Ease of swallowing potato paste in people with dysphagia: effect of potato variety

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**ABSTRACT**

In this study, we compared the texture of four varieties of potato paste (potato, sweet potato, taro and yam) with 80% moisture content to clarify the most suitable potato varieties for use by the elderly and persons with dysphagia. Taro paste was found to have greater softness and less stickiness, approximating those of commercially available care foods, and better cohesiveness in the oral cavity compared to the other potato varieties. The results suggested that taro starch is gelatinized slowly when the whole potato was heated, without breakdown of starch granules, contains water-soluble proteins of higher thermal stability than other potato varieties, and had less mucilage loss as a result of heating. Thus, it is concluded that taro paste can be used as a meal ingredient, serving both as a source of nutrition and as a dietary supplement that assists swallowing.

**Introduction**

Many countries around the world are experiencing a rapid aging of their populations. Aspiration and asphyxiation associated with dysphagia are among the issues that have become more prominent as populations age. In Japan, where the life expectancy is long, pneumonia is the fifth leading cause of death overall, with the percentage highest among the most elderly. It is estimated that over 70% of pneumonia cases in the elderly are aspiration pneumonitis, caused by saliva and food entering the airway. Further, malnutrition is another dysphagia-associated issue, which promotes sarcopenia and frailty. When the power to swallow is weakened, as is the case in dysphagia, it takes longer to eat. This is thought to be the reason for insufficient nutrient intake.

Therefore, to prevent aspiration and ensure nourishment, tube feeding, and intravenous nutrition are performed for persons with dysphagia. However, people gain a sense of satisfaction from eating food through the mouth, which plays a significant role in maintaining their quality of life (QOL). Choosing parenteral nutrition may result in a loss of enjoyment of meals and a decrease in the joy of living, with a consequent reduction in QOL. Therefore, it is considered important to provide dietary care to allow oral nutrition to the greatest extent possible.

Foods that the elderly consider easy to eat are generally sufficiently soft to be crushed between the tongue and the hard palate, contain adequate moisture, are not fibrous, and do not easily adhere to the teeth and mucous membranes. Therefore, the preparation of meals for the elderly must involve heating the food until it becomes soft, adding water as needed, then milling the food in a blender to achieve the consistency of a paste, or adding hydrocolloids to thicken liquid foods.

In addition to these methods, some foods that the elderly can easily swallow are those that make use of the physical properties of the food. For example, some varieties of potato develop a specific viscoelasticity when mashed, making them good candidates for meals from the viewpoint of
swallowing function. Furthermore, many hydrocolloids are not energy sources, but because potatoes serve as an energy source, incorporating them into the diet as thickeners also helps to prevent malnutrition.

In the present study, we aimed to clarify the types of potato that are suitable for use by the elderly and persons with dysphagia by comparing the texture of four pastes made from different types of potatoes eaten around the world. Additionally, we assessed the effect of potato components on the texture of potato paste.

Materials and methods

Materials

Potato (PT, Solanum tuberosum var. Danshyaku, from Shizuoka), sweet potato (SW, Ipomoea batatas var. Beniazuma, from Chiba), taro (TR, Colocasia esculenta var. Dodare, from Kagoshima) and yam (YM, Dioscorea opposita Thunb. var. Nebarisuta, from Aomori) were used as the samples. These potatoes were purchased from grocery stores in Shizuoka City, Japan. Table 1 shows the proximate composition of the potatoes, whose analysis was entrusted to the Japan Food Research Laboratories (https://www.jfrl.or.jp). For comparison, commercially available care foods (“Oishiku mikisā”; Foricafoods Corp., Niigata, Japan) made with sweet potato (SW-CC) or taro (TR-CC) were used. These commercially available care foods are classified into Category 4 (do not require mastication) under the Universal Design Food concept of the Japan Care Food Conference.\(^7\)

Preparation of pastes

After washing, the potatoes were heated with their skin intact in a microwave oven (NE-N30; Panasonic Co., Osaka, Japan) for 6 min at 500 W per 100 g so that they were edible. After heating, the potatoes could cool, then peeled, cut into small pieces, and 150 g was milled into a paste for 2 min using a food processor (MK-K80P; Panasonic Co.). Further, as shown in Table 1, since the moisture content differs according to the potato variety, based on the moisture content measured by the following method, a paste with a moisture content of 80% (approximating that of commercially available care foods) was prepared. Sufficient water for the moisture adjustment was added to 100 g of heated small potato pieces, and the mixture was milled for 2 min. The resulting paste is referred to as paste with 80% moisture content.

