3 g of each of the eight commercially available thickeners (A-H) to the 100f of “Daikon radish with minced chicken sauce” and “Sweet potato and Bean paste”, the viscosity after 30 seconds and 5 minutes was measured

using a superficial thickness measuring plate (manufactured by Saraya Co., Ltd.). Line spread test (LST) was performed using. The ingredients of the eight types of thickeners are listed, and the nutritional elements are listed in Table 2.

Contents	Nutrient contents (per 100g)									
	Energy	Protein	Fat	Carbohydrates (g)		Sodium	Potassium	Calcium	Phosphorus	Iron
	(kcal)	(g)	(g)	Sugar (g)	Dietary fiber (g)	(mg)	(g)	(g)	(g)	(g)
Dextriin, Polysaccharide thickener, Starch	226	1.2	0.2	64.4	25.1	188 ~ 405	10 ~ 20	868	18.5	1.5
Dextriin, Polysaccharide thickener	292	0.5	0	60.5	23.4	1550				
Dextriin, Xanthan gum, Calcium lactate, Trisodium citrate	346	0.5	0	86						

Dextriin, Polysaccharide thickener, CMC	390	0.8	0	54.9	34.3	1850	144	7.4	71	0.47
Dextriin, Polysaccharide thickener, Potassium chloride, Sucralose	263		0 ~ 1.0	64.3	23.5	540	870	13	72	0.3
Dextriin, Polysaccharide thickener, Potassium chloride	240		0	54	35	1180				
Dextriin, Polysaccharide thickener, Sodium chloride	260	0.7	0	46	37					
Dextriin, Polysaccharide thickener, Emulsifier	288	7.3	0.4 ~ 1.7	54	33	1773	107 ~ 288		85	

Table 2: Content and nutritional value of eight types of thickeners.

Sample (food with Thickener added) adjustment

Samples were adjusted according to previous reports [3-6]. Each of the three foods was prepared as follows.

- The thickness of the food product was measured without any change (homogenized with a mixer) after 30 seconds, 5 minutes.
- The thickness of the food product was measured with change (homogenized with a mixer) after 30 seconds, 5 minutes.
- The thickness was measured on the food product with modification (homogenized with a mixer) after adding 1 gram of Thickener (A, B, C, D, E, F, G, and H) to the food (100g) after 30 seconds, 5 minutes.

- The thickness was measured on the food product with modification (homogenized with a mixer) after adding 2 grams of Thickener (A, B, C, D, E, F, G, and H) to the food (100g) after 30 seconds, 5 minutes.
- The thickness was measured on the food product with modification (homogenized with a mixer) after adding 3 grams of Thickener (A, B, C, D, E, F, G, and H) to the food (100g) after 30 seconds, 5 minutes.

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. Thickness 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.

- Place the sheet on a level surface. Place a ring with an inner diameter of 30 mm in the center of the concentric circles.
- Add the liquid to be measured to the total thickness of the ring (20 ml) and let stand for 30 seconds.
- 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.
- After 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.

Criteria for viscosity

There are three levels of classification by LST value [9]. The first stage is mildly thick with a viscosity that falls within the 43 mm to 36 mm (50-150 mPa.s). As for the properties, when the spoon is tilted, it flows down quickly [4]. The second stage is moderately thick with a viscosity that falls within the 36 mm to 32mm (150-300 mPa.s). As for the properties, when you tilt the spoon, it flows to the surface [4]. The third stage is highly thick with a viscosity that falls within the 32mm to 30mm (300-500 mPa.s). Even if the spoon is tilted, the shape is maintained to some extent, and does not flow easily [9].

Results

Table 3 shows the LST value results of the commercially available UDF (tongue crushable) “Daikon radish with minced chicken sauce” gratin and the eight types of commercially available LST values.

		After 30 seconds			After 5 minutes					After 30 seconds			After 5 minutes					After 30 seconds			After 5 minutes		
Non mixer processing (NMP)		34.1	±	2.9	37.7	±	3.3																
Mixer process in (MP)		49.6	±	4.4	53.2	±	7.1																
MP with Thickener A	Add 1g	39.4	±	2.2	40.4	±	9.4	Add 2g	29.4	±	4.2	31.1	±	4.7	Add 3g	24.5	±	7.1	25.5	±	8.3		
MP with Thickener B		41.9	±	2.2	46.2	±	2.4		31.1	±	6.3	33.2	±	6.8		24.6	±	4.1	27.1	±	5.4		
MP with Thickener C		42.4	±	3.1	45.4	±	3.1		33.1	±	1.6	35.1	±	1.6		24.6	±	4.8	25.4	±	5.2		
MP with Thickener D		39.8	±	2.4	43.7	±	2.6		38.7	±	1.9	41.2	±	2.2		23.3	±	8.8	24.8	±	9.6		
MP with Thickener E		41.6	±	1.9	46.6	±	2.3		31.6	±	6.4	33.4	±	6.8		29.6	±	5.2	27.4	±	4.1		
MP with Thickener F		43.7	±	2.9	47.7	±	3.9		33.5	±	1.2	36.2	±	1.4		25.8	±	5.8	27.5	±	6.4		
MP with Thickener G		45.6	±	2.7	49.2	±	3.4		29.3	±	1.8	31.2	±	2		23.9	±	3.6	24.8	±	4		
MP with Thickener H		38.9	±	2.7	43.3	±	2.2		27.2	±	5.3	28.9	±	5.4		24.7	±	7.3	25.8	±	8.1		

