Introduction

- Infants may have difficulty swallowing (dysphagia) due to prematurity, congenital anomalies, and/or diseases that affect the nervous, respiratory, or digestive systems.
- A common treatment strategy for infants with dysphagia is to thicken the formula or breast milk they consume.
- Thickening increases the viscosity of the liquid, and slows the flow of the liquid through the upper aerodigestive tract and may result in improved swallowing function.
- Liquid is usually thickened with starch or gum-based thickening agents to a Nectar or Honey consistency.
- Previous research demonstrates that achieving the appropriate therapeutic consistency (nectar or honey) is difficult.
- Time, temperature, base fluid, and thickening agent have been shown to affect the resulting consistency of the fluid.
- Fluid that is thinner than recommended may not effectively remediate the swallowing problem and fluid that is thicker than recommended may cause the infant to fatigue and not finish their feeding.

* Due to the importance of providing the appropriate fluid consistency for effective treatment of swallowing problems in infants, this project sought to determine the effects of three commercially available thickening agents on the resulting thickened consistencies of commonly prescribed, ready to feed infant formulas.

Methods

- The Mini-Temp FS Infrared Thermometer was utilized to provide measurements of temperature.
- Thickeners mixed with formula per manufacturer’s instructions following strict protocol for reliability and consistency of mixing.
- Formula and thickener mixed in a Pyrex measuring cup with a wire whisk.
- Bolus flow was measured with a standard line spread test (LST).
- LST results have been shown to distinguish therapeutically relevant categories of thickened liquids (i.e. nectar and honey thick).
- LST was performed on a countertop confirmed as level with use of a carpenter’s level.
- Liquids prepared as described and measured via graduated syringe into 50-mL boluses and plunged into center cylinder.
- Mean of these 4 measures was calculated as a measure of bolus flow.
- Process completed 10 times for each formula and each thickness category (thin, nectar, and honey).
- Between each sample, the bolus was wiped off the plexiglass overlay with a slightly damp cloth; no chemicals or soap were used in the cleaning of the plexiglass overlay.

Results

<table>
<thead>
<tr>
<th>Formula</th>
<th>Manufacturer</th>
<th>Calori</th>
<th>Protein Source</th>
<th>Hypoalergenic</th>
<th>Lactose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparated</td>
<td>Mead-Johnson</td>
<td>20</td>
<td>Casein and supplement</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Infant A B</td>
<td>Mead-Johnson</td>
<td>20</td>
<td>20% Whey Protein</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Infant 20</td>
<td>Mead-Johnson</td>
<td>20</td>
<td>20% Soy protein Whey</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Infant 24</td>
<td>Mead-Johnson</td>
<td>20</td>
<td>20% Soy protein Whey</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Infant 30</td>
<td>Mead-Johnson</td>
<td>20</td>
<td>20% Soy protein Whey</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Similac Advance</td>
<td>Abbott</td>
<td>19</td>
<td>20% Soy protein Whey</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Similac Soy</td>
<td>Abbott</td>
<td>19</td>
<td>Soy</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Similac Special Care</td>
<td>Abbott</td>
<td>22</td>
<td>20% Soy protein Whey</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Similac Gerber</td>
<td>Abbott</td>
<td>22</td>
<td>20% Soy protein Whey</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

Thickening Agent | Active Thickening Ingredient
---|---
Gerber Single Grain Oatmeal Cereal | Whole Grain for flour and oat flour. Calcium website
MUTRA/Balance Thin & Clear | Whole Grain blend with fiber
Gelmix | Whole grain with maltodextrin, starch-based grain, and a blend of gums

<table>
<thead>
<tr>
<th>Hypoalergenic</th>
<th>Active Thickening Ingredient</th>
<th>Nectar</th>
<th>Honey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Gerber Single Grain Oatmeal Cereal</td>
<td>35 teaspoons of oat brunch per 1 ounce of formula</td>
<td>25 teaspoons of oat bran per ounce of formula</td>
</tr>
<tr>
<td>N</td>
<td>MUTRA/Balance Thin &amp; Clear</td>
<td>3.12 grams of starch to 4 ounces of formula</td>
<td>3.12 grams of starch to 4 ounces of formula</td>
</tr>
<tr>
<td>N</td>
<td>Gelmix</td>
<td>3.64 grams of thickener to 4 ounces of formula</td>
<td>3.64 grams of thickener to 4 ounces of formula</td>
</tr>
</tbody>
</table>

- LST values were statistically significantly different between the three thickening agents for the NECTAR thick consistency.
- Welch’s F (2, 167.042) = 203.41, p < .0005
- LST values increased as follows:
  - Thicker: Mean(SD)
  - Oatmeal: 4.43(0.30)
  - Gelmix: 4.84(0.14)
- LST values were statistically significantly different between the three thickening agents for the HONEY thick consistency.
- Welch’s F (2, 174.066) = 158.100, p < .0005
- LST values increased as follows:
  - Thicker: Mean(SD)
  - Oatmeal: 3.70(0.47)
  - Gelmix: 3.84(0.36)

Conclusions

- The choice of thickening agent impacts the resulting thickness of ready to feed infant formulas.
- Gelmix consistently produced thickened formula outside of desired therapeutic range.
- Differences in thickness likely due to the heat to the formula prior to mixing with Gelmix.
- Temperature is a known variable for resulting thickness, with an increase in temperature known to cause a decrease in viscosity.
- Formula mixed with Oatmeal and Thicker & Clear mixed at room temperature (76°F (24.56°C) ± 2°F)
- Formula mixed with Gelmix had to be heated to 100 – 120°F (37.8°C – 48.84°C) and then cooled to 96 – 100°F (35.56 – 37.8°C)
- Average Gelmix Nectar thick sample temperature was 98.35°F (36.86°C) and Gelmix Honey thick sample temperature was 98.12°F (36.73°C), more than 2°C warmer than the Nectar and Honey thick samples prepared with Oatmeal and Thicker & Clear.
- Limitations: limited formula representation, use of LST vs viscometer/autrometer, use of in vitro testing environment.
- Future research should explore the usefulness of more user-friendly methods of testing thickened fluids, such as the syringe test, to facilitate clinical decision making of appropriate thickening agent to meet the individual needs of the infant with dysphagia.

References:

3) Steele, C. M., Alsanei, W. A., Ayanikalath, S., Barbon, C. E., Chen, J., Cichero, J. A., ... & Hanson, B. (2017). The influence of food texture and liquid consistency modification on swallowing physiology and dysphagia and associated adverse effects: A systematic review.