Tools to modify the thickness of liquids and the texture of foods

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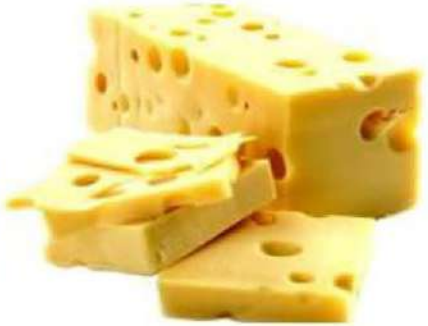
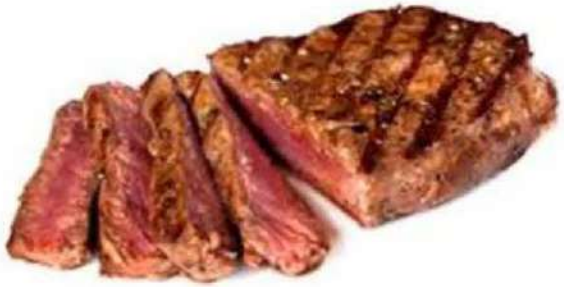
Ice Breaker

Ask yourself while swallowing different foods, why does food texture and liquid thickness matter?

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Goals of the lesson

The aim of this lesson is to learn some **basic concepts in rheology and textural properties** of dysphagia-oriented food, **how to measure their properties and** what **thickeners** can be used to modify the textural and rheological characteristics of food and beverages.

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Learning outcomes

- To learn some basic concepts in rheology and food texture needed to understand the characteristics of texture modified food and thickened fluids;
- To understand the consequences of the thickening of liquids and foods for dysphagia diets and how to measure their properties;
- To know the main characteristics of thickening agents and how to use them.

(Source: https://www.nestlehealthscience.com)

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Basic concepts

Rheological and textural properties in dysphagia management

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Flow and textural properties of food in dysphagia management

Remember!

- Specially made and nutritional enriched texture modified foods and thickened fluid has been implemented over the last years for dysphagia management.
- Ensuring thickened fluids have suitable flow properties is an essential part of dysphagia management to secure safe swallowing. Fluids that are too thin may be aspirated, potentially causing pneumonia, while over-thickened fluids may become a choking risk due to residue.
- Nevertheless the food and beverages used in dysphagia management are usually described qualitatively (e.g. hard, moisture-food, sticky, thin, thick, etc.) and it is still difficult and subjective to categorize the food for patients and caregivers.
- Many clinicians and researchers agree the terms thick or thin seem not to be enough to ensure the safety of the preparations. Thickened liquids and modified food used for dysphagia management, need to be characterized and described more in detail in terms of their **rheological properties.**

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Flow and textural properties of food in dysphagia management

- Rheological properties describe how the foods deform or flow in response to stress. They help to characterize the food behaviour in complex deformations, such as those encountered during swallowing.

Rheology *is a branch of physics that studies the deformation and flow of materials.*

- Rheological properties of food and beverages used in dysphagia nutrition are complex and they depend on the intrinsic characteristics, the type and concentration of the thickening agent, temperature, pH, composition, time after preparation….

- It is desirable that research communities and health professionals (dietitians, nurses, speech and language therapists, physicians and scientists….) can use a common terminology and methodology to be applied during texture modification for dysphagia management practices.

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Flow properties and dysphagia

Viscosity

- **Viscosity,** which is a rheological term broadly used in dysphagia management, is a measure of the resistance of the materials to flow. It is used for fluid foods or foods that flow.
- The unit of measurement is pascal-seconds in the International System of Units (SI), but it is also reported in Centipoise (cP), where 1cP=1 mPa. S.
- Liquids like water do not have much resistance to flow and are, therefore, classified as 'low viscosity'. It takes little effort to stir water with a spoon. However, liquids like molasses or tomato sauce have slow flow rates and consequently a 'high viscosity'.
- Some examples of viscosity values are the following: water at 20°C has a viscosity of 1.0 mPa.s.; honey has a viscosity of 10,000 mPa.s; and tomato sauce has a viscosity of 50,000 mPa.s.

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Rheology and dysphagia
Viscosity and related terms

- In the field of dysphagia, the viscosity of food products is commonly measured with a rheometer at 25 ºC at a shear rate of 50 s-1. Temperature influences viscosity.
- Common levels of liquid thickness used in dysphagia management in different countries are the following:

Table1 Common levels of liquid thickness reported in the literature for dysphagia management.

Country	Thinnest				Thickest
USA[34]	Thin		Nectar-like (51-350cP[1])	Honey-like (351-1700cP)	Spoon-thick (>1700cP)
UK[55]			Stage 1	Stage 2	Stage 3
Japan[56]	Less Mildly Thick (< 50mPa.s[1])		Mildly thick (50-150mPa.s[1])	Moderately thick (150-300mPa.s)	Extremely thick (300-500 mPa.s)
Ireland[57]	Regular	Grade 1- Slightly Thick	Grade 2- Mildly Thick	Grade 3- Moderately Thick	Grade 4- Extremely Thick
Australia[58], New Zealand[59]	Regular		Level 150- Mildly thick	Level 400- Moderately thick	Level 900- Extremely thick
Denmark[60]	Normal	Chocolate Milk	Syrup	Jelly	
Sweden[61]	Liquids		Thickened liquids		

[1] 1cP=1 mPa.s.

Source: Cichero and Lam, 2014.
Doi:10.6051/j.issn.2224-3992.2014.03.408-13

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Rheology and dysphagia
Viscosity, related terms and levels

The National Dysphagia Diet Task Force defines viscosity in standardized viscosity measurements in centipoise (cP) with strict class boundaries at a shear rate (s-1) of 50 s-1.

The International Dysphagia Diet Standardization Initiative utilizes flow rate as an indicator for liquid level; the scale of 0–4 is determined by the amount of liquid remaining in a 10 mL syringe following a free flow period of 10 s.

NDD Liquid Levels
Thin: 1-50 cP
Nectar: 51-350 cP
Honey: 351-1750 cP
Spoon Thick: 1750+ cP

Viscosity Dependent Levels

Flow Rate Dependent Levels

IDDSI Liquid Levels
0: "Thin", no liquid residue
1: "Slightly thick", 1-4 mL remains
2: "Mildly thick", 4-8 mL remains
3: "Moderately thick", >8 mL remains, some flow
4: "Extremely thick", no liquid flow

Source: Cichero and Lam, 2014.
Doi:10.6051/j.issn.2224-3992.2014.03.408-13

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Other meaningful rheological properties in dysphagia

- Whilst the viscosity of a liquid provides us with useful information, it does not provide us with a complete understanding of the structure of the fluid: Density and yield stress of fluids are also important.

(Source: NHS)

- **Density** is the mass per unit volume. It affects how the fluids move during swallowing processes.
- **Yield stress** is the force required to break down the internal structure of the fluid in order for it to flow.
  - All thickened liquids have a yield stress that must be overcome to allow the liquid to flow.

