Effects of Caloric Density on Infant Formulas and their Anti-Reflux Correlates According to IDDSI Methodology

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BACKGROUND

- **Increasing Dysphagia Prevalence**: Advancements in neonatal medicine have resulted in an increased prevalence of medically complex infants suffering from dysphagia.[1]
- **Gastric Limitations in Thickener Utilization**: Although the provision of thickened liquids is often an effective treatment strategy, immaturity of the infant gut prevents the utilization of many of the most effective external thickening products.[2]
- **Anti-Reflux Formula Thickening Options**: Recent research indicates formula used to treat reflux may offer a viable solution. Pados et al. (2021) found ready-to-feed Enfamil A.R.™ prepared in its 20 kcal/oz formulation qualifies as a slightly thick liquid.[3]
- **Unknown Effects of Caloric Density and Refrigeration**: While this offers a promising thickening option, there remains a paucity of knowledge regarding the thickness of these anti-reflux formulas under common clinical conditions such as formulas prepared at increased caloric densities or provided after refrigeration.

SPECIFIC AIMS

Aim 1: **Test the effect of caloric density on anti-reflux formula thickness.**

Aim 2: **Test the effect of refrigeration and warming on anti-reflux formula thickness.**

METHODS

- **Formulas:** Two commonly used anti-reflux formulas (Enfamil A.R.™, Similac Spit-Up®) were tested in their powder formulations.
- **Mixing:** Formulas were mixed at room temperature according to manufacturer instructions. Caloric density of powdered formulas were mixed and tested at 20-30 kcal formulations.
- **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 monitored for any changes in thickness as time progressed.[4,5]
  - 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
- **Refrigeration and Warming:** To test refrigeration effects formula was made and refrigerated for 3-hours and flow tested. The formula was then warmed to room temperature using an Eivotor bottle warmer and flow tested.
- **Analysis**: Average residual volumes across the three trials were calculated and categorized into their IDDSI level (*Fig*. 1).

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.

IDDSI CLASSIFICATION LEGEND

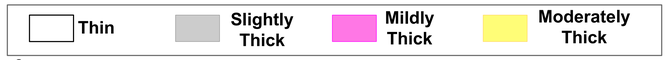
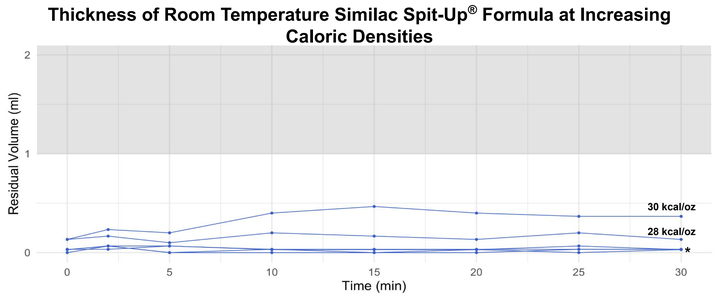


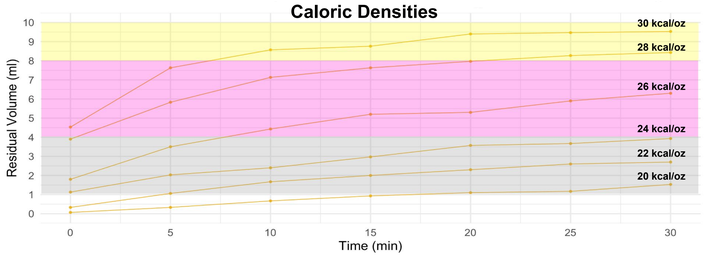
Figure 2:



*Lines represent 20-26kcal/oz.

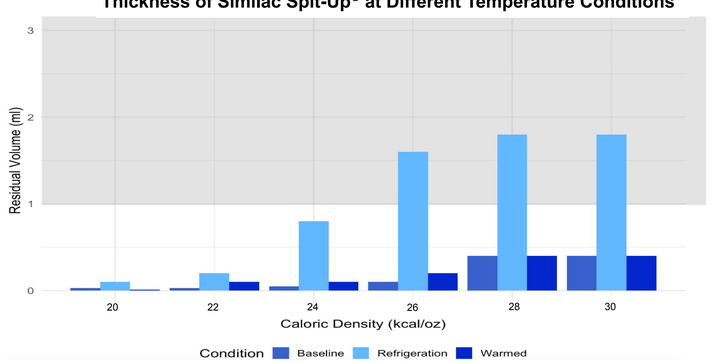
*The manufacturer does not recommend caloric densities over 24 kcal/oz.

Figure 3:



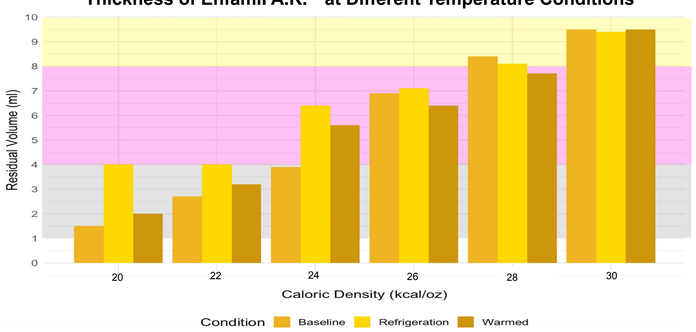
*The manufacturer does not recommend caloric densities over 24 kcal/oz.

Figure 4:



*Lines are offset to show dimension only at a residual volume of 0.

Figure 5:



RESULTS

Caloric Density

- Increasing powder formula caloric density had differing effects by formula brand. Increasing caloric density had no effect on Similac Spit-up® thickness, which classified as thin across all trials (*Fig*.2).
- Increasing Enfamil A.R.™ caloric density resulted in stepwise increases in thickness. Thickness increased throughout the 30-minute testing period (*Fig*. 3).
  - 20 kcal/oz: Initially thin, but slightly thick by 20 minutes.
  - 30 kcal/oz: Initially mildly thick, but moderately thick by 10 minutes

Refrigeration

- Enfamil A.R.™ and Similac Spit-up® both increased in thickness following refrigeration (*Fig. 4, 5*).
- Both formulas thinned with warming in their lower caloric density formulations, however they did not achieve pre-refrigeration levels (*Fig. 4, 5*).

CONCLUSIONS

- Similac Spit-Up® is not effective at increasing formula thickness regardless of its caloric density formulation.
- Slightly through moderately thick liquids can be achieved through the provision of Enfamil A.R.™ at increasing caloric densities, however their continued thickening throughout the 30-minute testing period may pose a problem for milk expression as bottle feeds progress.
- Provision of anti-reflux formulas after refrigeration alters their thickness level.
- Future investigations examining nutritional and gastric safety of this methodology are warranted prior to clinical application.

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