revvity

APPLICATION NOTE

Decarbonation of soda samples using rotor-stator based methodology.

Authors

Gabriella Ryan, M.S.
Rodney Nash, Ph.D.

Revvity, Inc.

Summary

When conducting research for beverage development or during final product manufacture, quality analysis is a vital step in the process. When analyzing sugar-additives like aspartame, or quantification of other characteristic ingredients, like caffeine, decarbonation is a required step during sample preparation to ensure quality of downstream results (Maes, 2012). For downstream analysis, carbonation, in the form of dissolved carbon dioxide (CO_2), decreases the quality of the sample and is an unwanted sample characteristic for ingredient analysis when utilizing methodologies like liquid chromatography or mass spectrometry-based analysis.

Examples of methods used for decarbonation include leaving the sample exposed to air to become flat over many hours or agitating the sample via ultrasonication. To speed up the decarbonation process, mechanical disruption offers a reliable method that allows for quick and efficient removal of dissolved CO_2. The Omni THq Homogenizer and variety of rotor-stator probes, from disposable Omni Tips™ to stainless-steel, provide an automation-compatible solution for decarbonation of soda for customers in the beverage industry.

Herein, we evaluate the Omni THq Homogenizer and its ability to reduce pressure and CO_2 volume in commercially available cola, diet cola, and lemon-lime soda samples.

Omni THq Homogenizer

Materials and methods

Equipment

- Omni THq Homogenizer (Cat # 12-500)
- 7mm Hard Tissue Omni Tip Plastic Homogenizing Probes (Cat # 30750H)
- 10 mm x 110 mm Stainless Steel Generator Probe (Cat # B10-110ST)

Procedure

Decarbonation control variables

Commercially available regular varieties of cola, diet cola and lemon-lime soda were obtained from a local grocer. Contents of 1 can, per beverage type, were emptied into separate 600 mL beakers and left out at room temperature (70 °F) for 24 hours. Separate 600 mL beakers were filled with the entire volume of 1 can, per beverage type, and left out at room temperature (70 °F) for 48 hours. Both 24 and 48-hour samples were used as positive decarbonation controls in the experiments described below, while fresh, unopened, carbonated beverages were used as a negative decarbonation control.

Sample preparation & decarbonation

Unopened cans of cola, diet cola and lemon-lime soda were stored at 39 °F until processing to reduce the incidence of CO_2 loss from samples sitting open prior to sample preparation. For processing and decarbonation of fresh samples, 300 mL of each beverage was poured into a 600 mL beaker situated in an ice bath. Either an 7mm Hard Tissue Omni Tip Plastic Homogenizing Probe (Cat # 30750H) or a 10 x 110 mm Stainless-Steel Generator Probe (Cat # B10-110ST) was connected to the Omni THq Homogenizer (Cat # 12-500), depending on phase of testing. Processing with either rotor-stator probe on the Omni THq Homogenizer was carried out using the speed parameters listed in Table 1. Samples were processed for an initial 10 minutes on ice, liquid homogenate was then transferred to a carbonation testing device (Taprite, Cat # 2701g) for determination of pressure and CO_2 volume. Following carbonation testing, the same sample was returned to the 600 mL beaker and processed for 5 additional minutes and carbonation testing repeated. Beverage samples were processed in 5-minute increments (after the initial 10-minute run) until a total of 20 minutes had elapsed. The same procedure was followed for all carbonated beverage samples.

Determination of pressure and CO_2 volume

Precisely 250 mL of beverage was added to the cannister of the carbonation testing device for determination of pressure and CO_2 volume. The top of the canister was screwed on until resistance was met, and then tightened an additional quarter turn. Then, the sealed cannister was agitated by shaking for 10 seconds. Pressure and temperature were obtained from appropriate gauges, and CO_2 volume was cross-referenced on provided reference table. In the instance that the pressure reading was less than minimum reading on provided reference table (<8 psi), calculated sample CO_2 volume was determined using the plotted equation obtained from Microsoft Excel. Sample temperature was kept consistent at 43-45 °F using an ice bath. The cannister and screw-top were rinsed twice with water between testing of all beverage samples. Pressure and CO_2 volume were obtained from positive and negative controls, as well as all processed samples after each timed run.

Table 1: Sample homogenization summary. Time parameter was variable between 5-20 minutes, depending on the experiment. Fresh carbonated beverages tested were cola, diet cola, and lemon-lime soda.