Viscosity, density and yield stress should be considered when designing and preparing thickened fluids for dysphagia conditions.

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Textural properties and dysphagia

- **Food texture** is the branch of physics that relates to solid or viscoelastic foods.
- Some textural attributes are: hardness, softness, cohesiveness, stickiness, adhesiveness, springiness, toughness, extensibility,.....
- Textural parameters are very important when preparing food for dysphagia patients.
- Food texture adaptation in dysphagia is achieved through particle size modification with/without incorporation of thickeners.
- Textural properties can be measured by specific equipment named texture analysers.

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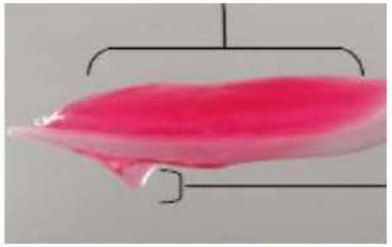
Methods to measure the rheological and textural properties



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Methods for measure the rheological and textural properties

- Rheological and textural properties can be measured by different devices and equipments.
- Methods are divided into **empirical** and **fundamental methods**

Empirical and imitative methods involve subjecting the food to a force using a device having specific characteristics, imitating the flow or deformation of the food. The data are usually highly specific to a particular food and are difficult to generalize.
IDDSI methods are imitative methods

Fundamental tests are based on the measurement of physical properties of the food and the data can be useful for determining processing characteristics. In dysphagia, they are used to evaluate thickeners and to design texture modified food and thickened beverages.

(https://assets.thermofisher.com)

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Methods for measure the rheological properties_ Empirical and imitative methods
IDDSI METHODS

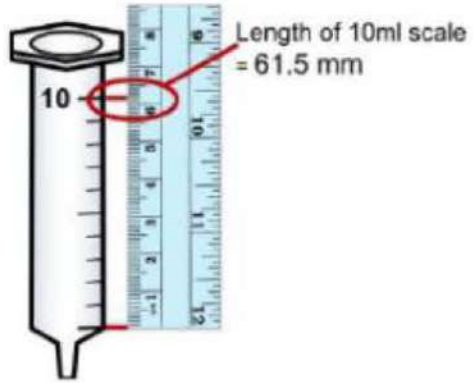
IDDSI Flow Test

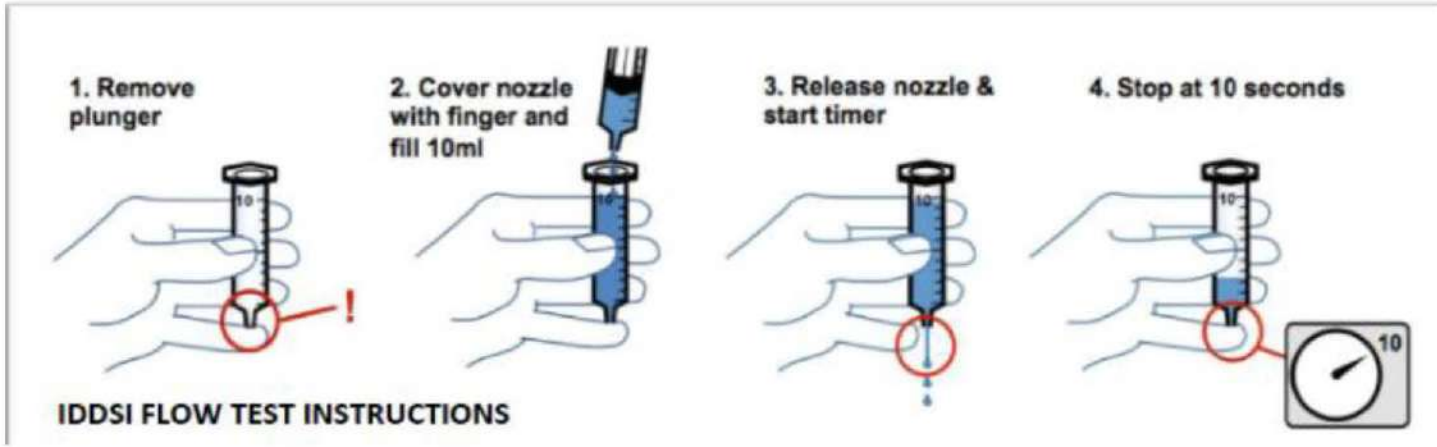
The IDDSI Flow test uses a 10 mL slip tip hypodermic syringe, as shown in the image below

How to perform the IDDSI Flow test:

https://iddsi.org/framework/drink-testing-methods/

#Before you test...
You *must check* your syringe length because there are differences in syringe lengths. Your syringe should look like this





(Source: https://www.iddsi.org)

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Methods for measure the rheological properties_ Empirical and imitative methods

IDDSI METHODS

IDDSI Flow Test

Testing tips:

- When using commercial thickener products, follow the manufacturer's instructions and mix thoroughly, watching closely that there are no lumps or air bubbles present. Be sure to allow the recommended time for the fluid to thicken completely.
- Use a clean, dry syringe of the correct type each time you test.
- Check the nozzle of the syringe is completely clear and free from any plastic residue or manufacturing defects that may occasionally occur.
- Test twice or more to ensure more reliable results.
- Check for lumps – especially if flow suddenly stops. In this case the fluid may not be suitable for dysphagia use.
- Ensure to test the liquid at the intended serving temperature.

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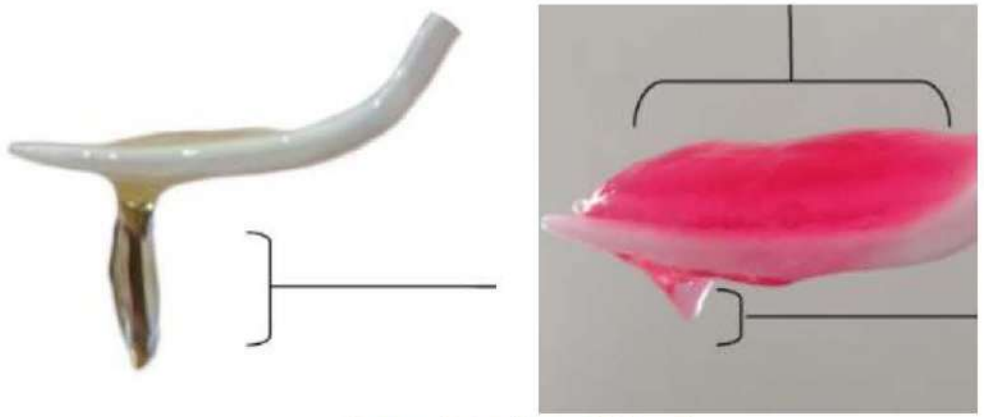
Methods for measure the rheological properties_ Empirical and imitative methods

IDDSI METHODS

IDDSI Fork/Spoon Drip Test

Food may be tested by assessing whether they flow through the tines/prongs of a fork or not.



(Source: https://www.iddsi.org)

The spoon tilt test is used to determine the stickiness of the sample (adhesiveness) and the ability of the sample to hold together (cohesiveness).