Moisture content of potatoes, pastes and commercially available care foods

Approximately 1 g of each sample was collected and subjected to measurement of moisture content by heating at 120°C with auto ending mode using an electronic moisture meter (MOS-120 H; Shimadzu, Kyoto, Japan).

| Component (g/100 g) | PT | SW | TR | YM |
|---------------------|----|----|----|----|
| Moisture            | 74.6 | 61.7 | 81.3 | 72.9 |
| Protein             | 1.9  | 0.9  | 1.9  | 2.8 |
| Fat                 | 0.1  | 0.5  | 0.2  | 0.2 |
| Ash                 | 0.9  | 0.9  | 1.3  | 1.0 |
| Carbohydrate        | 22.5 | 36.0 | 15.3 | 23.1 |
| Sugar               | 20.8 | 33.5 | 12.7 | 21.4 |
| Dietary fiber       | 1.7  | 2.5  | 2.6  | 1.7 |

The analysis of component was entrusted to the Japan Food Research Laboratories. PT, potato; SW, sweet potato; TR, taro; YM, yam.
Texture measurement of pastes and commercially available care foods

The hardness, cohesiveness and adhesiveness of the pastes without moisture adjustment, pastes with 80% moisture content, and commercially available care foods were measured using a universal test machine (RE 2–33005s; Yamaden., Tokyo, Japan). For the measurement method, reference was made to “Test Methods of Food for Persons with Difficulty in Swallowing” of the Consumer Affairs Agency.[8] The samples were each placed in a stainless-steel container with a diameter of 40 mm and a height of 15 mm, and using a plunger with a diameter of 8 mm, compression was performed twice at the compression speed of 1 mm/s with a clearance of 7.5 mm. While the test methods of the Consumer Affairs Agency specify a plunger with a diameter of 20 mm, compression speed of 10 mm/s, and a clearance of 5 mm, a modified method was employed in this study because sticking of the sample to the plunger made measurement difficult.

Appearance of squeezed pastes and commercially available care foods

To observe the appearance of pastes with 80% moisture content and commercially available care foods, an adaptive feeding device for persons with eating disorders (necessitating a fluid diet) in hospitals and nursing homes (Figure 1, Raku-raku Gokkun; Saito Industrial, Niigata, Japan) was used to squeeze the paste from the nozzle in a 10-cm long straight line onto a baking sheet. Further, 5 mL of paste, which corresponds to one mouthful, was squeezed out in a circle, 3 cm in diameter, drawn on the baking sheet. The appearance of each squeezed paste was photographed within approximately 30 s from the time it was squeezed out.

Sensory evaluation of taste

Sensory evaluation of the 4 types of paste with 80% moisture content was carried out using a ranking test. Twenty-five healthy female students at the University of Shizuoka (mean age, 22.1 ± 0.6 years) were selected as panelists. The 5 attributes evaluated were hardness, stickiness, and cohesiveness, ease

Figure 1. An adaptive feeding device for persons with eating disorders necessitating a fluid diet in hospitals and nursing homes. After filling the device with care food, push down the piston and fill to the tip of the nozzle with care food. Squeeze the nozzle and extrude care food into the mouth of the person with an eating disorder.
of swallowing and desirability of texture. These were determined in reference to the attributes used for sensory evaluation of cereals,\textsuperscript{[9]} thickeners,\textsuperscript{[10,11]} and high-pressure-heat-treated pork meat gels.\textsuperscript{[12]}

The definitions of the attributes are shown in Table 2. Prior to the sensory evaluation, the panelists were provided an explanation of these attributes and definitions. The panelists were provided with the 4 types of paste with 80% moisture content in a plastic cup with a spoon and a glass of water. The panelists were instructed to rank the pastes from 1 (strongest) to 4 (weakest) for each attribute, and to rinse their mouths between each paste.