Table 3: Viscosity measurement results of eight types of thickeners for Eel with egg.

Table 4 shows the LST value results of the commercially available UDF (tongue crushable) “Sweet potato and Bean paste” gratin and the eight types of commercially available LST values.

		After 30 seconds			After 5 minutes				After 30 seconds			After 5 minutes				After 30 seconds			After 5 minutes		
			±			±				±			±				±			±	
Non mixer processing (NMP)		18	±	3.3	18.4	±	3.5														
Mixer processin (MP)		22.1	±	2.2	22.9	±	2														
MP with Thickener A	Add 1g	21.6	±	3.3	21.7	±	3	Add 2g	19.3	±	3.3	19.9	±	2.7	Add 3g	19.2	±	1.5	19.7	±	1.4
MP with Thickener B		22.1	±	1.7	23	±	1.7		20.7	±	2	21.1	±	2.1		20.6	±	3.4	20.7	±	3.4
MP with Thickener C		20.9	±	5.3	21.8	±	5.5		19.9	±	2.5	20.9	±	3.3		21.4	±	4.9	21.6	±	5.1
MP with Thickener D		22.9	±	3	22.6	±	2.4		21	±	2	21.2	±	2.1		19.5	±	2.4	19.7	±	2.5
MP with Thickener E		21.1	±	3.4	22.6	±	3.6		20.3	±	3.2	20.8	±	3.4		20.2	±	2.1	20.3	±	2.2
MP with Thickener F		20.9	±	1.6	22.2	±	1.6		19.3	±	3.1	20.3	±	4		20.8	±	2.3	21.1	±	2.1
MP with Thickener G		19.8	±	2.3	20.8	±	2.6		19.8	±	1.9	20.1	±	1.9		20	±	1.8	20.1	±	1.8
MP with Thickener H		21	±	1.7	21.6	±	1.8		20.9	±	2.4	21.2	±	2.4		21.6	±	2.4	22.1	±	2.5

Table 4: Viscosity measurement results of eight types of thickeners for Sweet potato and Bean paste.

Figure 1 shows the line spread test (LST) results of universal design hoods (UDF: can be crushed with tongue).

UDF (Daikon radish with minced chicken sauce) with a high water content had an LST value of 43 mm or more after the mixer treatment. However, the LST value of UDF (Sweet potato and Bean paste), which contains a lot of carbohydrates and calcium, was within 30 mm even after the mixer treatment.

Figure 2 shows the results when 1 g, 2 g, and 3 g of 8 types of thickeners were added to 2 types of UDF (can be crushed with the tongue) after mixer

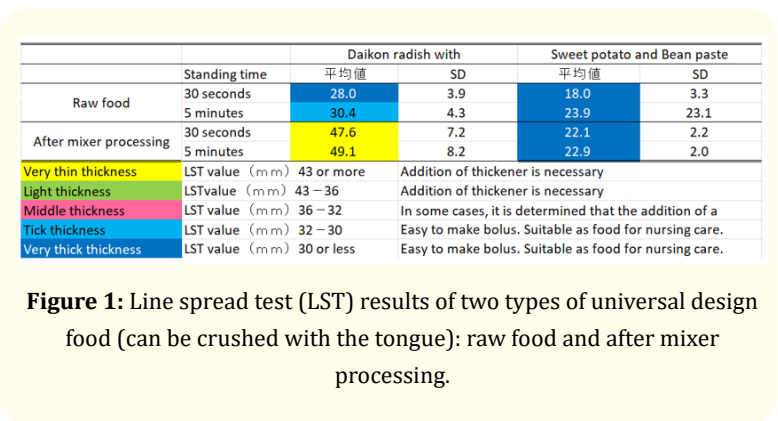


Figure 1: Line spread test (LST) results of two types of universal design food (can be crushed with the tongue): raw food and after mixer processing.

treatment of 100g “Daikon radish with minced chicken sauce” and “Sweet potato and Bean paste”.