Testing tips:

- The sample should be cohesive enough to hold its shape on the spoon.
- A full spoonful must plop off the spoon if the spoon is tilted or turned sideways; a very gentle flick (using only fingers and wrist) may be necessary to dislodge the sample from the spoon, but the sample should slide off easily with very little food left on the spoon. A thin film remaining on the spoon after the Spoon Tilt Test is acceptable, however, you should still be able to see the spoon through the thin film; i.e. the sample should not be firm and sticky.
- A scooped mound may spread or slump very slightly on a plate.

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Methods for measurement of rheological properties

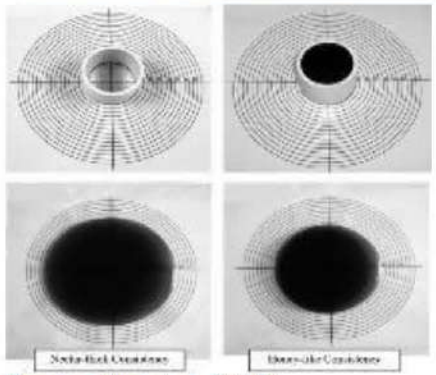
Other Empirical and imitative methods

(Source: https://www.cscscientific.com)

Bostwick Consistometer

Simple device for measuring consistency and flow rate in a variety of products. It can be used on any viscous material such as sauces, salad dressings, paints, chemicals or cosmetics. The normal way to use the consistometer is to measure the distance a sample flows in a given time interval. The trough is separated near one end by a spring-loaded gate. This forms a chamber where the sample is loaded. To perform a test, first a sample is loaded, then the gate is opened and a timer is started. At a predetermined time the position of the sample in the trough is recorded.

Nicosia & Robins, (2007) Dysphagia 22: 306–311



(Source: Kim et al., 2018)

Line-spread test (LST)

Some results of the current study suggest that the LST may be useful in the broad categorization of fluids into therapeutically significant groupings but that it cannot be used more specifically to measure fluid viscosity.

Some other results suggest that the LST is a more reliable method than the IDDSI test for evaluating the correct and desirable viscosity for the dysphagia diet, and that the IDDSI test provides a means to predict the rheometer-measured viscosity of water thickened with only XG-based thickeners.

Kim et al., (2018). Journal of texture Studies.

(Source: https://www.nonpaints.com)

Ford Cup

It is a simple device, based on gravity, used to measure the viscosity of fluids. It measures the time of a known volume of a fluid passing through an orifice located at the bottom. It is not commonly used for dysphagia preparations.

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Methods for measurement of textural properties

Fundamental & imitative methods

Texture analyzers

Texture analysers are also used to measure the rheological and textural properties of semi-solid food.

Both fundamental and imitative tests can be implemented.

The equipment is expensive, but several probes are available for different types of food.

It has been proposed that a texture analyser would be optimal for the evaluation of the texture of solid or gel-type food used in dysphagia.

https://www.stablemicrosystems.com/TAXTplus.html

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Methods for measurement of rheological properties
Fundamental methods

For optimal design of food and liquid adapted for dysphagia, it is necessary to know not only the viscosity of the products, but also the bolus viscoelasticity, yield stress, extensional viscosity, mechanical properties and lubrication properties of food.

They can be obtained using fundamental testing methods.

Fundamental tests are based on the measurement of physical properties of the food.

They are commonly used at a laboratory scale for the design of thickening agents and pre-packaged ready-to-use thickened products.

Rheometer
(Source: https://assets.thermofisher.com)

Viscosimeter

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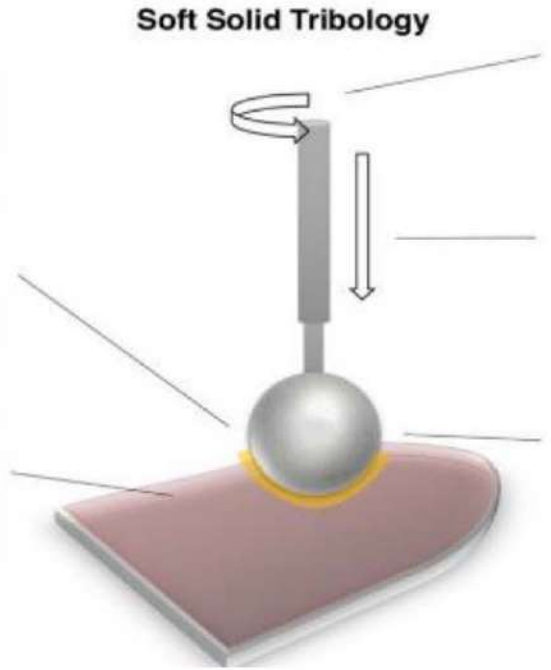
Methods for measurement of rheological properties

Fundamental methods

Tribology

Nowadays, the study of the interaction of food with saliva and surfaces during mouth manipulation and swallowing is being studied applying food tribology.

- Tribology describes friction, lubrication and wear between two interacting surfaces.
- Soft tribology refers to the study of the interaction between food and surfaces within the oral cavity during food consumption.
- It is an interesting approach for understanding oral processing and sensory perception of foods, specially in dysphagia.
- It can be useful to study the behavior of food when xerostomia appears, a common problem developed by geriatric population and by other patients.
- The study of lubrication properties of different thickened liquids, shows differences between thickeners. For example, tribology shows that modified-starches based thickeners have a lower lubricant capacity than that of gum-based ones.
- Inclusion of tribological parameters into the IDDSI scale would be of interest.



(Source: https://doi.org/10.1016/j.cofs.2019.06.011)

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Adjusting the consistency of dysphagia-oriented food and beverages

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Adjusting the consistency of dysphagia-oriented food and beverages

- The supply of foods with modified texture and thickened fluids is the basis for the nutritional treatment of dysphagia.

  For fluids, viscosity is usually increased by the use of thickening products which is an effective strategy to reduce the risk of airway invasion in dysphagia. It was reaffirmed by the European Society for Swallowing Disorders' (ESSD) review, published in 2016.

- Thin liquids are the type of product that most easily causes choking and should be thickened to improve bolus control and to help prevent aspiration. A range of starches and gums has historically been used to thicken liquids.

- On the other hand when solid food is pureed, it may also require the use of thickening agents to adjust the rheological and textural characteristics, if they are not achieved by the culinary preparation and/or the reduction of size particle.

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Importance of proper thickening of liquids and foods

- In the past, thickening foods and fluids with starches such as wheat flour, corn flour or tapioca starch, was commonplace.
    - Gravies and custards are homemade modified fluids that have used these starches for many years. When the grains of starch come into contact with boiling water they absorb the water and expand, thickening the fluid. Unfortunately, when left to cool, the starch may break down and the product 'weeps' water.
    - Domestic thickening using ingredients containing starch naturally in its composition (potato, bread….) is also possible, but it is still rarely used in the diets guided by caregivers and health professionals.
- Nowadays, **modified starches and vegetable gums are preferred**. They act as thickening agents, gelling agents, emulsifiers and stabilizers.