### Table 2. Assessment definitions of sensory attributes.

| Sensory attribute name | Assessment definition |
|------------------------|-----------------------|
| Hardness              | Force required to squeeze the paste with the tongue and hard palate |
| Stickiness            | Adhesion of the paste to hard palate during tasting, needing efforts of tongue to transfer the bolus to the back of the mouth for swallowing |
| Cohesiveness          | Agglomeration of the paste together, characteristic of a compact bolus in the mouth, not dispersed |
| Ease of swallowing    | Effort required for the throat muscles to swallow |
| Desirability of texture | Desirability of the paste texture felt in the mouth |

### Pasting properties of potato flours and starches

The pasting viscosity of potato flours and starches was measured using a Rapid Visco Analyzer (RVA-4; Perten Instruments, Hägersten, Sweden). Potato flours were obtained by slicing the raw potatoes and drying the slices at 50°C for approximately 7 h with an electric blest dryer (DSH-mini; Shizuoka-Seiki, Shizuoka, Japan), then pulverizing them with a mill-equipped mixer (BM-RS08; Zojirushi, Osaka, Japan) and passing the resulting flour through a sieve with 150-μm openings. Potato starches were prepared according to the method of Wickramasinghe et al.\textsuperscript{[13]} Water was added to the sliced raw potatoes to achieve a potato/moisture ratio of 3:4, and after the mixture was milled for 1 min using a mill-equipped mixer, it was passed through two sieves with respective openings of 250 μm and 150 μm. Next, the pass-through material was centrifugally cooled at 12,110 × g for 10 min. The same operation was repeated twice more for the precipitate. The resulting precipitate was washed three times with 70% ethanol, dried, and passed through a sieve with 150-μm openings. In addition, the supernatants obtained by centrifugation were collected, combined, and used for the determination of water-soluble protein described later.

For the RVA measurement conditions, the reports of Aric et al.\textsuperscript{[14]} and Sit et al.\textsuperscript{[15]} were referenced. To obtain the suspension, 4.0 g of solid content for the flour and 3.5 g of solid content for the starch were mixed in 25.0 g and 24.5 g of water, respectively. The resulting suspension was held at 50°C for 1 min, heated to 95°C in 3.7 min, and then held at 95°C for 2.5 min. Then, the suspension was cooled to 50°C in 3.8 min and held at 50°C for 2.0 min. The paddle rotation speed was 960 rpm for the first 10 s, which was reduced to 160 rpm throughout the remainder of the measurement. From the recorded RVA curve, viscosities of peak, trough, breakdown, final and set back, and pasting temperature were read using the supplied software.

### Determination of water-soluble protein in potatoes

The amount of water-soluble protein in potatoes before and after heating was measured by the Bradford method\textsuperscript{[16]} using the extraction liquid from the preparation of potato starches. The extraction liquid was diluted 30-fold with distilled water. The extraction liquid was heated to 95°C for 5 min using a constant-temperature aluminum heating block (HDB-1; AS ONE, Osaka, Japan). Then, the heated extraction liquid was centrifugally cooled at 20,880 × g for 5 min, and the supernatant was used for the measurement.
**Statistical analysis**

All measurements were performed in triplicate or more, and each value was expressed as mean ± standard deviation. The results were evaluated using ANOVA, and the means were compared by Tukey’s test with statistical significance set at $p < .05$. Kendall’s rank correlation coefficient was used for the statistical analysis of sensory evaluation by the ranking test. For attributes in which consistency ($p < .01$) was observed between subjects, a significant difference ($p < .05$) between means was determined using the ranking test table.\(^\text{[17]}\)

**Results and discussion**

**Texture properties of pastes and commercially available care foods**

First, the texture properties of the pastes prepared by milling the heated potatoes were measured and are represented in Figure 2 by black bars. The moisture content of the pastes ($n = 5$) was $72.7 \pm 1.4\%$ for PT, $60.5 \pm 1.8\%$ for SW, $79.6 \pm 0.9\%$ for TR, and $71.1 \pm 3.6\%$ for YM, and the rate of moisture loss due to heating and milling ranged from $1.3\%$ to $1.9\%$.

SW and YM produced the highest hardness values, while TR produced the lowest. The cohesiveness value was the highest for SW and TR, and lower for PT and YM. The adhesiveness value was the lowest for TR, and equivalent among the other samples. Compared with the commercially available care foods (white bars in Figure 2), TR had similar values of hardness and adhesiveness, and a significantly higher cohesiveness value. Foods of low stickiness and that offer good cohesiveness are suitable for elderly people with decreased swallowing function. TR paste, which has the same level of hardness and adhesiveness as care foods as well as high cohesiveness, was assumed to offer the most suitable texture for care foods among the four potato varieties.