	Standing time	Thickener A			Thickener B			Thickener C			Thickener D		
		1 g	2 g	3 g	1 g	2 g	3 g	1 g	2 g	3 g	1 g	2 g	3 g
Daikon radish with minced chicken sauce	30 seconds	42.1	31.5	26.3	41.7	32.6	27.1	43.2	33.8	25.4	43.9	34.1	26.6
	5 minutes	45.6	33.7	27.5	45.8	34.7	29.0	45.4	36.8	26.8	47.6	36.4	27.9
Sweet potato and Bean paste	30 seconds	21.6	19.3	19.2	22.1	20.7	20.6	20.9	19.9	21.4	22.9	21.0	19.5
	5 minutes	21.7	19.9	19.7	23.0	21.1	20.7	21.8	20.9	21.6	22.6	21.2	19.7
	Standing time	Thickener E			Thickener F			Thickener G			Thickener H		
		1 g	2 g	3 g	1 g	2 g	3 g	1 g	2 g	3 g	1 g	2 g	3 g
Daikon radish with minced chicken sauce	30 seconds	44.1	39.5	29.1	43.1	34.8	28.0	40.4	29.2	23.8	40.8	28.5	24.1
	5 minutes	48.6	43.2	32.0	46.7	37.3	30.4	44.2	31.1	25.3	44.6	30.7	25.1
Sweet potato and Bean paste	30 seconds	21.1	20.3	20.2	20.9	19.3	20.8	19.8	19.8	20.0	21.0	20.9	21.6
	5 minutes	21.2	20.8	19.8	22.2	20.3	21.1	20.8	20.1	20.1	21.6	21.2	22.1
Very thin thickness	LST value (m m)	43 or more			Addition of thickener is necessary								
Light thickness	LST value (m m)	43 – 36			Addition of thickener is necessary								
Middle thickness	LST value (m m)	36 – 32			In some cases, it is determined that the addition of a thickener is necessary								
Tick thickness	LST value (m m)	32 – 30			Easy to make bolus. Suitable as food for nursing care.								
Very thick thickness	LST value (m m)	30 or less			Easy to make bolus. Suitable as food for nursing care.								

Figure 2: Line spread test results when 1g, 2g, and 3g of eight types of thickeners were added to two types of universal design food (can be crushed with the tongue).

UDF (Sweet potato and Bean paste) was so viscous even after mixing that no thickening agent was needed. However, UDF (Daikon radish with minced chicken sauce) required the addition of a thickening agent to obtain the correct viscosity for safe swallowing.

By adding 2 g of thickeners G, and H, UDF B became viscous enough to be swallowed safely. However, 3 g of thickeners A, B, C, D, E, and F were required to obtain the viscosity required for UDF B to be safely swallowed.

Discussion

All eight types of thickening agents used this time contained dextrin and thickening polysaccharides. However, the mixing ratio of the ingredients has not been clarified. There are no common ingredients in the ingredients other than dextrin and thickening polysaccharide of the eight thickening agents. Due to these differences, there is a possibility that the viscosity after adding to the food (UDF in this case) is different.

From the results of this time, we think that thickeners A, B, G or H are suitable for UDF (can be crushed with the tongue: Daikon radish with minced chicken sauce).

Studies on the palatability of thickeners have reported that the production of food pastes not only adversely affects their

appearance, but also their palatability and texture [10] and the production of food pastes does not look good and gives poor taste and texture.

The content was helpful in unifying food properties in various facilities [11-13] on adding thickeners to food have been published.

Many studies have also been reported on differences in viscosity due to differences in the main components of thickeners (xanthan gum, guar gum, starch, etc.) [11,14].

In addition, calcium, phosphoric acid, whey protein, etc., have a synergistic effect and help increase viscosity [15].

Thickeners made food easier to swallow [16] and the effectiveness of thickening agents in preventing gastroesophageal reflux in enteral feeding [17].

In this study, it was shown that adding a small amount of thickening agent can achieve the desired thickness in the case of foods containing a large amount of carbohydrates. The result is beneficial in terms of taste and cost.

However, it has been reported that the use of thickeners in water may have a negative effect on the efficacy of drugs when

administered to patients with swallowing dysfunction, so that caution may be necessary [18,19]. But it cannot be said that it is very food for palatability and digestion and absorption. Therefore, in the future, we believe that further research on safety, palatability, cost, etc., in swallowing is necessary.

Conclusions

An attempt was made to create nursing care food that can be safely swallowed even at home. Viscosity was measured using the line spread test (LST) by combining two types of commercially available universal design foods (UDF: can be crushed with the tongue) and eight types of commercially available thickeners. As a result, 2-3g of thickener was required per 100g of food with a high water content. Foods high in carbohydrates and calcium did not need thickeners because it was already viscous. However, in order to maintain a stable viscosity during meals, it is desirable to add 1g or less of a thickening agent per 100g of food.

