

## Article Review

**“A novel stable isotope approach for determining the impact of thickening agents on water absorption”**



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McGill Dietetics Student Level IV  
Wednesday, October 19<sup>th</sup> 2011



## Outline

- **Brief introduction of thickened beverages**
- **Starch vs. gum based thickeners**
- **Water content of corn starch, xanthan gum and common liquids/solids**
- **Summary of the article**
- **Critique of the article**
- **Conclusion - what does this mean for dietitians?**



## Did You Know?

- **Approximately 45-50% of Ste-Anne's Hospital (SAH) patients are dysphagic to solids**
- **As of October 7<sup>th</sup>, 2011 9.2% of the total population at SAH (n = 415) were prescribed thickened beverages**
  - **50% (n = 19) require nectar thickened beverages**
  - **18%(n = 7) require honey thickened beverages**
  - **32% (n = 12) require pudding thickened beverages**

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## Latest Update: Making the Switch

- **Starch based thickeners are more traditionally used**
- **However, it is reported that the industry would like to start using gums as their choice of thickener as they claim it will:**
  - **Improve the appearance of the liquid (more glossy) while maintaining their standard of viscosity**

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## What Does This Mean for Dietitians?

- Will this affect the hydration status of our patients?
- Will patients enjoy the mouth feel and taste of the new gum based thickened beverages?
- How will this affect our budget?

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## What is Starch?

- Most common digestible polysaccharide
- Found in plants
- Made up of:
  - Amylose
    - Linear, unbranched chain
    - Glucose molecules attached by  $\alpha$  1-4 glycosidic bonds
  - Amylopectin
    - Branched chain
    - Glucose molecules attached by  $\alpha$  1-6 glycosidic bonds
- Starch is made up of about 15-20% amylose and 80-85% amylopectin

Gopper, S.S., Smith, J.L. & Groff, J.L. (2009). *Advanced nutrition and human metabolism* (5<sup>th</sup> ed.). Belmont, CA: Wadsworth.

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## How is Starch Digested?

- **Step 1: Begins in the mouth**
  - Salivary  $\alpha$ -amylase breaks down the  $\alpha$  1-4 glycosidic bonds into dextrins
- **Step 2: No digestion in stomach**
  - Acidity of gastric acid inactivates salivary amylase
  - Dextrins continue into the small intestine
- **Step 3: Small intestine – duodenum**
  - Pancreas releases pancreatic  $\alpha$ -amylase which hydrolyzes the  $\alpha$  1-4 bonds
  - Dextrins are broken down into maltose and limit dextrins
- **Step 4: Brush Border**
  - Maltose is hydrolyzed by maltase → glucose
  - 1-6 bonds in limit dextrins are hydrolyzed by  $\alpha$ -dextrinase → glucose

Gropper, S.S., Smith, J.L. & Groff, J.L. (2009). *Advanced nutrition and human metabolism* (5<sup>th</sup> ed.). Belmont, CA: Wadsworth.  
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## What are Gums?

- Indigestible polysaccharide
- Classified as a soluble and functional fiber
- Also referred as hydrocolloids (a substance that forms a gel in the presence of water)
- Made up of a variety of sugars and sugar derivatives
  - **Ex:** glucose, mannose, glucuronic acid are found in xanthan gum
- Xanthan gum: made by fermentation using the bacteria *xanthomonas campestris*

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## How are Gums Digested?

- Unlike starch, fibers cannot be broken down by human digestive enzymes
- Therefore, they are fermented by colonic bacteria in the large intestine
- Leads to the production of short-chain fatty acids
- One of the effects of short-chain fatty acid production is increased water reabsorption in the colon
  - **Remember:** the majority of water is absorbed in the large intestine

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## Why are Starches Used as Thickeners?

- Abundant
- Inexpensive
- Gelling capabilities
  - Have positive influences on the sensory character of foods
- Different types of starches gel differently
  - The more amylose content present the more likely a starch will gel
    - **Ex:** cornstarch (high in amylose) = more opaque gels
    - **Ex:** potato/tapioca starch (low in amylose) = clearer gels

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## Why are Gums Used as Thickeners?

- Provide viscosity
- Emulsify
- Stability
- Provide mouth feel to foods, impart body and texture
- Water loving nature
  - Provides a desirable appearance, texture and stability
- Lower concentrations are required

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## Starch: Mechanism of Gelatinization

- Starch granules must be heated in a liquid
  - Not necessary if using modified starch
    - Already cooked and dried, so when cold water is added it is immediately absorbed and expands
- Hydrogen bonds break
- Water penetrates starch molecules
- Starch molecules swell and expand

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## Starch: Factors Affecting Gelatinization

- **Adequate amount of liquid**
  - Depends on the amount of amylose and amylopectin
- **Temperature & Timing**
  - Varies depending on the type of starch
  - If overheated, starch granules break and decreases viscosity
- **Stirring**
  - Over stirring causes starch granules to break and decreases viscosity

Brown, A. (2008). *Understanding food: Principles & Preparations* (3<sup>rd</sup> ed.). Belmont, CA: Thomson Wadsworth.