In contrast to TR, the other potato varieties were significantly higher in hardness and adhesiveness values than the commercially available care foods and milling alone did not result in a product suitable as a care food. Therefore, the moisture content of all pastes was standardized to 80% to approximate the moisture content of commercially available care foods; the texture of the resulting pastes was measured and is indicated by gray bars in Figure 2. For SW, the hardness and adhesiveness values decreased to levels comparable with those of the commercially available care foods and TR. PT and YM had higher hardness and adhesiveness than the commercially available care foods, SW and TR, even after adjusting the moisture content. For all potatoes, cohesiveness was equivalent to that of the commercially available care foods.

These results indicate that, except for TR, which has the highest moisture content in its raw form, the addition of water is essential for use of potatoes as a care food in paste form. However, it is inferred that the components of potatoes affect the texture of the paste even when the moisture content is standardized to 80%, evidenced by the obvious differences in the texture of the pastes depending on the potato variety.

**Appearance of pastes with 80% moisture content and commercially available care foods when extruded**

To compare the ease of handling of pastes and the condition when one mouthful is taken into the oral cavity, the pastes with 80% moisture content and the commercially available care foods were extruded onto baking sheets using the adaptive feeding device, and the shapes were compared. As shown in Figure 3, because PT and YM are hard and highly adhesive, they were not smoothly extruded as a continuous line. However, when the amount corresponding to one mouthful was extruded, the shape retention was satisfactory. TR could be extruded as an unbroken line and had good shape retention when extruded as a mouthful portion. In contrast, SW was soft and easy to extrude, but the paste flowed slowly and did not maintain its shape. The commercially available care foods could be squeezed out as an unbroken line, and they retained their shape even when a mouthful portion was squeezed out.
These observations indicate that TR most closely approximates the condition of commercially available care foods. The texture values of SW also closely approximated those of the commercially available care foods and TR; however, the appearance of the paste differed greatly. In contrast to the commercially available care foods and the other potato varieties, whose paste held moisture uniformly, the SW paste exhibited separation of some of the added water, resulting in a highly liquid paste. In its raw state, SW had the lowest moisture content of all potato varieties (Table 1), and when heated in the microwave oven, there was less moisture available for hydration of the starch content through gelatinization. Moreover, SW starch has lower swelling power than other potato varieties. Therefore, it is surmised that the increase in liquidity was due to a substantial amount of free water.
that could not be used for starch hydration. In addition, it has been reported that foods that are easy and safe to swallow are characterized by softness, low-adhesiveness, high-cohesiveness, homogeneity (like puree), smoothness, and little water separation.\textsuperscript{18,19} While SW paste is soft and has low adhesiveness, it is prone to water separation, which is thought to increase the difficulty of swallowing for people with dysphagia. On the other hand, YM starch has high amylose content,\textsuperscript{20} and PT contains large starch granules that are easily broken down. Therefore, it was surmised that in the case of YM and PT, amylose eluted from starch granules undergoes gelation via hydrogen bonds, resulting in a paste that is hard and has low flowability.

**Sensory evaluation of pastes with 80% moisture content**

The above results indicate that even if the moisture content is standardized to 80%, the pastes differ greatly according to the potato variety. Therefore, to clarify the influence of potato variety on human senses, we employed sensory evaluation of pastes with 80% moisture content using a ranking test. Although it would have been desirable to use elderly persons for the panel, young people were selected to eliminate the risk of aspiration and in light of the fact that mastication function and salivation vary greatly among the elderly. Further, the panel consisted of women only, as saliva production differs between men and women.\textsuperscript{21}

As shown in Table 3, paste hardness was evaluated as significantly softer for SW, followed by TR, compared with PT and YM. For stickiness, SW and TR were found to be significantly less likely to cling to the teeth and oral mucosa than PT and YM. These assessments are in general agreement with the texture measurements. Regarding cohesiveness, SW was evaluated to be significantly less cohesive than the other potato varieties. For ease of swallowing, there were no significant differences among the potato varieties. Desirability of texture was evaluated to be significantly better for SW than the other potato varieties.