Probe	Speed (rpm)	Time (min)
7mm Hard Tissue Omni Tip Plastic Homogenizing Probe	30,000	variable
10 x 110 mm Stainless Steel Generator Probe	28,000	variable

Results

Using the Omni THq Homogenizer, pressure and dissolved CO_2 levels were reduced as elapsed processing time increased, when compared to control data. Specifically, when using the Omni Tips plastic probes to process cola, diet-cola and lemon-lime soda, samples were decarbonated at least 50 % (Figures 1, 3, 5) after processing for 20 minutes, when compared to negative control (fresh soda). Whereas pressure was reduced by at least 93 % in cola, diet-cola, and lemon-lime samples (Figures 2, 4, 6) after processing for 20 minutes, when compared to the negative control (fresh soda). The 10 mm x 110 mm Stainless Steel Generator Probe allowed for 58 % decarbonation (Figure 7) and 96 % pressure reduction (Figure 8) after only 10 minutes of processing on the Omni THq Homogenizer.

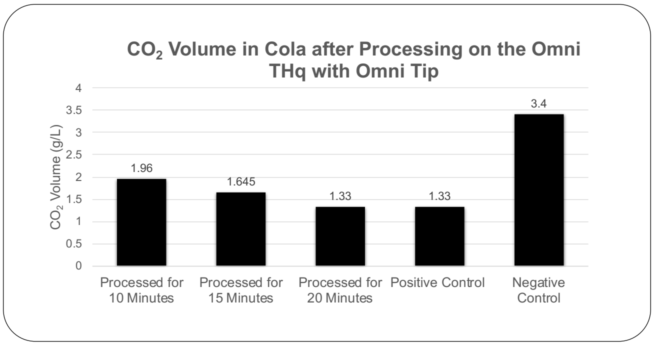

Figure 1: CO_2 Volume in Cola post-processing with Omni Tip plastic probe. After 10, 15, and 20 minutes of processing, percent dissolved CO_2 loss was 42, 52, and 61 %, respectively, when compared to the negative control (fresh soda).

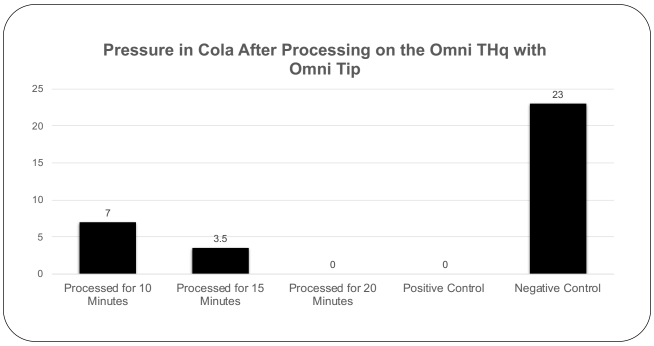

Figure 2: Pressure in Cola post-processing with Omni Tip plastic probe. After 10, 15, and 20 minutes of processing, percent pressure loss was 70, 84, and 100 %, respectively, when compared to the negative control (fresh soda).

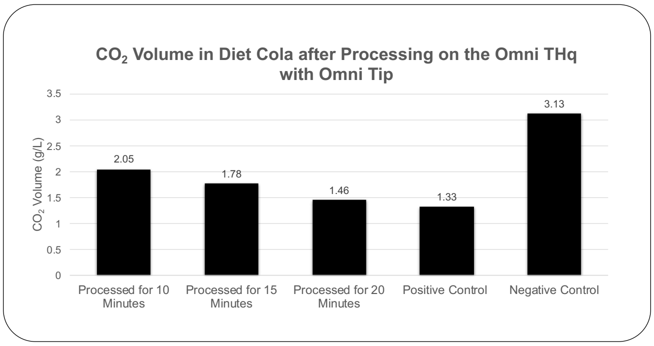

Figure 3: CO_2 Volume in Diet-Cola post-processing with Omni Tip plastic probe. After 10, 15, and 20 minutes of processing, percent dissolved CO_2 loss was 35, 43, and 53 %, respectively, when compared to the negative control (fresh soda).