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Importance of proper thickening of liquids and foods

- Modified starches, proteins, exudates and seed gums, seaweed extracts andmicrobial polysaccharides, are found to have the ability to improve product mouthfeel, handling properties, and stability characteristics.

- Commercial thickeners are also available and include different thickening agents (from those cited above) in their composition.

- However, they may be considered expensive by some patients. In addition, in some places, they are not easily found in common commercial establishments and those factors limit the acquisition.

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Tips for proper thickening of liquids and foods

- The type and amount of thickener and the characteristics of the food or beverage (dispersing media) are relevant factors.
- Time after preparation is a key factor, as consistency changes with time.
- Temperature is also a critical factor.
- The right consistency is very important, since thickened liquids which are nevertheless still thin, are swallowed quickly by the patients and may flow prematurely into the pharynx.
- Sticky and adherent textures, along with fine liquids should be avoided, because these textures may cause food residues to accumulate in the oropharynx and lead to aspiration after swallowing.
- Excessive thickening can also cause negative effects, as it can leave residues inside the pharynx, which may incur risk of aspiration, reduce palatability, and increase viscosity, in addition to generating changes in consistency and cohesiveness.
- When preparing the liquid beverage, the liquid may become lumpy if it is stirred too slowly or if more thickener is added once it has started to thicken.
- It takes approximately 5–15 min for its physical properties to stabilize.

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Functions and action mechanism of food thickeners

Functions

- Improvement in moisture binding capacity, structural modification and modifying bolus flow behavior properties are the major functions of food thickeners.

Mechanism of thickening

- Most commercial thickeners available are polysaccharides and the thickening properties are due to the expanding nature of these high-molecular-weight molecules in solution, even when used at relatively low concentrations.
- Generally, these long-chain polysaccharide molecules exist as conformationally disordered ‘random coils' in solution, whose shape fluctuates continuously under Brownian motion, increasing the viscosity.
- Each thickener has different rheological behaviour and characteristics when mixed with fluids
- The addition of thickeners to fluid affects the perception of flavours.

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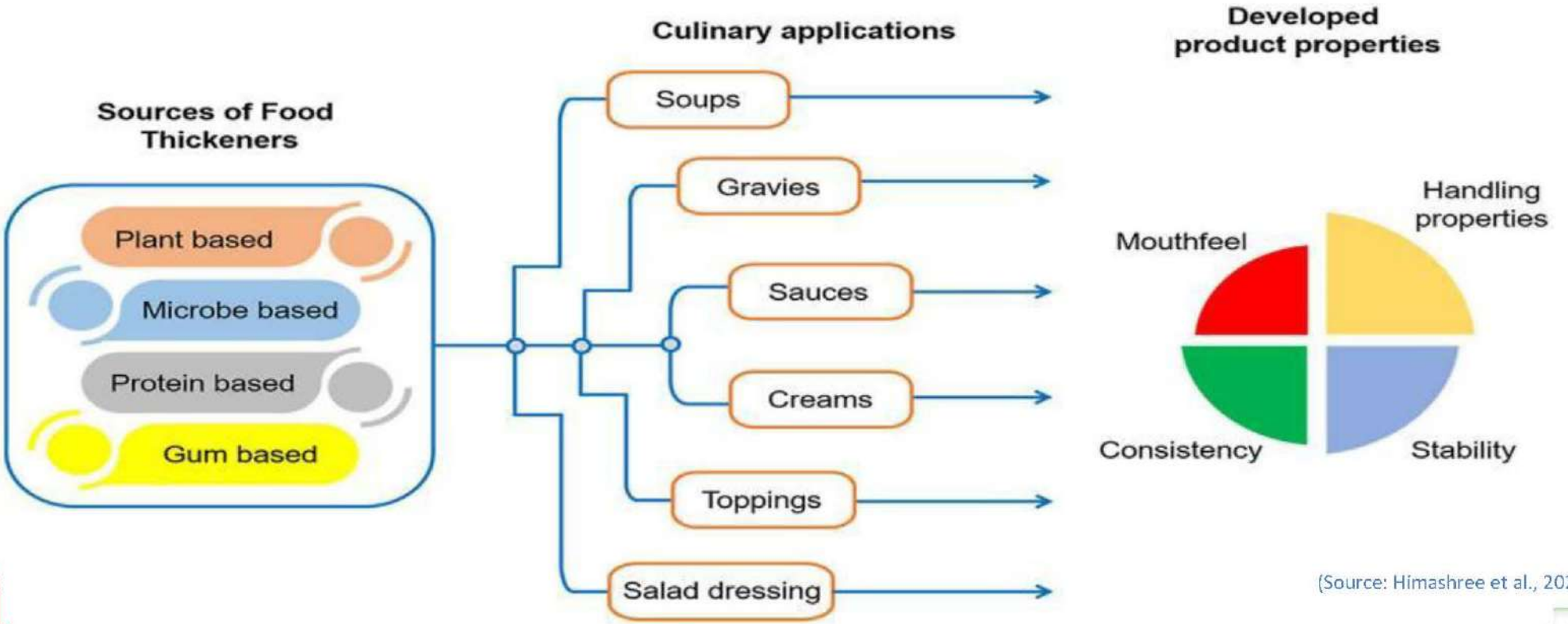
Sources and uses of food thickeners

Food thickeners are obtained from different natural raw material sources which include vegetables, marine plants, microorganisms, and animal connective tissues.

They can be classified into four broad categories: gum based, protein based, plant based, and microbe based (Himashree et al., 2022).



(Source: Himashree et al., 2022)

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Thickeners used in dysphagia

Thickeners for dysphagia management are categorized as Food for Special Medical Purposes (FSMP) which is a group of products intended for the dietary management of specific groups of patients with deficits that need to be medically and regulated by EU No 609/2013 and the supplementing (EU) 2016/128.

Thickeners used in dysphagia diets can be classified into two categories: **starch-based thickeners and gum thickeners.**

- **Starch-based thickeners** are the most common **thickeners** used in commercial foods for dysphagia and in food preparations in puree consistency (Cichero, 2013). This may be because they are inexpensive and easily available.
- **Gum-based thickeners or hydrocolloids** have emerged as an alternative to dysphagia by promoting an increase in viscosity and shear properties in watery media. The name comes from **"Hydro" which means water and "colloids" that means glue**. They are macromolecules that can form viscous dispersions and/or gels with water.
- In commercial products, combinations of both types may appear. (See Table 2)

In some types of fluids, gum-based thickeners are preferred for the treatment of patients with dysphagia, since gums are not influenced by saliva during consumption of fluid foods and starch-based are.