Based on these results, SW was found to be soft and less sticky, yet lacking in cohesiveness in the oral cavity. On the other hand, in addition to TR being soft and less sticky like SW, TR was found to
have better cohesiveness in the oral cavity than SW. However, TR was not found to be necessarily superior in the attribute of ease of swallowing. Loret et al.\textsuperscript{[9]} reported that no specific physical markers for swallowing were found between subjects, and that each subject had their own mastication strategy, leading to food boluses with different rheological properties. Based on the above findings, it was determined that sensory evaluation using a panel of young healthy people without dysphagia cannot determine the superiority of TR in terms of attributes such as ease of swallowing. Therefore, we plan to carry out sensory evaluation using elderly people in a future study. Regarding the desirability of texture, SW received a high score. Even before foods are eaten, people recognize them by sight and smell and judge whether they are suitable for eating.\textsuperscript{[22]} It is surmised that the fact that SW, which is often offered in paste form, is easier to recognize than potato varieties such as TR and YM, which are rarely consumed in paste form, affected the evaluation of desirability of texture.

### Pasting properties of potato flours and starches by RVA

To elucidate the factors that account for differences in the characteristics of pastes depending on the potato variety, we first examined the pasting properties of starch, the main component of potatoes, using RVA. RVA curves for the dried potato flours are shown on the left of Figure 4, and those for the purified potato starches are shown on the right. Table 4 shows various parameters obtained from the RVA curve.

In the case of the potato flours, a rapid rise in the viscosity of the suspension occurred at 68.6 ± 0.1°C for PT, 75.9 ± 0.1°C for SW, and 72.7 ± 0.5°C for YM. When swelling of the starch granules reached

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**Table 3.** Sensory scores of paste with 80% moisture content.

| Attribute              | PT   | SW   | TR   | YM   | W    |
|------------------------|------|------|------|------|------|
| Hardness               | 32\(^a\) | 10\(^b\) | 21\(^b\) | 37\(^c\) | 0.868** |
| Stickiness             | 34\(^b\) | 15\(^a\) | 16\(^a\) | 35\(^b\) | 0.724** |
| Cohesiveness           | 25\(^a\) | 38\(^b\) | 16\(^a\) | 21\(^a\) | 0.532** |
| Ease of swallowing     | 32\(^a\) | 17\(^a\) | 23\(^a\) | 28\(^a\) | 0.252   |
| Desirability of texture| 30\(^b\) | 13\(^a\) | 28\(^b\) | 29\(^b\) | 0.388** |

Abbreviations are the same as in Table 1. W indicates the Kendall’s rank correlation coefficient (p**<0.01). Means with different letters are significantly different (p < 0.05).

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**Figure 4.** Rapid visco analyzer curves of potato flours and starches. Abbreviations are the same as in Table 1. The amounts of solid content of flours and starches were 4.0 g and 3.5 g, respectively.
Table 4. Pasting properties of potato flours and starches.

|           | Peak      | Trough    | Breakdown | Final     | Set back | Pasting temperature (°C) |
|-----------|-----------|-----------|-----------|-----------|----------|--------------------------|
| Flour     |           |           |           |           |          |                          |
| PT        | 11521 ± 125a | 5834 ± 48b | 5687 ± 112a | 6679 ± 51a | 845 ± 29b | 68.6 ± 0.1 c             |
| SW        | 1654 ± 6 c  | 718 ± 6 c  | 936 ± 11 c  | 985 ± 10d | 267 ± 7 c  | 75.9 ± 0.1 a             |
| TR        | N.D.      | N.D.      | N.D.      | 3585 ± 129b | N.D.     | N.D.                     |
| YM        | 4549 ± 472b | 2050 ± 163b | 2499 ± 318b | 2930 ± 323c | 880 ± 164a | 72.7 ± 0.1 b             |
| Starch    |           |           |           |           |          |                          |
| PT        | 16401 ± 333a | 5231 ± 51c | 10770 ± 51c | 5639 ± 115b | 342 ± 34d | 68.6 ± 0.1 c             |
| SW        | 7199 ± 42c  | 1857 ± 14c | 3542 ± 41b  | 3139 ± 52f | 1282 ± 59a | 76.8 ± 0.1 b             |
| TR        | 2796 ± 16d  | 1632 ± 28c | 1164 ± 37d  | 2399 ± 59f | 767 ± 31c  | 81.6 ± 0.8a              |
| YM        | 9077 ± 90b  | 4924 ± 30b | 4154 ± 63c  | 5912 ± 94c | 989 ± 67c  | 75.6 ± 0.4b              |

