Differences in Thickened Formula Attributes: Influence of Cereal Type and Cereal Pulverization

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BACKGROUND

- **Infant Cereal Thickening**: Rice and oatmeal infant cereals are among the most commonly utilized thickening agents for dysphagic infants.[1,2]
- **Bottle Nipple Clogging**: Unfortunately, infant cereals pose limitations, with many clinicians and caregivers reporting frequent clogging of bottle nipples through which the grains cannot pass.[1]
- **Cereal Pulverization:** To circumnavigate this problem clinicians often recommend caregivers pulverize infant cereals to reduce the grain size prior to adding it to infant formula.[3]
- **Paucity of Evidence Regarding Variables Influencing Cereal Thickening Effects**: Despite the widespread use of these products and practices, there is little research examining the validity of these clinically relevant effects. This investigation elucidated the effect of two of these variables, cereal type and pulverization, on particle size and formula thickness.

SPECIFIC AIMS

Aim 1: Test the effect of cereal type (rice vs. oatmeal) on formula thickness.

Aim 1: Test the effect of cereal pulverization on formula thickness.

Aim 3: Compare particle size of rice and oatmeal cereals in their pulverized and off-the-shelf formulations

METHODS

- **Formula Preparation:** Similac Advance® powdered formula was mixed at room temperature according to manufacturer instructions. Beechnut® cereals were added in ratios of 2tsp/2oz, 3tsp/2oz, 4tsp/2oz, and 5tsp/2oz.
- **Cereal Pulverization**: Beechnut® cereals were pulverized using a mortar and pestle for 1 minute. Formula preparation procedures were followed in the same way for both off-the-shelf and pulverized varieties.
- **Particle Size Measurement:** Dry off-the-shelf and pulverized cereal particle size were measured using an Olympus-IX73 microscope. A camera collected 25 images for each cereal variation.
- **IDDSI Flow Testing**: All formula conditions underwent 3 trials of IDDSI flow testing at room temperature according to IDDSI methodology. Formulas were tested every 5 minutes over 30 minutes to represent the length of a typical bottle feed and monitor for any changes in thickness as time progressed.[5,6]
  - Fill 10 mL BD syringe with 10mL liquid
  - Remove finger from syringe tip and allow 10 seconds of unconstrained vertical flow
  - Record the residual volume of formula remaining in the syringe
- **Analysis**: Average residual volumes across the three trials were calculated and categorized into their IDDSI level (Fig. 1) with differences in residual volumes calculated using ANOVA.

IDDSI Thickness Level	Residual Volume (mL)
Thin	0-1 mL
Slightly Thick	1-4 mL
Mildly Thick	4-8 mL
Moderately Thick	8-10mL

Figure 1: IDDSI classification based on residual volume.

Figure 2:

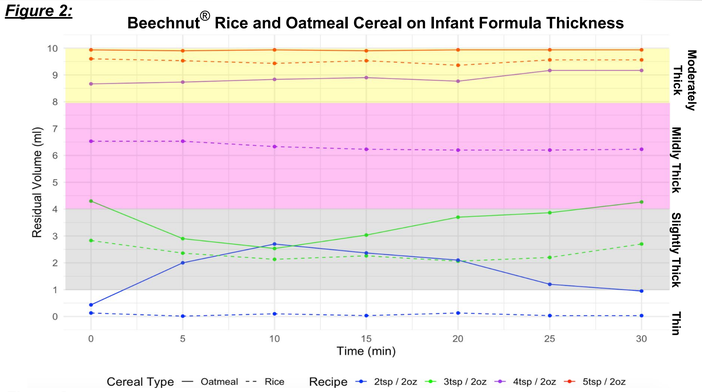


Figure 3:

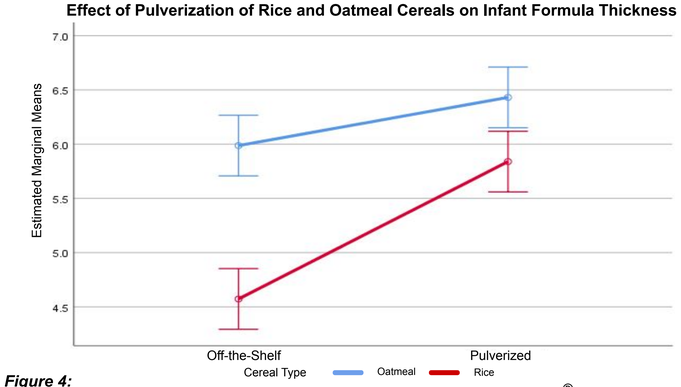
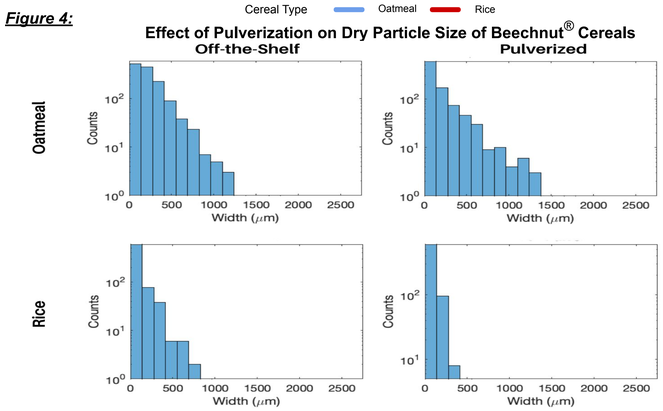


Figure 4:



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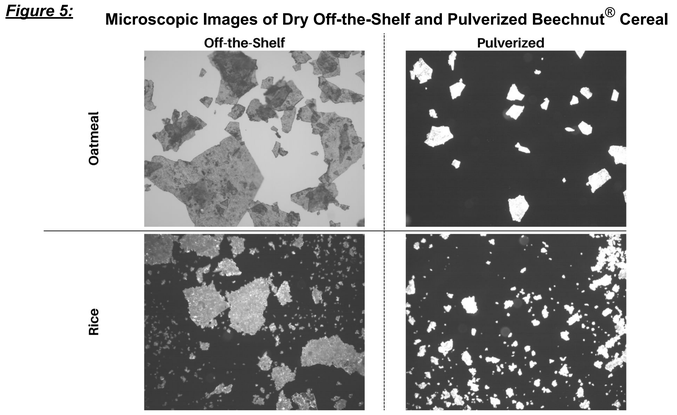

RESULTS

- Rice and oatmeal yielded a stepwise increase in formula thickness with every additional teaspoon of cereal that was added ($p \leq 0.001$).
- Formula thickness did not significantly change throughout the 30-minute testing period within either cereal ($p \geq 0.768$).

Aim 1: Cereal Type

- Formula prepared with oatmeal cereal was significantly thicker than that prepared with the same amount of rice cereal (1.0 ∓ 0.12 mL, $p \leq 0.001$) (*Fig* 2).

Aim 2: Pulverization

- Pulverization of rice and oatmeal yielded thicker liquids than the off-the-shelf formulations (0.86 ∓ 0.12 mL, $p \leq 0.001$) (*Fig* 3).

Aim 3: Particle Size

- Cereal Type: Off-the-shelf oatmeal had a larger average flake size (225.5 ∓ 180.3 μm) than rice cereal (21.9 ∓ 45.8).
- Pulverization:
  - Pulverization reduced the number of large flakes across both cereal types (*Fig* 4).
  - Oatmeal flake radius decreased from 225.5 ∓ 180.3 μm in its off-the-shelf form to 155.8 ∓ 227.1 μm after pulverization (*Fig* 5).

CONCLUSIONS

- Formulas thickened with Beechnut® oatmeal cereal generate thicker liquids than those thickened with rice cereal.
- While pulverization may reduce clogging by reducing the number of large cereal grains that cannot fit through a 1300 μm bottle nipple, it generates thicker liquids which may pose other barriers to milk expression.
- The broad-based use of generic thickening recipes across differing cereal types may pose complications due to differing thickening effects.
- Future investigations examining the influence of infant cereal brand on formula thickness are warranted.

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