



Viscosity Measurement Result Comparison Using Line Spread Test (LST) – Uses Two Types of Universal Design Foods (UDF: Crush with Tongue; “Cod with Colorful Sauce” and “Meat and Potatoes”) and Eight Types of Thickeners

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Abstract

In Japan, which is a super-aging society, nursing care food will become more and more necessary in the future. Nursing care food that can be prepared at home is in demand. The point of safe food for nursing care is viscosity. Therefore, we compared the viscosities of two commercially available universal design foods (UDF: crush with tongue) with uniform physical properties when eight types of thickeners were added. After adding 1 g, 2 g, and 3 g of each of the eight types of thickeners to commercially available UDF “Cod with colorful sauce and Meat and potatoes” gratin, a line spread test (LST) was performed using a superficial thickness measuring plate (manufactured by Saraya Co., Ltd.). As a result, “Meat and potatoes”, which has a lot of starch, has a high viscosity, and 1 g of the thickener was enough to make it easy to swallow (a thick viscosity of 30 mm or more and less than 32 mm). The watery “Cod with colorful sauce” needed more than 2g of thickener to make the easy to swallow. Eight kinds of thickeners are commercially available products containing xanthan gum, among which the thickener containing xanthan gum, calcium lactate, and trisodium citrate showed the highest viscosity.

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

Introduction

In a previous study, Shyoko Kondo [1,2] and Mayumi Hirabayashi [3,4] reported the results of a line spread test on a commercially available universal design hood (UDF: need not to chew, can be crushed by gums, and easy to chew). And last time, we

reported on the universal design food that can be crushed with the tongue: shrimp gratin, and reported the viscosity results with the addition of eight types of thickeners [5]. Therefore, in this study, among the commercially available universal design foods (UDF: “Cod with colorful sauce and Meat and potatoes”) that are available

in general households, foods labeled as being crushable with the tongue were treated with a simple thickening board (manufactured by Saraya Co., Ltd.) with eight types of thickeners. The purpose was to measure the viscosity after addition and to indicate the amount of thickener to be added to obtain a concentration that can be safely swallowed.

Materials and Methods

“Cod with colorful sauce and Meat and potatoes” 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 “Cod with colorful sauce and Meat and potatoes” 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) |
| Cod with colorful sauce | 42 | 1.6 | 2.2 | 3.6 | 0.6 | 0.5 | |
| Meat and potatoes | 57 | 1.5 | 1.6 | 8.6 | 0.9 | 0.5 | 122 |

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 100g of “Cod with colorful sauce and Meat and potatoes”, 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) |
| A | Dextriin, Polysaccharide thickener, Starch | 226 | 1.2 | 0.2 | 64.4 | 25.1 | 188 ~ 405 | 10 ~ 20 | 868 | 18.5 | 1.5 |
| B | Dextriin, Polysaccharide thickener | 292 | 0.5 | 0 | 60.5 | 23.4 | 1550 | | | | |
| C | Dextriin, Xanthan gum, Calcium lactate, Trisodium citrate | 346 | 0.5 | 0 | 86 | | | | | | |
| D | Dextriin, Polysaccharide thickener, CMC | 390 | 0.8 | 0 | 54.9 | 34.3 | 1850 | 144 | 7.4 | 71 | 0.47 |
| E | Dextriin, Polysaccharide thickener, Potassium chloride, Sucralose | 263 | | 0 ~ 1.0 | 64.3 | 23.5 | 540 | 870 | 13 | 72 | 0.3 |