Abbreviations are the same as in Table 1. Means with different letters in same column are significantly different (p < 0.05).

its maximum level, peak viscosity was attained, followed by the breakdown of the starch granules. In contrast, the pasting curve of TR differed from the other potato varieties. The viscosity of the TR suspension started to rise gradually at around 94°C, representing a higher temperature than for the other potato varieties, and the level of viscosity was maintained until the end of the measurement. Therefore, viscosities of peak, trough, breakdown, and set back could not be confirmed for TR, unlike the other potato varieties (Table 4).

Next, to identify the factors that account for the remarkable differences in pasting properties of TR flour relative to the other potato varieties, RVA measurement was performed again using the purified potato starchy. As a result, the pasting properties of the starch of PT, SW and YM were found to be almost the same as previously reported,[20,23] and no significant differences were found in the curves of the starchy and flours. On the other hand, TR differed from the flour suspension; the viscosity increased rapidly in the vicinity of 81.6 ± 0.8°C, closely approximating a previous report,[24] and the peak viscosity and breakdown were also confirmed.

Based on these results, it was speculated that PT, SW and YM are less affected by components other than starch during starch gelatinization, even when heated in the whole potato condition. On the other hand, TR was found to contain a water-soluble component that imparts viscosity, and when heated as a whole potato, the starch slowly gelatinizes without breakdown of starch granules. Hung et al.[20] also reported that the peak viscosity of RVA changes in the presence of mucilage in TR. Therefore, it was suggested that components other than starch also contribute to the characteristics of TR paste.

**Thermal stability of water-soluble protein**

As shown in Table 1, TR and YM have a higher protein content than SW and PT. In addition, TR has a protein to sugar ratio of 14.6%, which is higher than that of PT (9.0%), SW (2.7%) and YM (12.7%). TR[25] and YM[26,27] also are characterized by the presence of mucilage, in which protein and galactan are linked. Thus, in TR and YM, protein changes due to heating are also expected to affect the state of the paste. Therefore, the amount of water-soluble protein before and after heating was measured using the extract obtained when preparing the starch samples from potatoes, and the thermal stability of the protein was examined.

As shown in Figure 5, the amount of water-soluble protein in the solution before heating (black bar) showed the same tendency as the amount of protein in the raw potatoes, and is in the rank order of YM > TR > PT > and SW. The amount of water-soluble protein in the solution after heating (gray bar) was the greatest for TR, roughly the same for PT and YM, and lowest for SW. Thus, it was inferred that TR paste is smooth, with low adhesiveness and good cohesiveness, on account of TR containing a large amount of proteins that are not easily thermally denatured, with some being present in the paste as mucilage. Moreover, the TR flour also showed different pasting properties than the other potato varieties according to RVA measurement (Figure 4). Therefore, it was inferred that the thermal stability of proteins is also involved in this phenomenon. On the other hand, the mucilage of YM (D. opposita Thumb.) has a particularly small amount of heat absorption capacity.
compared with other yam family varieties, and thus is easily thermally denatured. Therefore, it was inferred that the mucilage in YM thermally sets during the heating process, resulting in hardening of the paste.

From the results presented herein, it was inferred that the mouthfeel and texture of TR and YM are attributable to the nature of their proteins. However, potato extracts were heated in this experiment, and the effect may be different when heating whole potatoes. Going forward, studies on the heat denaturation of proteins during heating of whole potato are called for. In view of the RVA results, the heat denaturation of proteins is considered to have little influence on the state of pastes in the case of PT and SW.

**Conclusion**

Pastes of 80% moisture content were prepared from four varieties of potato, and the potato varieties most applicable for care food were investigated. As the results, TR paste was found to have greater softness and less stickiness, approximating those of the commercially available care foods, as well as better cohesiveness in the oral cavity compared with the other potato varieties. These results suggest that TR starch is gelatinized slowly when the whole potato is heated without breakdown of starch granules, contains water-soluble proteins of high thermal stability, and shows less loss of mucilage (sliminess) as a result of heating. Therefore, it is concluded that TR paste can be used as a meal ingredient, applicable as both a source of nutrition and a dietary supplement to assist swallowing.

**Disclosure statement**

The author(s) declare no conflict of interest.

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