



## An analysis of texture and viscosity of local thickness as a substitute of commercial food thickener for patients with swallowing disorders

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### Abstract

**Introduction:** Management of cases of difficulty swallowing in Indonesia has so far only used standardized forms of hospital food consisting of ordinary foods, soft foods, chopped foods, filtered foods and liquid foods. In developed countries, the use of commercial food thickener is commonly used for cases of swallowing disorders. Commercial food thickener products are difficult to obtain in Indonesia and the price is quite expensive so that substitute products that are derived from local and cheap food are needed. It is necessary to develop an alternative formulation of food thickener made from local which is easily obtained and cheaper in price as an alternative solution to the problem of eating difficulties. Some ingredients that have properties as a food thickener are glucomannan porang and xanthan gum. Porang glucomannan has a high fiber content while xanthan gum has high viscosity in low concentration.

**Objective:** The purpose of this study was to determine the texture and viscosity of local thickener food in accordance with the consistency of commercial food thickener as a gold standard.

**Methods:** eksperimental laboratorium research which is held at the Nutrition Department in UGM Academic Hospital on June until November 2019, with the research steps are: 1) Make a standard gold solution of 6 grams of commercial food thickener 2) Measuring the texture and viscosity of a standard gold solution used as a comparison with other products 3) Conducting subjective and objective tests of local ingredients, namely glucomannan porang and xanthan gum.

**Results:** From the research conducted in the laboratory by using the RVA method, all 4 flour (cornstarch, sago flour, arrowroot flour, tapioca flour and porang glucomannan flour) showed a viscosity close to the thickness of commercial food thickener. The advantage of glukomanan flour is that after the maximum viscosity value is reached, the viscosity does not change with an increase in temperature or when the temperature decreases. **Conclusions:** Porang glucomannan has a texture similar to commercial food thickener (gold standard), the viscosity of porang glucomannan tends to be stable with changes in temperature and when the temperature decreases so that it can be used as an alternative food thickener for dysphagia patients.

**KEY WORDS:** food thickener, glucomannan porang, swallowing disorders, xantan gum

### 1. Introduction

The prevalence of swallowing disorders in adults is more than 50 years, which is around 7-22% of the population<sup>1</sup>. In the general population, it is about 5-8%<sup>2</sup>. Fiberoptic Endoscopic Evaluation of Swallowing (FEES) is a standard examination to assess patients with swallowing disorders, especially evaluating the risk of aspiration at oral intake and determining subsequent management<sup>3</sup>.

There is about 28 – 65% of patients who experience dysphagia after a stroke. After 14-day rehabilitation from a stroke, there is about 90% of patients can practice swallowing.

Adequate nutrition is an essential thing to achieve optimal health, while swallowing disorders can directly affect a patient's food intake, which affects the patient's nutritional status. It is necessary to modify the right diet so that the patient's intake of food can be optimal. Modification of food texture is needed to

prevent aspiration<sup>4</sup>. For instance, the case management of difficulty swallowing has only used the standard of hospital food such as ordinary, soft, chopped, filtered, and liquid foods. There is an adjustment between the shape of the food and the degree of swallowing difficulty. For liquid consistency food, there are two types of classification, namely clear liquid and thick liquid. It is useful for feeding routes through oral or tubes (sonde).

In developed countries such as Australia, America, Taiwan, or Thailand for the Asian, commercial food thickener is used for cases of swallowing disorders. The commercial food thickener formula is efficient to use because it has a standardized size, which adjusted to the needs of the right food consistency for the case encountered<sup>5</sup>. However, commercial food thickener products are challenging to find, and they have high prices in Indonesia. On the other hand, Indonesia is an agricultural country that has local and cheap food products. Some food products are in the form of starch, such as maize flour, sago flour, arrowroot flour, and konnyaku flour. All of them used as thickener substitutes for commercial food thickener<sup>6</sup>.

In 2018, there was a study conducted which was about analysis of local thickener formulation as a substitute for commercial food thickener on diets for swallowing disorders<sup>7</sup>. The result was that several types of local flour used, maize flour was 3% (5 grams in 300 ml water) dissolved and cooked at a temperature of 400C is similar to the gold standard (commercial food thickener), which is equivalent to a 2% formulation. Moreover, the research development needs to study more regarding local products as thickening agents that are more stable to temperature, so it does not require cooking/heating treatment. The goal is that the product is easy to use and mix with daily food according to the degree of dysphagia.