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Thickeners used in dysphagia

Thickening product	Composition	Manufacturer
Fresubin Clear Thickener	Maltodextrin, xanthan gum, modified starch, modified cellulose	Fresenius Kabi GmbH, Bad Homburg, Deutschland
Thick & Easy	Modified starch, maltodextrin	Hormel Foods Sales, LLC, Austin, USA
Bi1	Modified starch	Adventia Healthcare, S.L. Las Palmas de Gran Canaria, Spain
Nutilis Powder	Maltodextrin, modified starch, tara gum, xanthan gum, guar guam	Nutricia N.V., Zoetermeer, The Netherlands
Nutilis Clear	Maltodextrin, guar gum, xanthan gum	Nutricia N.V., Zoetermeer, The Netherlands
Espesante NM	Modified starch	Cantabria Labs Nutrición Médica, S. L., Madrid, Spain
Wallax	Modified Starch	Wallax Farma SL Easy Pharma, Córdoba, Spain
Nutavant	Modified starch	Persan Farma Las Palmas de Gran Canaria, Spain
Resource Thicken Up	Modified starch	Nestle S. A., Barcelona, Spain
Resource Thicken Up Clear	Maltodextrin, xanthan gum, potassium chloride	Nestle S. A., Barcelona, Spain

Table 2
Commercial thickening products and their composition.
Adapted from Bolivar Prados et al. (2022).

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Thickeners _ Starch based

Starch-based thickeners are obtained from tubers or cereals and are frequently used.

Table 3
Starch Based Thickener Characteristics and examples of use (adapted from Giura et al., 2021)

Thickener Type	General Properties	Thickeners	Uses	Characteristics
Starch-based	Consistency alters over time	Corn starch	Pureed carrots	High adhesiveness; therefore, a bolus difficult to swallow
	Susceptible to hydrolysis	Tapioca starch	Distilled water	Good thickening agent for instant consumption due to its solubility
	Increased prevalence of pharyngeal residue		Sport drinks	
	Grainy texture		Orange juice	
	Cloudy appearance			

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Thickeners_ Gum based

Table 4. Gum-Based Thickeners: Characteristics and examples of use (adapted from Giura et al., 2021)

Thickener Type	General Properties	Thickeners	Uses	Characteristics
Gum-based	Stable over the time Amylase-resistant Temperature and pH stability Low oropharyngeal residue Soft uniform texture Clear appearance Tasteless Odorless	Xanthan gum	Fruit juices Milk Water Pork paste Pureed vegetables	Amylase-resistant
				Temperature and pH stability
				Low oropharyngeal residue
				Clear appearance
				Tasteless
				Odorless
				Shear-thinning behavior
				The banana gel containing agar was considered suitable for the elderly
		Agar	Banana dessert gels	Capacity to form soft gels
		Carboxymethyl cellulose	Tailor-made thickened pea cream	Therapeutic properties: prevent the occurrence of colorectal cancer, promoting an improvement in postprandial glycemia and weight control Presents phenolic compounds that could exhibit pharmacological properties including antidiabetic, antihypertensive, immunomodulatory, anti-inflammatory and neuro-protective properties.

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Thickeners_ Gum based

Table 4 (cont.). Gum-Based Thickeners: Characteristics and examples of use (adapted from Giura et al., 2021)

Thickener Type	General Properties	Thickeners	Uses	Characteristics
Gum-based	Stable over the time Amylase-resistant Temperature and pH stability Low oropharyngeal residue Soft uniform texture Clear appearance Tasteless Odorless	Flaxseed gum	Water Milk Orange-flavored soy juice	Good lubrication profile α-amylase resistance
		Gellan gum	Water Pureed carrots	Provide a suitable texture for people with chewing and swallowing difficulties
		Guar gum	Pork paste	Provide a good viscous component and a bolus easier to swallow
		Konjac gum	Tailor-made thickened pea cream	Provide a good viscous component and a bolus easier to swallow
		Tara gum	Tailor-made thickened pea cream	

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Starch

- Starch is a soft, white, tasteless powder that is insoluble in cold water, alcohol, or other solvents.
- Starch is a polysaccharide comprising glucose monomers joined in α 1,4 linkages.
- Starch is composed by two components: the linear polymer is named amylose and amylopectin, is the branched form.

Amylose

Amylopectin

- It comes from cereals (corn, wheat…), roots (tapioca, potato….) or other origins.
- Starch becomes more viscous as it cools.
- The longer the time taken to eat a meal, the colder it becomes and the more likely it is to stick to the pharynx; therefore, caution is required.
- A large amount must be added.
- Thickens immediately.
- Provides stable viscosity irrespective of the type of food or drink.

Uses: Good for making molded dishes such as blended foods or mousses.

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Modified starches

- Modified starch is the starch extracted from grains and vegetables which has been treated to improve its ability to keep the texture and structure of the food.
- "Modified starch" does not mean that it has been genetically modified or produced from genetically modified organisms.
- All modified starches are safe to use in the EU – they are independently tested by the European Food Safety Authority in order to guarantee their safety. They are labelled either by their name (e.g. modified starch) and/or their E number (e.g. E1404) on a product pack.
- Modified starches are used in food products that need to be microwaved, freeze-dried, cooked at high temperatures (for example, a ready-made pizza, instant soup, sauces) or baked and fried so that the texture of such food does not change during the cooking process.
- There are three different ways of modifying starch – it can be heated with water (which is called physical modification), treated with enzymes (enzymatic modification) or with various chemicals (chemical modification).

Physically modified starches are the ones used as food thickeners in dysphagia oriented products.

The thermal treatment of starch (physical modification) makes it able to form a paste even in cold liquids, so it swells and behaves as an instant thickener.

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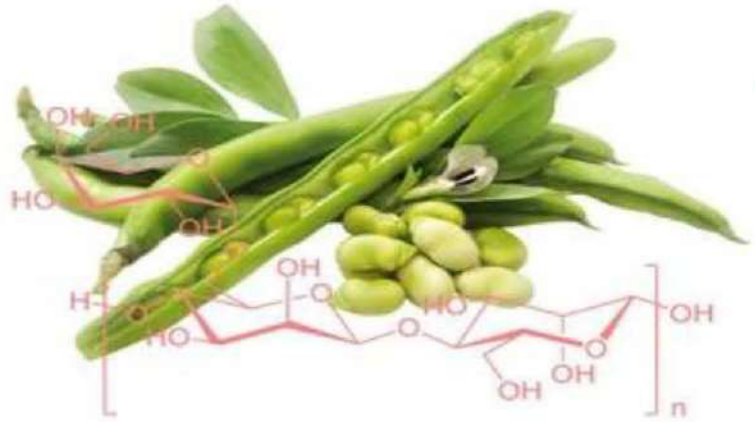
Guar gum



- Guar gum, also called guaran, is a galactomannan polysaccharide extracted from guar beans that has thickening and stabilizing properties useful in food, feed, and industrial applications.
- It is typically produced as a free-flowing, off-white powder.
- Only a small amount is needed for thickening, but it takes time for stable viscosity to be obtained.
- Changes the smell and appearance of food (to the smell of guar gum).
- One feature is that it also thickens milk.
- Uses: Good for thickening soups, milk and adding to blended foods and purées to make molded dishes.

