Results

Strowd et al. (2008) investigated the viscosity of pre-packaged thickened liquids and barium test feeds. The pre-thickened liquids were evaluated for variability in lots, variability between flavours, changes in viscosity due to shaking, and stability over time after opening. At least five different samples of each product were tested for each condition. The investigators tested the thickness of nectar- and honey-thick pre-thickened liquids in water, apple, orange and cranberry juice flavours immediately, 30-minutes and 120-minutes after opening in comparison to corresponding barium test feeds. They tested all samples at 24 C due to the assumption that the samples would not significantly change in temperature due to open-mouth oral temperature. Data were presented as mean +/- standard error of measurement (SEM) due to the fact that the authors were investigating the absolute variability in rheology of pre-

replication of the study incredibly difficult, as well as poor viscosity measurement technique. The investigators chose to utilize the methodology in *Safe Liquids* (Lockhart & Radar, 1998) to obtain thickness measurements. Flow rates of the fluids were compared to a table in the *Safe Liquids* text to determine the thickness category of the liquid (i.e., thin, nectar, syrup, sauce, honey, or pudding). Multiple difficulties were encountered in attempting to utilize this method of measurement, ultimately resulting in changes to the classification and procedures from those indicated in the text of *Safe Liquids.* This may have resulted in inaccurate categorization of multiple liquids involved in this study.

While the authors note that ideally thickness is measured using a viscometer, they reported that these devices are not used in health care agencies in Ohio where the study was performed. Although viscometers may not be used consistently in clinical situations, they are an accurate tool for measuring changes in fluid thickness and would have been a more appropriate choice to ensure the reliability and validity of the results (Koperna et al., 2004). Also, Koperna et al. (2004) utilized a cooking thermometer to measure the temperature of all liquids at each time interval, which may not have provided the appropriate level of accuracy for this study. Most studies investigating changes in temperature in thickened liquids utilize water baths to maintain consistent temperature of samples and employ sophisticated tools that provide precise measurement of temperature.

Further limitations of this study included the lack of statistical analysis provided by the authors. All data was presented in tabular form with no provision of means, standard deviations or analyses of variance. The investigators also did not control for starting temperature in their cold and hot liquids, which may have had an effect on viscosity measurements and weakens the reliability of their results. Therefore, due to poor statistical analyses, poor methodology and procedures, and lack of control of many variables within the study, the validity and reliability of these results should be questioned. Given the multiple limitations of this study, the evidence of the effect of time and temperature changes on thickened liquids must be considered with caution.

Adeleye & Rachal (2007) utilized a repeated measures design to investigate the rheological differences in commercially available pre-thickened beverages and powder-thickened beverages at two different temperatures and using three different measurements of viscosity (line-spread test, funnel test and viscometer). They studied the following nectar- and honey-thick pre-packaged liquids: milk, lemon-flavoured water, apple juice, orange juice and cranberry juice. They compared the pre-packaged liquids to one brand of powdered thickener (ThickenUp) mixed with 2% reduced fat milk, water, apple juice, orange juice and cranberry concord grape juice. Unlike other studies, these authors utilized household devices (i.e., tablespoons, teaspoons, and measuring cups) to measure the appropriate amount of powdered thickener, per manufacturer instructions. As an added reliability measure, Adeleye & Rachal (2007) weighed the measured ingredients and took an average of four measurements to determine a standard amount to use in preparation of the sample liquids. Samples of each of the liquids were refrigerated at 10 C and 20 C. Statistical analyses included one-way ANOVA with

the powder-thickened liquids seemed to depend on the composition of the thickener itself. Starch thickeners were thicker at higher temperature (vs. room

Pre-thickened liquids tend to be thinner at higher temperatures as compared to lower temperatures,

Weight measurement of powdered thickener is more accurate than volume measurements.

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