The development of this research made a raw formulation of a local food thickener in some degree of texture from commercial food thickener (gold standard), namely formulations 1%, 2%, and 3%. From several studies, the results were that glucomannan produced from the

extraction of porang tubers is one of the thickening materials that has widely used in the food industry so that it is safe for consumption. Glucomannan contains high levels of fiber and function as a thickening and gelling agent. It can form and stabilize the gel structure, so its use is as a food thickener and fat substitute<sup>8</sup>.

Xanthan gum is one of the thickening agents used. Kedar and Bholay, 2014 said that xanthan gum is pseudoplastic (has high viscosity despite low concentration). It is not toxic and irritating, so it used as a food additive. Besides, various industrial fields use xanthan gum, a stabilizer, thickener, emulsifier, and friction damper for each food, pharmaceutical, and petroleum industry.

The combination of porang and xanthan glucomannan gel will produce thickening products that are more stable to temperature. Liang et al. stated that glucomannan could form the most durable gel with xanthan compared to other hydrocolloids such as guar gum, carrageenan, sodium alginate, sodium carboxyl cellulose, methylcellulose, hydroxyethylcellulose, and Arabic gum.

Based on the background, the researcher wanted to conduct further research to understand the percentage of porang glucomannan and xanthan gum use which is in accordance to the gold standard regarding the consistency of food thickener. In addition, this study aimed to determine the subjective characteristic of commercial food thickener and various local food flours, including cornstarch, arrowroot flour, sago flour, and tapioca flour.

## 2. Materials and Methods

This research used was a laboratory experimental research design. The aim was to determine the solution percentage levels of maize starch, arrowroot starch, sago starch, tapioca starch, porang glucomannan, xanthan gum. Moreover, it also investigated how they produced consistency according to the gold standard, both subjectively and objectively. The researcher carried out the subjective testing at nutrition installation in UGM Academic Hospital; meanwhile, product testing run at the UGM

Agricultural Technology Laboratory. The research conducted on June-November 2019.

The type of data used in this study was quantitative and qualitative data. Quantitative data obtained from the measurement of the texture and viscosity of gold standard, maize starch, arrowroot starch, sago starch, tapioca starch, porang glucomannan, xanthan gum using a tool. At the same time, qualitative data obtained from the results of subjective measurements using the fork test.

In the initial phase of the research, a 6-gram food consistency solution measured in 150 ml of water. The measured consistency parameters are texture and viscosity. Measuring consistency is done objectively using the Rapid Visco Analyzer (RVA) and subjectively using the fork test method. The results of the measurement of the texture and viscosity of the food thickener become a reference (gold standard) in determining the consistency of maize starch, arrowroot starch, sago starch, tapioca starch, glucomannan porang, xanthan gum.

After conducting subjective testing, texture and viscosity measurements tested objectively using RVA. Data from the objective test of the texture and viscosity of the five formulas were then statistically tested descriptively. Data collection of texture and viscosity data was subjectively carried out by the fork test method. This method conducted based on the flow or droplet of food between the fork bars and the food left on the fork. Categories of consistency using the fork test shown in the following figure

Kategori	Deskripsi
Tingkat 1: cair encer	Jenis makanan yang semuanya segera mengalir dengan mudah dan tidak ada yang tertahan di atas garpu. 
Tingkat 2: seperti "nectar"	Jenis makanan yang mengalir perlahan diantara jeruji garpu dan hanya sedikit yang tertahan di atas garpu. 
Tingkat 3: seperti madu	Jenis makanan yang mengalir perlahan diantara jeruji garpu dan sebagian besar tertahan di atas garpu. 
Tingkat 4: seperti puding	Jenis makanan yang dapat diambil dengan garpu dan semua tertahan di atas garpu. 

Figure 1. the consistency categories based on fork tests

Subjective data with fork tests were analyzed qualitatively descriptive. The results of objective measurements of texture and viscosity of the five formulas tested using descriptively statistics test.

### 3. Results

In the initial phase of the research, the standard gold formula made was a solution of commercial food thickener by using the subjective test as follow:

#### A. The Characteristics of Textural Subjective in Commercial Food Thickener Solution

Table 1. Subjective Characteristics in Commercial Food Thickener Solution

Material	Concentration	Stirring Duration	Consistency category	Consistency description
Commercial Food Thickener	6 gram in 150 ml of water (4%)	10 minutes	Level 2	Like nectar

The subjective test showed the standard gold formula which has the 2-level consistency (like nectar)

#### B. The Characteristics of Textural Subjective in Various Local Flours

The results of the subjective assessment, each local material has a different texture and viscosity characteristics on the amount/weight of the material, cooking temperature is the same.