(Source: https://www.plantmedia.com/products/guar-gum

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Xanthan gum

- Xanthan gum is the most studied hydrocolloid in diets for dysphagia along with starch. It is a high molecular weight heteropolysaccharide that has residues of 1,4 linked β-D-glucan as the primary structure and trisaccharide side chains with two mannose molecules and a glucuronic acid linked to a D-glucose in the structure.
- It is well accepted in relation to the viscosity and texture attributes by patients with dysphagia when incorporated into drinks.
- Xanthan gum is usually dosed in concentrations between 0.88 and 11.5% (De OS Schmidt et al., 2021).
- Highly transparent, colorless and odorless, and of low adhesiveness. Suitable for thickening clear liquids and the like. It is not good for thickening milk or high-density liquid diets, although it has recently been improved. It is currently the most popular thickening agent.

Uses: Ideal for thickening to a low viscosity.

(Source: https://www.istockphoto.com)

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Characteristics, types, and methods of use of thickeners-gelling agents

- Gelling agents have the property of solidifying liquid components, and are used in foods such as jellies and puddings.
- A small amount can solidify liquids, and their hardness can be adjusted by varying the amount used.
- Gelling agents include gelatin (derived from animal skin and bones), agar (*Gelidium divaricatum*), carrageenan, and pectin.
- These all have different properties, and are used for different purposes.
- In recent years, gelling agents for making warm jellies have also come onto the market.

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Proteins

- Some proteins from animal origin are used in some food preparations due to their gelling properties.
- Proteins from bones, skins and tendons of animals (gelatin), skins of fish (gelatin), milk (caseinates and whey proteins), eggs (egg white proteins.
- Some proteins from plant origin: chickpea, faba beans and others, are also used.

(Source: https://www.istockphoto.com)

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Gelatin

- Gelatin jelly (1.6% gelatin concentration, made from 80 g juice and 1.3 g gelatin) is the best-known food that meets dysphagia conditions.
- Gelatin melts at 20ºC–30ºC. It melts at the temperature of the inside of the mouth. Moreover, as it retains water well, meaning that it flows while the interior remains as a gel and changes shape, it has a pleasant texture when eaten, it is able to flow smoothly through the narrow pharynx.
- Temperature management must be taken into account because gelatin melts at room temperature.
- The appropriate concentration of gelatin jelly for use at the start of swallowing training is 1.6% (5 g of gelatin per 300 ml of liquid). The jelly should be soft enough to obble when shaken.
- The normal gelling agent concentration is 1.5% – 3.0%.
- Because the surface melts slightly and becomes covered in liquid, This phenomenon is seen in gelatin because at the structural level, its surface possesses hydrophilic groups while its interior possesses hydrophobic groups.
- The affinity between the oral and pharyngeal mucosa and food is important, and the characteristics of gelatin can be utilized effectively in this area (De OS Schmidt et al., 2021).
- Care should be taken as it melts in mouth and generate a food with two phases

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Agar

- Although they do form food boluses, the physical properties of these materials still pose problems.
- Agar breaks up inside the mouth when chewed, meaning it is susceptible to aspiration and thus unsuitable for a dysphagia diet.
- Agar forms a gel at a temperature of 30ºC–40ºC and melts at 70ºC–85ºC. It thus solidifies at room temperature. It is characterized by high cohesiveness and a tendency for water to separate out; it does not dissolve in the mouth; and when it is crushed, it does not change shape while passing through the pharynx, which means caution is required.
- When making agar jelly, the agar is boiled to dissolve it.

*The raw ingredient for agar is a complex polysaccharide obtained from *Gelidium divaricatum* and other types of red algae. It is a gel that dissolves when heated and solidifies when cooled. It is also used as a coagulating agent in culture medium.

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Carrageenan

Carrageenan is a gelling agent derived from red algae (*Gigartina tenella, Chondrus crispus*).

Its physical properties are similar to those of gelatin and agar: it solidifies at room temperature, and is stable enough not to leak out.

As it is tasteless and odorless, it has no effect on the flavor of other ingredients, and is extremely soft and slightly elastic.

Carrageenan is nutritionally neutral and has an extremely high content of fibre, making it indigestible by the human body.

A group of similar sulphated polysaccharides, its ability to bind to protein is what makes it useful in meat and dairy products. There are three basic types: Iota Carrageenan, Kappa Carrageenan and Lambda Carrageenan, which all have different uses, gelling conditions and potential risks pertaining to it (De OS Schmidt et al., 2021).

Read more at: https://www.boldsky.com/health/wellness/2019/carrageenan-uses-benefits-side-effects-128665.html

(Source: https://www.istockphoto.com)

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Pectin

- Pectin is a polysaccharide found in citrus fruits and apple skin that car extracted in water.
- It is used for gelling jams, jellies, yogurt, and other foods.
- Pectins with a high methyl ester content turn into gel in the presence sugars and other solutes and at low pH. The strength of the gel and th regulating temperature depend on the concentration and type of sugar (at least 60%), the cooling rate, and the pH (around 3).
- There are other types of pectin which form gels at different conditions.
- Pectin shares similarities with carrageenan in conditions of low strain but exhibits quite different characteristics when subjected to conditions of high strain (Sharma et al., 2017).

(Source: https://www.istockphoto.com)

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Glucomannan and galactomannan

Glucomannan is a dietary fiber usually made from the root of the **konjac plant**. It's historically been used as food and medicine in Asian cultures.

Glucomannan is a water-soluble polysaccharide that is considered a dietary fiber.

It is a hemicellulose component in the cell walls of some plant species. Glucomannan is a food additive used as an emulsifier and thickener.

It is a major source of mannan oligosaccharide (MOS) found in nature, the other being galactomannan, which is insoluble.

Its role as thickening agent in dysphagia products has been recently investigated.

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High fiber products of plant origin

The chia (*Salvia Hispanica L.*) seeds will gel and thicken the drink. Chia seeds don't always have to be soaked in liquid - they can be added to baked goods like muffins, scones, and the like. Because chia seeds form a gel in liquid, they can be added to soups, stews, sauces, and marinades to help thicken the liquid in place of corn starch or flour. Chia seeds can also be blended into juice smoothies to add the thicker texture normally provided by whole fruits or yogurt.

Ground flax seed (*Linum usitatissimum*) can also be used to thicken soups and stews. It can be used as an egg replacement in quick bread recipes (1 tablespoon ground flaxseed combined with 3 tablespoons water is equivalent to one medium egg).

(Source: https://www.istockphoto.com)

To be used in dysphagia oriented products, the mucilage must be extracted from the seeds and used in the form of chia gum or flaxseed gum.
See Ribes et al. (2022) or Viera et al., (2021) for more information.

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Commercial thickening agents

- Food thickeners are commercially available as powders that can be added to any drink or pureed food.
- Modified maize starch (pre-gelatinised) and gums (such as xanthan gum or galactomannans) are the polysaccharides normally used in commercially available thickeners. In some cases, they are used in combination.
- Viscosities of starch-based thickened beverages are different from those of gum-based thickened beverages, mainly due to this different thickening process. They also differ in to what extent they modify the taste and the appearance of the food or beverages.(See Image in next slide)
- Some studies show that gum-based thickeners are safer because they are not affected by salivary enzymes (amylase).
- Their thickening properties may change in different food matrices and should be studied.
- The composition of the thickeners could influence hydration, satiety and absorption of medication.
- It is also convenient to check the instructions given in the labels.