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## Starch: Factors Affecting Gelatinization

- **Acidity**
  - Decreases the viscosity
  - Use modified starches to thicken acidic beverages
- **Sugar**
  - Competes for water, delays gelatinization and increases the required temperature
- **Fat/Protein**
  - Coats the starch, prevents it from absorbing water, delays gelatinization
- **Amylose Content**
  - Due to its linear structure, water molecules form stronger bonds
    - Forms a three dimensional network
    - Traps water
    - Increases the rigidity

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## Xanthan Gum: Mechanism of Binding

- Soluble in hot or cold liquid
  - Due to its side chains (mannose and glucuronic acid)
- -OH group binds water molecules through hydrogen bond interactions
- Particles swell and develop viscosity
- Requires even distribution of xanthan gum in a liquid

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 Sopade, P.A., Liang, S., Halley, P.J., Cichero, J.A.Y., & Ward, L. (2007). Moisture absorption characteristics of food thickeners used for the management of swallowing dysfunctions. *Eur Food Res Technol*, 224: 555-560.

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## Xanthan Gum: Factors Affecting Gelatinization

- The effectiveness of dispersion
  - Higher stirring speed required
- Size of the gum particles
  - Smaller particles hydrate quicker (but are harder to disperse)
- Salt
  - Reduces hydration speed
- Sugar
  - > 40% sugar content, reduces hydration speed

Imeson, A. (1997). *Thickening and gelling agents for food* (2<sup>nd</sup> ed.). London: Blackie Academic and Professional

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## Water Holding Capacity

- **Ease of forming hydrogen bonds influences:**
  - Gel formation
  - Viscosity
  - Quality (syneresis)
- **Gum based thickeners:**
  - Absorb and retain water better
  - Give a smoother and more homogeneous dispersion
    - With no sediments when combined with water
  - However, starch-based thickeners are more viscous than xanthan-based thickeners

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## Cost of Starch and Gum

- **Traditional Corn Starch:**
  - Can be found at Bulk Barn and IGA
    - \$0.40 per 100 grams (Bulk barn)
    - \$0.46 per 100 grams (IGA – compliment brand)
- **Modified Corn Starch:**
  - \$0.77 per 100 grams (institutional pricing)
- **Xanthan Gum:**
  - Can be found at Bulk Barn
    - \$13.69 per 250 gram package (El Peto brand)
    - \$6.08 per 100 grams

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## Examples of Thickening Agents

| Product Name                        | Brand              | Thickener Used       |
|-------------------------------------|--------------------|----------------------|
| Thickener                           | HFS                | Modified corn starch |
| Instant Food Thickener              | Ultra Thick        | Modified corn starch |
| Thicken Up Instant food Thickener   | Resource           | Modified corn starch |
| SimplyThick Thickening Gel          | Simply Thick       | Xanthan Gum          |
| Thick & Easy Instant Food Thickener | Hormel Health Labs | Modified corn starch |
| Ultrasperse M                       | Necan              | Modified corn starch |

Pronovost, A. (2010). Thickened Beverage Project: An evaluation of quality based on adherence to current standards and a selection of commercially available products.

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## Risk of Dehydration

- **People with dysphagia are at an increased risk of developing dehydration**
- **Elderly patients are also at risk due to the following reasons:**
  - **Decreased fluid intake**
  - **Decreased kidney function**
  - **Increased urine output due to medications (diuretics, laxatives)**
  - **Impaired sense of thirst**
- **Important to determine if the patient is meeting his/her fluid requirements**

Mahan, L.K. & Escott-Stump, S.(2008). *Krause's food & nutrition therapy (12<sup>th</sup> ed.)*. St-Louis, Missouri: Saunders Elsevier.