Porang glucomannan with a concentration of 0.7%, a stirring, and without a heating process showed a level-1 consistency category (dilute liquid), whereas a level of 1% showed a level-2 consistency category (such as nectar). Adding a solution percentage above 1% can be challenging to achieve homogenization. It was because of solutions, solids, and liquids could not mix homogeneously. Porang glucomannan has hydrocolloid that can form a solid solution in water, expand with high expansion power, and make a gel<sup>9</sup>. Based on the subjective test of *Xanthan gum*, it indicated a low

level of solubility, so it could not mix with the added water. There is difficulty in mixing solids and liquids. Moreover, the study of Ario stated

that xanthan gum could form a thick solution at low concentrations (0.1% -0.2%), and a gel formed in a concentration of 2% - 3%<sup>10</sup>.

Table 2. Subjective Characteristics of Local Food Thickener

Material	Concentration	Temperature	Stirring duration	Consistency category	Consistency description
Porang Glukomanan	1 gram in 150 ml of water (0,7%)		10 minutes	Level 1	Runny liquid
Porang Glukomanan	2 gram in 150 ml of water (1%)		10 minutes	Level 2	Like nectar
Xanthan Gum				Cannot dissolve	Runny liquid
Maize starch*	10 gram in 300 ml of water (3%)	40°C	10 minutes	Level 1	Runny liquid
Maize starch	20 gram in 300 ml of water (7%)		15 minutes	Level 2	Like nectar
Tapioca starch *	15 gram in 200 ml of water (8%)	37°C	10 minutes	Level 2	Like nectar
Arrowroot starch	10-gram in 150 ml of water (7%)	40°C	15 minutes	Level 1	Runny liquid
Arrowroot starch	15 gram in 150 ml of water (10%)		15 minutes	Level 2	Like nectar
Arrowroot starch*	20 gram in 150 ml of water (15%)	35°C	10 minutes	Level 4	Like pudding
Sago starch	10 gram in 150 ml of water (7%)		15 minutes	Level 1	Runny liquid
Sago starch	15 gram in 150 ml of water (10%)		15 minutes	Level 2	Like nectar
Sago starch *	20 gram in 150 ml of water (13%)	32°C	15 minutes	Level 4	Like pudding

The table showed that maize, arrowroot, and sago flours have a level-1 consistency category (runny liquid). Maize flour stirred with a concentration of 3% for 10 minutes with a cooking temperature of 400C; arrowroot flour mixed with a level of 7% for 15 minutes with a boiling heat of 400C, and sago flour stirred with a concentration of 7% stirred for 15 minutes with a heating temperature of 400C. Then, maize flour with 7 % concentration, arrowroot starch with 10%, and sago starch with 10% have a level-2 consistency category (level 2), which is like nectar. Tapioca starch has smooth viscous characteristics with a temperature drop of up to 370C, stirring time of 10 minutes and in a concentration of 8% showed a level 2 consistency category that is like nectar. The characteristics of maize, sago, arrowroot, and tapioca flours have a similarity as a type of starch used as a local thickener. All of them used in a variety of

cuisines, either the main ingredient or a food thickener.

#### Objective and Viscosity Tests

Texture and viscosity data objectively measured using the Rapid Visco Analyzer (RVA). In RVA, a viscosity test was carried out by gradually increasing the temperature from 40 degrees to 90 degrees, then held at 90 degrees for 6 minutes, after which to 40 degrees. The thickness assessed every 4 seconds. RVA results obtained:

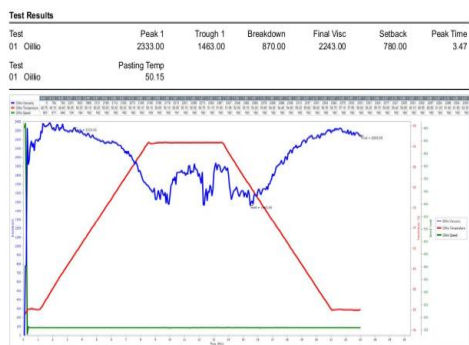


Figure 1. The RVA result of commercial food thickener

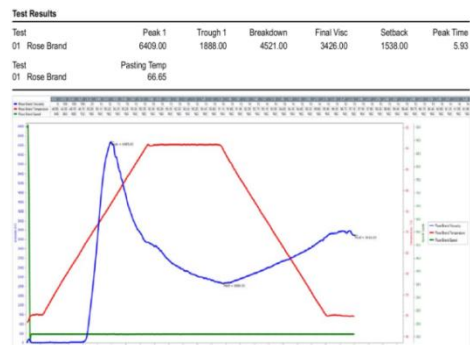


Figure 5. The RVA result of tapioca starch

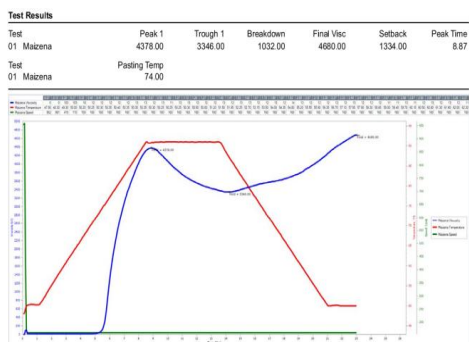


Figure 2. The RVA result of maize starch



Figure 6. The RVA result of porang glucomannan

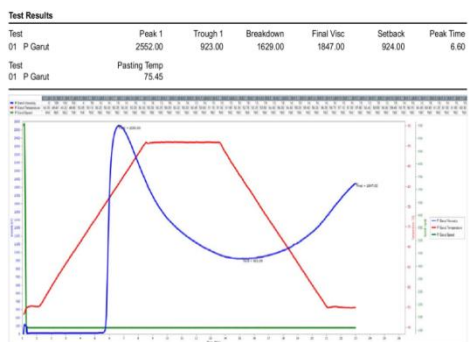


Figure 3. The RVA result of arrowroot starch

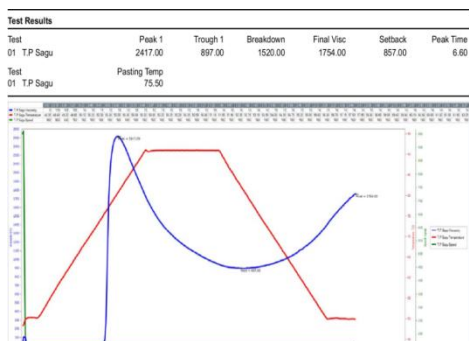


Figure 4. The RVA result of sago starch

The objective test results were listed in Figure 1 to Figure 6. Tests using RVA showed that each local material tested had different characteristics based on temperature and time of thickness.

The thickness assessed every 4 seconds. RVA results obtained:

1. pasting temp, i.e., the temperature at which the curve began to rise or viscosity began to form.
2. peak viscosity/peak 1, i.e., peak viscosity or showing starch gelatinized.
3. trough viscosity/trough 1, i.e., viscosity when the temperature maintained at 95 degrees.
4. breakdown, i.e., viscosity change during heating or the difference between peak 1 and trough 1.
5. Final viscosity, i.e., thickness, when the temperature maintained at 50 degrees.
6. set back, i.e., viscosity changes during cooling or the difference between final viscosity and trough 1.

**4. Discussion**

The RVA results indicated that porang glucomannan had a more stable viscosity value.

The viscosity value tended to remain with the heating time and temperature. It was different from other flour such as arrowroot flour, sago flour, maize flour, where the value of viscosity changes when the temperature decreases

From the commercial food thickener research, it indicated that maize, sago flour, arrowroot flour, tapioca flour, and porang glucomannan could function as liquid thickening agents. It was because it has a similar texture to standard ingredients, namely commercial food thickener. According to the conducted research using the RVA method, all four flours (maize, sago flour, arrowroot flour, tapioca flour, and porang glucomannan) showed a viscosity close to the thickness of commercial food thickener. The advantage of porang glucomannan is that after reaching the maximum viscosity, it does not change with an increase or decrease of the temperature.

### 5. Conclusions

1. Local food can function as an alternative food thickener in dysphagia patients.
2. Porang glucomannan has a similar texture to olio flour.
3. The viscosity of porang glucomannan tends to be stable with temperature changes and decreases.
4. Porang glucomannan can be an alternative liquid thickener.

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### Competing interests

Researchers did not have a conflict of interest in conducting this research.

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