(Source: ncd@nutricia.com)

(Source: https://www.nestlehealthscience.com)

(Source: https://www.flavourcreations.com.au)

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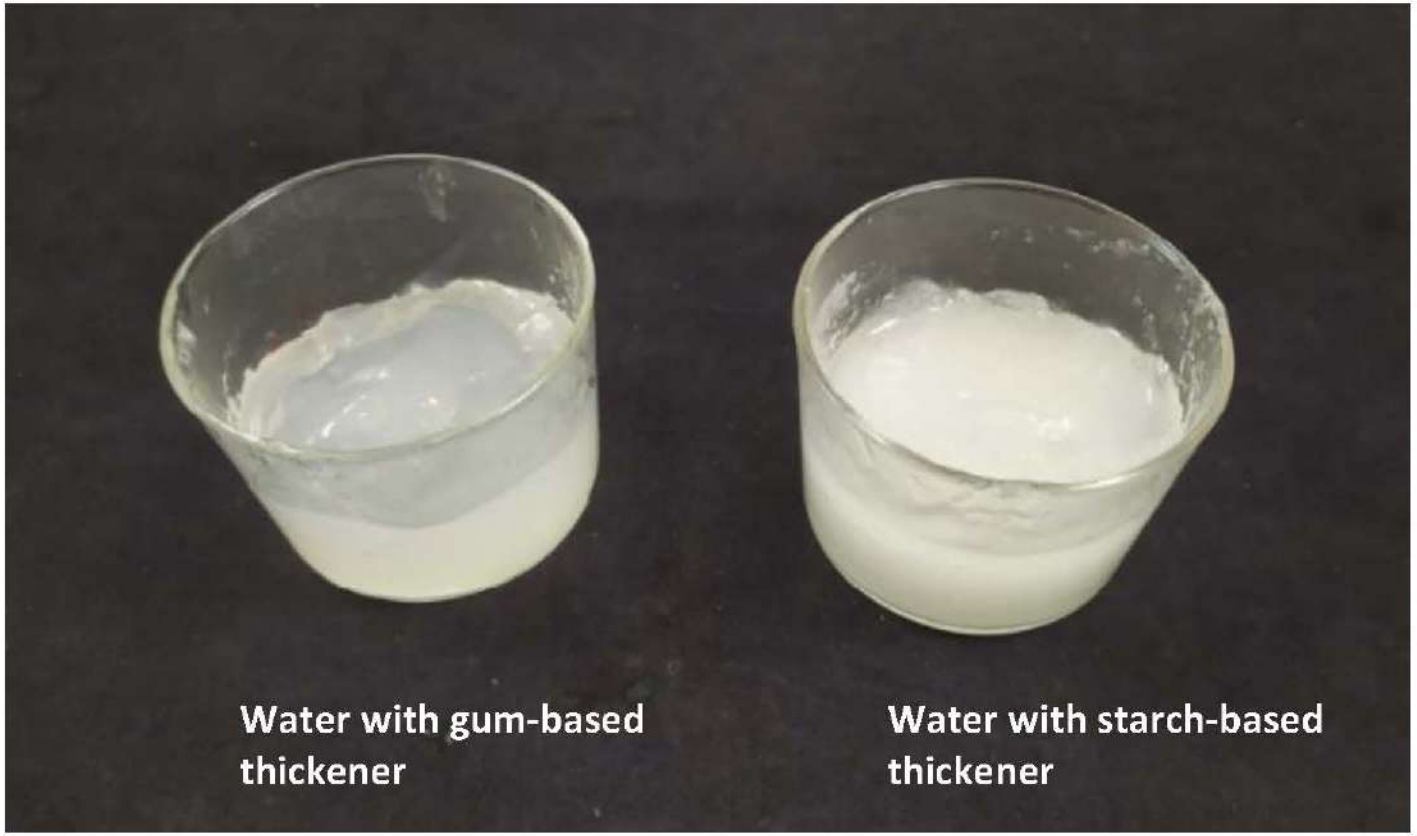
Commercial thickening agents



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Commercial thickening agents

Some examples of commercial products and uses are the following:

1. By adding **Resource® ThickenUp™** Clear (Nestle) or **Nutlis Clear** (Nutricia) into foods such as puréed vegetables you can achieve the correct consistency, without changing the taste or look of the food.

2. PreciseR have developed a liquid thickener also useful for drink and medication trollies which gives instructions for level 1-4 fluids and thickens a wide range of beverages, supplements and laxatives. Free online training is available on the website: https://elearning.precisethickn.com.au

3. Nutricia also have a thickener called **'Nutilis'** powder, which is starch-based. This has a table of levels of scoops for thickening levels 1-4 (given as a guide only). Support is available from: nccl@nutricia.com.

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Example: How to thicken drinks

1. Add the recommended number of flat scoops of resource Thicken Up Clear™ to a dry empty cup/glass;
No. of level scoops: mildly= 2; moderately=4; extremely=8 per 200 mls;
2. Pour in 200 mls of your chosen drink;
3. Immediately stir briskly with a spoon until the powder is dissolved;
4. Leave to stand for 2 minutes until the drink has thickened;
5. Check consistency is correct - if it is not right you will have to pour the drink away and start again.

Other commercially available thickened products

A large range of pre-thickened fluids as waters, juices or supplements are available from different pharmaceutical companies.

In some cases, they provide the IDDSI levels of thickness. These are labelled with the colours which represent the thickness level.

Different companies are able to supply products oriented to different levels.

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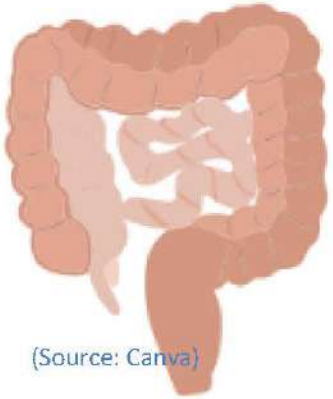
Thickeners and bowels disorders

- Most gums are polysaccharides (soluble fibre and/or insoluble fibre eg xanthan gum). Some mostly soluble gums such as guar and pectin, can have a laxative effect if used in large quantities (>12g per day).
- Xanthan gum is not recommended in quantities greater than 10g per day. This is worth noting for patients on thickened fluids, who may need to be supplied with a variation of thickened fluids made with varied ingredients to suit their individual needs.
- Nursing staff should check products used if bowel issues occur.