| | | | | | | | | | | | |
|---|--|-----|-----|-----------|----|----|------|-----------|--|----|--|
| F | Dextriin, Polysaccharide thickener, Potassium chloride | 240 | | 0 | 54 | 35 | 1180 | | | | |
| G | Dextriin, Polysaccharide thickener, Sodium chloride | 260 | 0.7 | 0 | 46 | 37 | | | | | |
| H | 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 [1-4]. 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 30mm in the center of the concentric circles.
- Add the liquid to be measured to the total thickness of the ring (20ml) and let stand for 30 seconds.
- Lift the ring vertically, and after 30 seconds, measure the spread distance of the solution [6]. 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 [7]. The first stage is mildly thick with a viscosity that falls within the 43mm to 36mm (50-150 mPa.s). As for the properties, when the spoon is tilted, it flows down quickly [2]. The second stage is moderately thick with a viscosity that falls within the 36mm to 32mm (150-300 mPa.s). As for the properties, when you tilt the spoon, it flows

to the surface [2]. 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 [7].

Results

Table 3 shows the LST value results of the commercially available UDF (tongue crushable) “Cod with colorful 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) | | 3.3 | ± | 4.8 | 36.2 | ± | 4.8 | | | | | | | | | | | | | | |
| Mixer processin (MP) | | 46.3 | ± | 2.8 | 49.5 | ± | 4.1 | | | | | | | | | | | | | | |
| MP with Thickener A | Add 1g | 34.1 | ± | 1.7 | 36.3 | ± | 2 | Add 2g | 26.6 | ± | 7.4 | 27.1 | ± | 7.3 | Add 3g | 24.2 | ± | 5.5 | 24.8 | ± | 5.9 |
| MP with Thickener B | | 37.9 | ± | 1.4 | 40.4 | ± | 1.5 | | 27.1 | ± | 4.1 | 29.5 | ± | 3.9 | | 24.1 | ± | 4.8 | 25.7 | ± | 5.6 |
| MP with Thickener C | | 35.5 | ± | 2.9 | 38.5 | ± | 3.1 | | 29.2 | ± | 2.9 | 31.3 | ± | 2.9 | | 24.6 | ± | 7.7 | 25.6 | ± | 8.3 |
| MP with Thickener D | | 36.3 | ± | 1.7 | 39.1 | ± | 1.7 | | 30.2 | ± | 1.2 | 32.3 | ± | 1.1 | | 24.8 | ± | 6.6 | 24.5 | ± | 6.2 |
| MP with Thickener E | | 36.3 | ± | 2.8 | 38.7 | ± | 2.8 | | 31 | ± | 2.5 | 33.2 | ± | 2.7 | | 24.3 | ± | 6.4 | 25 | ± | 6.7 |
| MP with Thickener F | | 34.7 | ± | 2.4 | 37.6 | ± | 2.2 | | 28.2 | ± | 2.3 | 30.1 | ± | 2.5 | | 25.8 | ± | 6 | 26.4 | ± | 6.5 |
| MP with Thickener G | | 33.3 | ± | 2.6 | 38.1 | ± | 4.4 | | 24.7 | ± | 5.5 | 26.3 | ± | 6.1 | | 23.4 | ± | 7.4 | 24.7 | ± | 8.3 |
| MP with Thickener H | | 35.3 | ± | 2.6 | 38.4 | ± | 2.9 | | 24.9 | ± | 5.2 | 26.4 | ± | 5.7 | | 21.4 | ± | 2.5 | 22.1 | ± | 3.1 |

Table 3: Viscosity measurement results of eight types of thickeners for Cod with colorful sauce.

Table 4 shows the LST value results of the commercially available UDF (tongue crushable) “Meat and potatoes” gratin and the eight types of commercially available LST values.