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## Moisture Content

- **Percentage of moisture in regular starch:**
  - **8.0 % - 15 %**
- **Percentage of moisture in xanthan gum:**
  - **8.0 % - 15 %**
- **Interesting observation:**
  - **They are dry products that have binding capabilities**

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 Garcia-Ochoa, F., Santos, V.E., Casas, J.A., & Gomez, E. (2000). Xanthan gum: production, recovery, and properties. *Biotechnology Advances*, 18, 549-579

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## Water Content in Liquids

| Liquid   | Portion | Percentage of Moisture |
|--|---------|------------------------|
| Water  | 500 ml  | <b>100%</b>            |
| Skim milk                                      | 250 ml  | <b>90.84%</b>          |
| Apple juice, canned or bottled, with vitamin C | 125 ml  | <b>88.2%</b>           |
| Soup, minestrone chunky, canned ready to serve | 250 ml  | <b>86.72%</b>          |

Canadian Nutrient File (2009). Health Canada. Retrieved from <http://webprod3.hc-sc.gc.ca/cnf-fce/newNutrientSearch-nouvelleRechercheAliment.do?lang=eng> on October 16<sup>th</sup>, 2011.

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## Don't Forget About Solids!

| Food Item                                      | Portion                        | Percentage of Moisture |
|--|--------------------------------|------------------------|
| Apple sauce, canned, unsweetened               | 125 ml                         | 88.2%                  |
| Apple, raw, with skin                          | 1 medium fruit (7 cm diameter) | 85.56%                 |
| Sweet potato, boiled                           | 125 ml mashed                  | 80%                    |
| Chicken breast, oven-roasted, fat free, sliced | 75 grams                       | 76%                    |

Canadian Nutrient File (2009). Health Canada. Retrieved from <http://webprod3.hc-sc.gc.ca/cnf-fce/newNutrientSearch-nouvelleRechercheAliment.do?lang=eng> on October 16<sup>th</sup>, 2011.

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## We Need to Know the Facts

- **The dietitians at SAH have to be extra careful**
- **Why?**
  - **The mean age of the population is 85 years old**
  - **9.2% are dysphagic to liquids**
- **Therefore, if thickeners do affect the bioavailability of water, this puts our population at an even greater risk of developing dehydration**

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## Article Review

- **Title:**
  - **"A Novel Stable Isotope Approach for Determining the Impact of Thickening Agents on Water Absorption"**
- **Authors:**
  - **Rebecca J Hill, Pamela Dodrill, Leslie J. C. Bluck, Peter S. W. Davies**
    - **All PhDs**
    - **Associated with Children's Nutrition Research and Human Nutrition Research (Bluck only)**
- **Published:**
  - **Dysphagia, 2010**

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## Why Did We Choose This Article?

- **As previously mentioned, the industry would like to use xanthan gum as their choice of thickener**
- **Combining gums and starches can reduce the cost as less thickener is required to obtain a similar consistency**
- **This article specifically uses xanthan gum to determine its effects on the bioavailability of water**

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## Background

- **Thickening agents are recommended for patients with dysphagia to liquids**
- **Pediatric clinicians prescribe thickened fluids to:**
  - Children at risk of aspirating
  - Children who are regurgitating their food
- **Thickened beverages are provided to:**
  - Promote safe swallowing
  - Prevent aspiration
  - Reduce regurgitation of feeds in children
  - Optimize nutritional status
  - Prevent dehydration

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## Background

- **Hydration status is very important in managing infants**
- **Why?**
  - Infant's diet is solely comprised of breast milk or formula until approximately 6 months and makes up most of their diet until approximately 12 months
- **Problem?**
  - Infants are unable to meet the rest of their hydration needs from the water content of solid foods
- **If bioavailability of water is decreased when using thickeners → increased risk of dehydration → more complications (such as constipation)**

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## Type of Study

- **“Proof of Concept” study design**
  - **Wanted to use a less invasive and more accurate approach in assessing the bioavailability of water when mixed with fluid thickener**
- **Compared method to previous study (Sharpe et al)**
  - **Which used blood and saliva samples and bioelectrical impedance to determine total body water (TBW) of participants**

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## Method

- **Thickener used: xanthan gum fluid thickener (EasyThick, Flavour creations)**
  - **Solution was thickened according to manufacturer’s instructions to produce a pudding thick solution**
- **Administered to a single subject as a case study**
  - **25 year old**
  - **Weight: 64 kg, Height: 181 cm (approximately 5’11”)**
- **Measured TBW using stable, nonradioactive, nontoxic isotopes**
  - **Isotope of oxygen ( $O^{18}$ ) on day 1**
  - **Isotope of hydrogen ( $^2H$ ) with xanthan gum on day 2**
  - **Urine samples were collected before each dose and 4-6 hrs post dose, and once every 24 hours for 15 days**

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## Findings

- **Using the stable isotope method to determine the bioavailability of water when consumed with xanthan gum is more accurate and less invasive compared to the methodology used in Sharpe et al's study**
- **Based on their single-subject, single thickened fluid example, xanthan gum does not alter the bioavailability of water**
  - **Agreed with the findings of Sharpe et al**
  - **However, this study focused more on the method of measuring the bioavailability of water rather than the effect of the thickening agent**
- **Concluded that more research is needed**