(Source: Canva)

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Table for activity

- The activity take 40 minutes
- The goal of the activity are to learn thickening methods of liquids and foods
- Theoretical lecture and practical activity
- To do this activity we need a glass 200ml, spoon,fork or whisk, syringe, thickeners, water or drinks.
- Online or live

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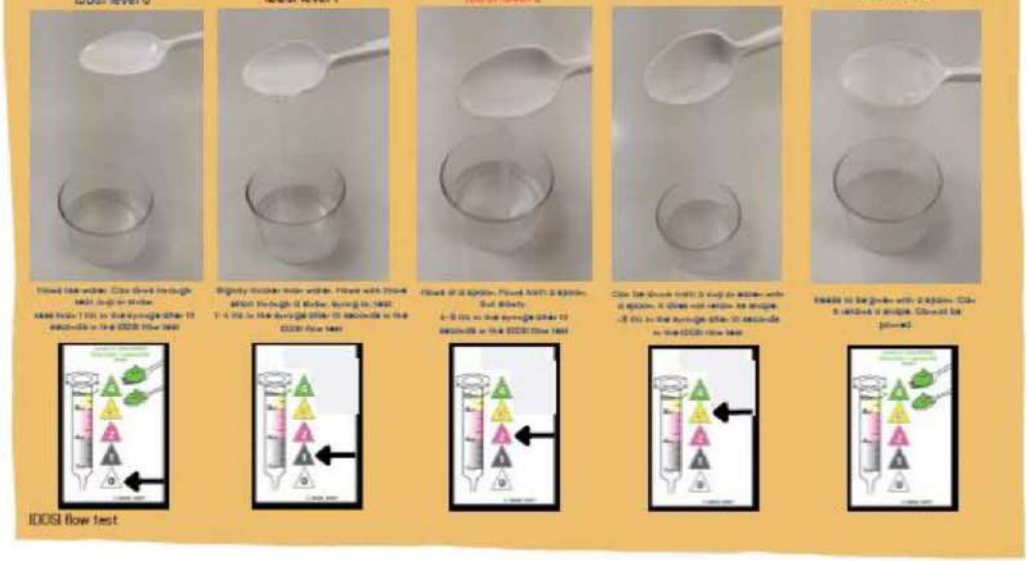
Guidelines for thickening liquids

Thickened liquids are made by mixing a thickening powder with usual drinks. Thickened drinks are safer in dysphagia because they move more slowly and are better controlled by people with swallowing difficulties. There are different levels of thickness. A speech and language therapist will assess the required particular level.

Levels of liquid thickeness



See Unit 4.3. For more information about levels

Guidelines for thickening liquids

1. Add the recommended number of flat scoops* of thickener to a dry empty cup/glass

*A speech and language therapist will assess the recommended level of thickness

2. Measure the amount of liquid

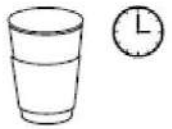
3. Pour in your chosen drink

Each beverage has a different thickness and the amount of thickener required may be different

4. Immediately stir briskly with a whisk or fork until the powder is dissolved

You can also use a drink shaker

5. Leave to stans for 1-5 minutes to allow the liquid to thicken



6. Test the consistency of the liquid berfore seving

If it is not right, do not add more powder. Pour the drink away and start again. Some liquids may thicken with time.

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Time for discussion

Any questions?

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Review

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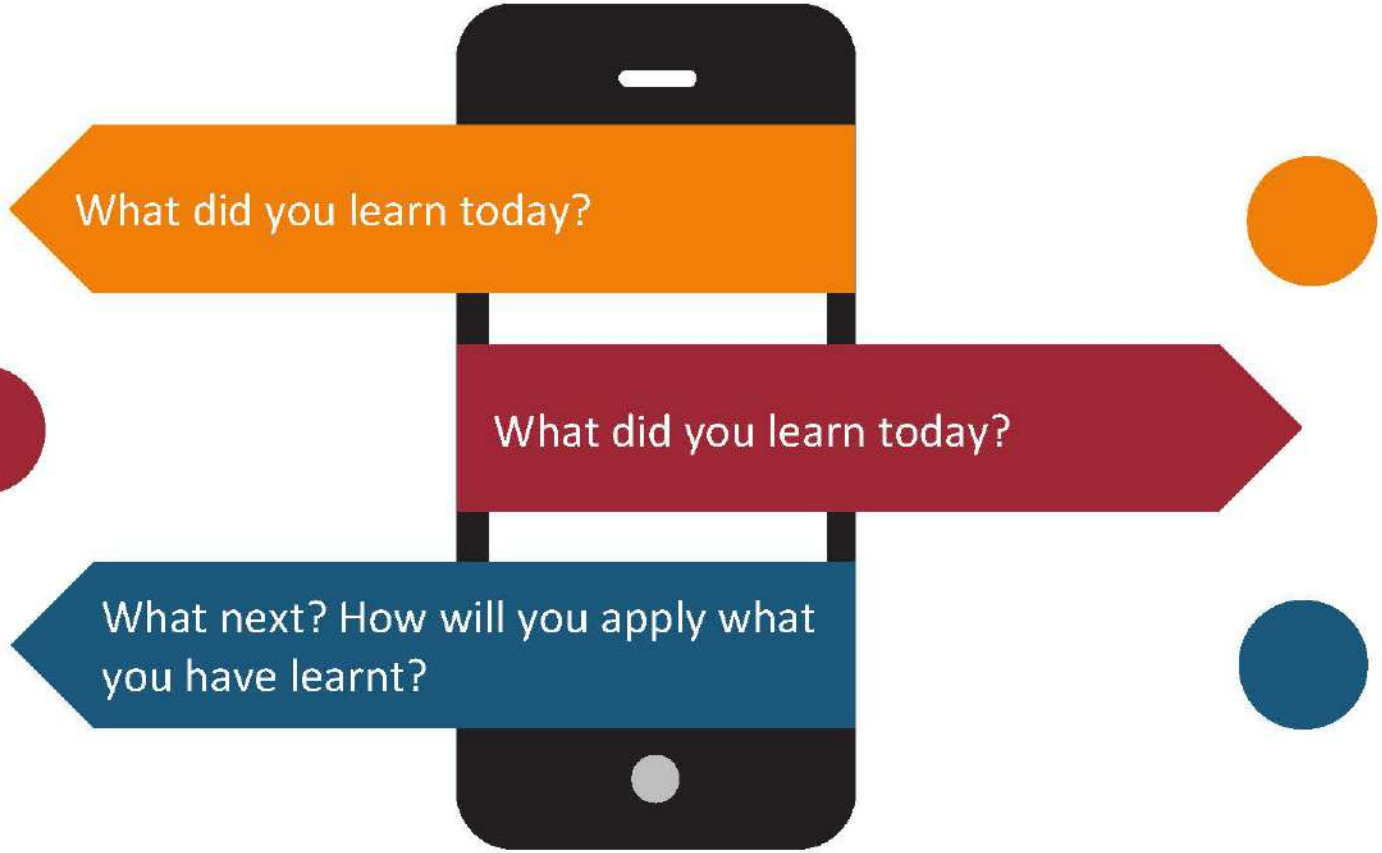
Reflect on the session



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Feedback

How many stars would you give this workshop (1 to 5)?

What did you like the MOST?

What reasonable change would you recommend?

What did you like the LEAST?

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Indeed partners

https://indeed-project.org/

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