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

| | | After 30 seconds | | | After 5 minutes | | | | After 30 seconds | | | After 5 minutes | | | | After 30 seconds | | | After 5 minutes | | |
|----------------------------|--------|------------------|---|-----|-----------------|---|-----|--------|------------------|---|-----|-----------------|---|-----|--------|------------------|---|-----|-----------------|---|-----|
| | | | ± | | | ± | | | | ± | | | ± | | | ± | | | ± | | ± |
| Non mixer processing (NMP) | | 21 | ± | 1.6 | 22 | ± | 2.2 | | | | | | | | | | | | | | |
| Mixer processing (MP) | | 26.3 | ± | 1.9 | 27.1 | ± | 1.9 | | | | | | | | | | | | | | |
| MP with Thickener A | Add 1g | 20.8 | ± | 2.3 | 21.3 | ± | 2.7 | Add 2g | 21.2 | ± | 1.8 | 21.8 | ± | 1.8 | Add 3g | 21.4 | ± | 2.6 | 21.7 | ± | 2.5 |
| MP with Thickener B | | 27.2 | ± | 2.2 | 28.3 | ± | 2.2 | | 21.6 | ± | 2 | 21.9 | ± | 2.1 | | 20.1 | ± | 2.4 | 20.4 | ± | 2.6 |
| MP with Thickener C | | 24.6 | ± | 1.3 | 25.4 | ± | 1.4 | | 22.1 | ± | 1.8 | 23.2 | ± | 2.1 | | 19.7 | ± | 2.4 | 20.5 | ± | 2.7 |
| MP with Thickener D | | 21.7 | ± | 3 | 21.9 | ± | 3.3 | | 21.6 | ± | 2.7 | 22 | ± | 3 | | 21.2 | ± | 2.8 | 21.2 | ± | 2.7 |
| MP with Thickener E | | 23 | ± | 4.9 | 23.5 | ± | 4.8 | | 21.1 | ± | 1.9 | 21.7 | ± | 2 | | 20.6 | ± | 2.7 | 21.1 | ± | 2.7 |
| MP with Thickener F | | 26.8 | ± | 1.7 | 27.7 | ± | 1.9 | | 22.8 | ± | 0.9 | 23.8 | ± | 0.8 | | 19.7 | ± | 1.4 | 20.2 | ± | 1.8 |
| MP with Thickener G | | 27.3 | ± | 1.7 | 28 | ± | 1.7 | | 25 | ± | 2.7 | 25.4 | ± | 2.4 | | 20.3 | ± | 1.7 | 20.8 | ± | 1.8 |
| MP with Thickener H | | 20.3 | ± | 2.6 | 21 | ± | 3.1 | | 20.8 | ± | 1.9 | 21.6 | ± | 2.2 | | 19.4 | ± | 1.4 | 19.8 | ± | 1.6 |

Table 4: Viscosity measurement results of eight types of thickeners for Meat and potatoes.

| | Standing time | Cod with colorful sauce | | Meat and potatoes | |
|------------------------|----------------|--|-----|-------------------|-----|
| | | Average value | SD | Average value | SD |
| Raw food | 30 seconds | 33.3 | 4.8 | 21.0 | 1.6 |
| | 5 minutes | 36.2 | 4.8 | 22.0 | 2.2 |
| After mixer processing | 30 seconds | 46.3 | 2.8 | 26.3 | 1.9 |
| | 5 minutes | 49.5 | 4.1 | 27.1 | 1.9 |
| Very thin thickness | LST value (mm) | 43 or more | | | |
| Light thickness | LST value (mm) | 43 – 36 | | | |
| Middle thickness | LST value (mm) | 36 – 32 | | | |
| Tick thickness | LST value (mm) | 32 – 30 | | | |
| Very thick thickness | LST value (mm) | 30 or less | | | |
| | | Addition of thickener is necessary | | | |
| | | Addition of thickener is necessary | | | |
| | | In some cases, it is determined that the addition of a | | | |
| | | Easy to make bolus. Suitable as food for nursing care. | | | |
| | | Easy to make bolus. Suitable as food for nursing care. | | | |

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.