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## Observations & Critique

- **The majority of the article focused on the comparison of methods used in Sharpe et al's article rather than the bioavailability of water**
- **Only 1 participant**
- **Stated that the patient was within "the well-documented physiologic range of TBW" however there was no reference**
- **The authors have a pediatric focus however their methodology was tested on a healthy adult**
  - **Unable to generalize the results**
- **Included 14 references whereas the article it was comparing to included 62**

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## Information Omitted in Article

- **Sex of the participant**
  - Did you notice that the BMI of the participant was 19.5?
    - It is assumed that the participant is male (due to a height of 1.81cm) and if this is the case → very thin male
- **Health status**
- **Medications**
- **Quantity of the xanthan gum given to participant**

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## Why Does This Matter for Dietitians?

- ***Will patients enjoy the mouth feel and taste of the new gum based thickened beverages?***
  - **Starch based thickeners: grainy texture and starchy taste at nectar and honey consistencies, higher viscosity**
  - **Gum based thickeners: more slick, less grainy and starchy flavor, least viscosity**
  - **Both thickeners had the tendency to negatively affect the main flavours of the beverage tested (coffee, milk, apple juice)**
  - **Each patient has their own personal preference and should be considered**

Matta, Z., Chambers, E., Garcia, J.M., Helverson, J.M. (2006). Sensory characteristics of beverages prepared with commercial thickeners used for dysphagia diets. *American Dietetic Association, 106*(7), 1049-1054.

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## Why Does This Matter for Dietitians?

- ***How does this affect our budget?***
  - **Xanthan gum is more expensive than corn starch**
    - **Xanthan gum: \$6.08 / 100 grams**
    - **Traditional Corn starch: \$0.40 / 100 grams**
  - **Corn starch is more readily available**
    - **Low-priced and abundant commodity**
  - **However, a smaller amount of xanthan gum is required to produce the same texture as when using a starch-based thickener**

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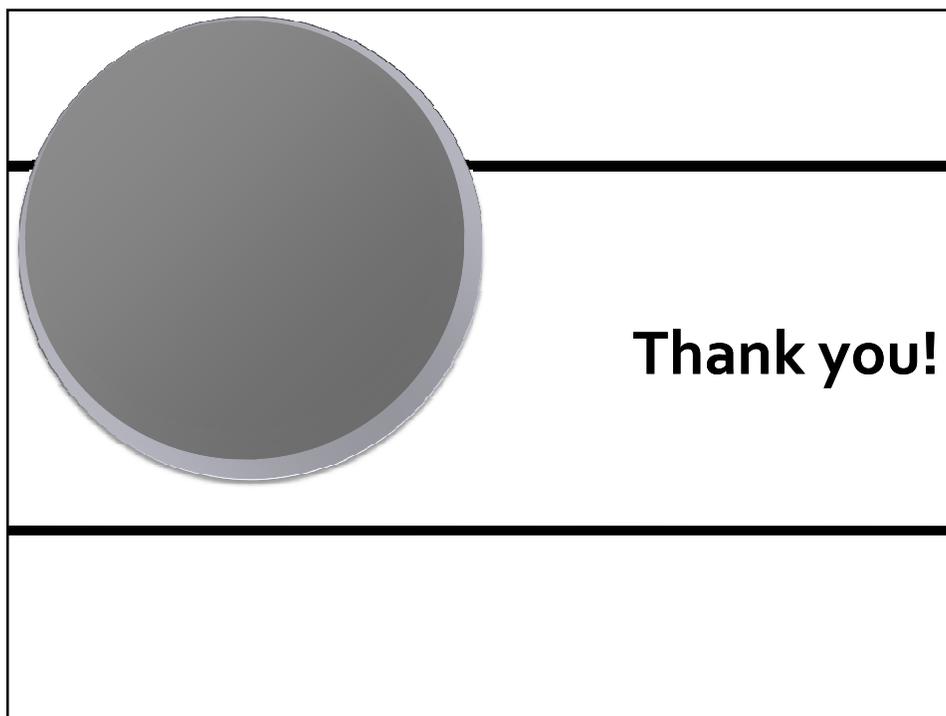


## Why Does This Matter for Dietitians?

- ***Will this affect the hydration status of the patient?***
  - **So far, it seems as though the bioavailability of water is not affected when mixed with thickeners such as xanthan gum**
  - **However, there is little information currently available regarding the bioavailability of water from thickened fluids therefore a concrete answer cannot be provided at this point in time**
  - **More research is needed**

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Professionnelle des  
Nutritionnistes  
Experts en  
Dysphagie

## References

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