Acknowledgements

This study was supported by research aid of the Japanese Society of Taste Technology, 2023.

Bibliography

1. Leder SB., *et al.* “Promoting safe swallowing when puree is swallowed without aspiration but thin liquid is aspirated: nectar is enough”. *Dysphagia* 28 (2013): 58-62.
2. Murray J., *et al.* “Intake of thickened liquids by hospitalized adults with dysphagia after stroke”. *International Journal of Speech-Language Pathology* 16 (2014): 486-494.
3. Shoko Kondo., *et al.* “Research on the combination of commercially available thickeners and nutritional supplemental drink –aiming at the care food that can be done in the general family”. *Advances in Nutrition and Food science* (2019): 1-9.
4. Naomi Katayama., *et al.* “Research on the Combination of Commercially Available Thickeners and Commercially Available Nursing Food -By using Universal - Design Food: UDF (Do not have to Bite)”. *Global Journal of Medical Research* 20.11 (2020): 49-53.
5. Mayumi Hirabayashi., *et al.* “Research on the Combination of Commercially Available Thickeners and Commercially Available Nursing Food-Universal Design Food: UDF (Can be Crushed with Gums)”. *Global Journal of Medical Research* 20.11 (2020): 11-15.
6. Mayumi Hirabayashi., *et al.* “Research on the Combination of Commercially Available Thickeners and Commercially Available Nursing Food -Aiming for Viscosity Adjustment that can be done at Home”. *Global Journal of Medical Research* 20.11 (2020): 43-47.
7. Sahoko Ito., *et al.* “Viscosity Measurement Results of Commercially Available Universal Design Food (UDF: Can be crushed with the tongue) using the Line Spread Test (LST)”. *Global Journal of Medical Research* 23.4 (2023): 55-61.
8. Hirabayashi M and Katayama N. “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”. *Open Access Journal of Biomedical Science* 3.6 (2021): 1323-1331.
9. Claire de Saint-Aubert., *et al.* “Comparison of 2 tests used for the classification of food thickeners in the management of dysphagia. Gums and stabilisers for the food industry 17 (2013): 2014.
10. Nagai Y and Yamamura C. “Changes of Basic Gustatory Thresholds and Gustatory Intersities by Thickener Addition”. *The Japanese Journal of Dysphagia Rehabilitation* 18.2 (2014): 131-140.
11. Nakamura M., *et al.* “Applicability of Modified Line Spread Test for Evaluating Physical Properties of Thickened Liquid Foods Prepared by Instant Food Thickeners”. *The Japanese Journal of Dysphagia Rehabilitation* 13.3 (2009): 197-206.
12. Nakamura M., *et al.* “Physical Properties of Index foods for the Thickness: Classification of Various Index foods by Thickness by the Line Spread Test”. *The Japanese Journal of Dysphagia Rehabilitation* 16.2 (2012): 155-164.
13. Iwasaki Y., *et al.* “Study a of Inccx (Model food) for Thickener Solutions when Users Prepare Them – Evaluation for Physical Measurements and Non-Oral Sensory Properties”. *The Japanese Journal of Dysphagia Rehabilitation* 15.1 (2011): 3-13.

14. Kim SG., *et al.* “Relationship between Apparent Viscosity and Line-Spread Test Measurement of Thickened Fruit Juices Prepared with a Xanthan Gum-based Thickener”. *Preventive Nutrition and Food Science* 19.3 (2014): 242-245.
15. Yoshinaga N., *et al.* “Evaluation of the Texture of Food for the Dysphagia Diet Served in Hospitals”. *Nagasaki International University Review* 12 (2017): 199-209.
16. Shiozawa K., *et al.* “Influence of a Thickening Agent on the Swallowing Threshold”. *Journal of Japanese Society for Masticatory Science and Health Promotion* 17.1 (2007): 27-34.
17. Kanaoka S., *et al.* “Prevention of aspiration pneumonia due to gastroesophageal reflux during enteral nutrition and long term effect of patient’s QOL (quality of life) using pectin gel”. *The Journal of Japanese Society for Parenteral and Enteral Nutrition* 20.1 (2005): 85-89.
18. Tomita T., *et al.* “Effect of Food Thickener on Disintegration and Dissolution of Magnesium Oxide Tablets”. *Journal of the Pharmaceutical Society of Japan* 135.6 (2015): 835-840.
19. Hashimoto Y., *et al.* “Adsorption of drugs to soluble dietary fiber used as thickeners”. *Japanese Journal of Food Chemistry and Safety* 23.3 (2016): 113-117.