UDF (Cod with colorful 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 (Meat and potatoes), 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 treatment of 100g “Cod with colorful sauce and Meat and potatoes”.

| | 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 |
| Cod with colorful sauce | 30 seconds | 34.0 | 26.6 | 24.2 | 37.9 | 27.1 | 24.1 | 35.5 | 29.2 | 24.6 | 36.3 | 30.2 | 24.8 |
| | 5 minutes | 36.3 | 27.1 | 24.8 | 40.4 | 29.5 | 25.7 | 38.5 | 31.3 | 25.6 | 39.1 | 32.3 | 24.5 |
| Meat and potatoes | 30 seconds | 20.8 | 21.2 | 21.4 | 27.2 | 21.6 | 20.1 | 24.6 | 22.1 | 19.7 | 21.7 | 21.6 | 21.2 |
| | 5 minutes | 21.3 | 21.8 | 21.7 | 28.3 | 21.9 | 20.4 | 25.4 | 23.2 | 20.5 | 21.9 | 22.0 | 21.2 |
| | 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 |
| Cod with colorful sauce | 30 seconds | 36.3 | 31.0 | 24.3 | 34.7 | 28.2 | 25.8 | 33.3 | 24.7 | 23.4 | 35.3 | 24.9 | 21.4 |
| | 5 minutes | 38.7 | 33.2 | 25.0 | 37.6 | 30.1 | 26.4 | 38.1 | 26.3 | 24.7 | 38.4 | 26.4 | 22.1 |
| Meat and potatoes | 30 seconds | 23.0 | 21.1 | 20.6 | 26.8 | 22.2 | 19.7 | 27.3 | 25.0 | 20.3 | 20.3 | 20.8 | 19.4 |
| | 5 minutes | 23.5 | 21.7 | 21.1 | 27.7 | 23.8 | 20.2 | 28.0 | 25.4 | 20.8 | 21.0 | 21.6 | 19.8 |
| Very thin thickness | LST value (mm) | 43 or more | | | Addition of thickener is necessary | | | | | | | | |
| Light thickness | LST value (mm) | 43 – 36 | | | Addition of thickener is necessary | | | | | | | | |
| Middle thickness | LST value (mm) | 36 – 32 | | | In some cases, it is determined that the addition of a thickener is necessary | | | | | | | | |
| Tick thickness | LST value (mm) | 32 – 30 | | | Easy to make bolus. Suitable as food for nursing care. | | | | | | | | |
| Very thick thickness | LST value (mm) | 30 or less | | | Easy to make bolus. Suitable as food for nursing care. | | | | | | | | |
| Cod with colorful sauce | | | | | | | | | | | | | |
| Meat and potatoes | | | | | | | | | | | | | |

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 (Meat and potatoes) was so viscous even after mixing that no thickening agent was needed. However, UDF (Cod with colorful sauce) required the addition of a thickening agent to obtain the correct viscosity for safe swallowing.

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

Thickeners made food easier to swallow [8] and the effectiveness of thickening agents in preventing gastroesophageal reflux in enteral feeding [9] were reported. The production of food pastes does not look good and gives poor taste and texture after adding thickeners. 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].

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

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

The amount of thickening agent used should be kept to a minimum. This is because excessive use of thickeners can affect digestion and absorption, and in some cases interfere with the effectiveness of the medicines patients are taking to treat the disease [16,17]. In the super-aged society, there will be more demand for nursing care food prepared at home for home care. For that purpose, research on the combination of food and thickener is necessary.

Conclusions

In Japan, which is a super aged society, there is a demand for nursing care food that can be prepared even at ordinary homes. In this study, we used two types of commercially available universal design food (UDF: can be crushed with the tongue) that can be purchased by ordinary households, and added eight types of commercially available thickeners to achieve a viscosity that can be safely swallowed. When there was a lot of moisture, the amount of thickener added was 3g per 100g food. However, when the amount of carbohydrates was high, 1g of thickening agent was sufficient. In some cases no thickener was required. Viscosity varies depending on the combination of food and thickener, but the nutrients of the food (water content, protein content, fat content, carbohydrate content, etc.) must also be considered.

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