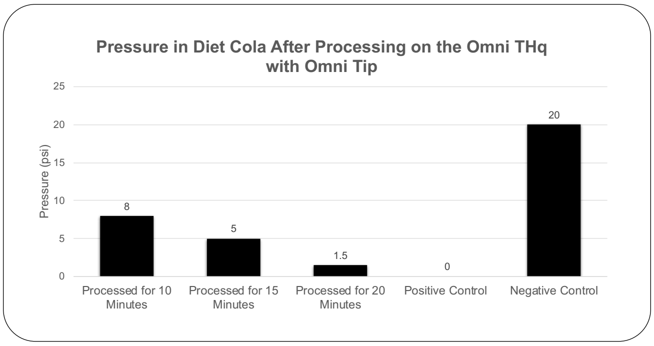

Figure 4: Pressure in Diet-Cola post-processing with Omni Tip. After 10, 15, and 20 minutes of processing, percent pressure loss was 60, 75, and 93 %, respectively, when compared to the negative control (fresh soda).

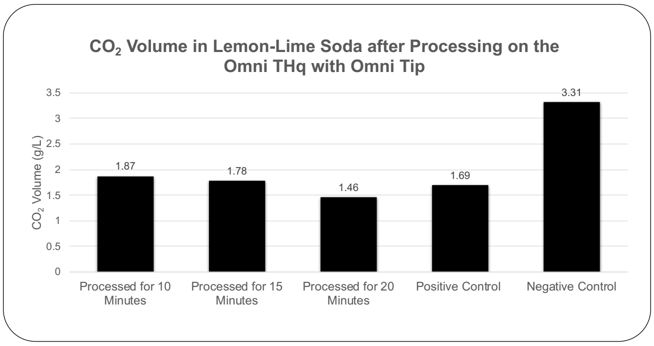

Figure 5: CO_2 Volume in Lemon-Lime Soda post-processing with Omni Tip plastic probe. After 10, 15, and 20 minutes of processing, percent dissolved CO_2 loss was 44, 46, and 56 %, respectively, when compared to the negative control (fresh soda).

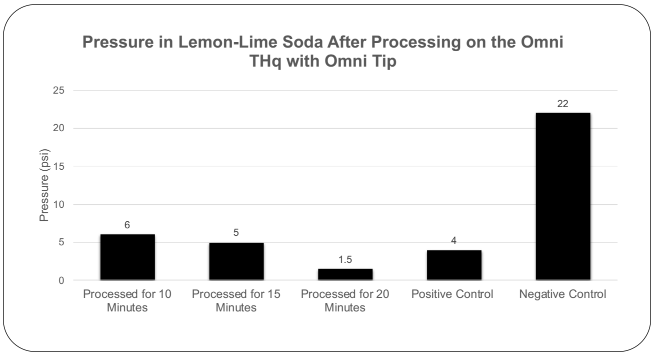

Figure 6: Pressure in Lemon-Lime Soda post-processing with Omni Tip Plastic Probe. After 10, 15, and 20 minutes of processing, percent pressure loss was 73, 77, and 93 %, respectively, when compared to the negative control (fresh soda).

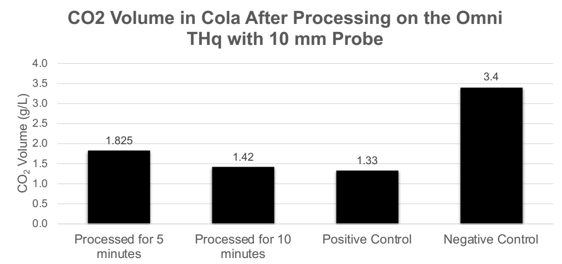

Figure 7: CO_2 Volume in Cola post-processing with 10 x 110 mm Stainless Steel Probe. After 5 and 10 minutes of processing, percent dissolved CO_2 loss was 46 and 58 %, respectively, when compared to the negative control (fresh soda).

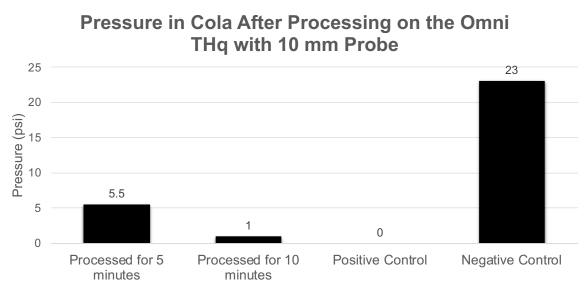

Figure 8: Pressure in Cola post-processing with 10 x 110 mm Stainless Steel Probe. After 5 and 10 minutes of processing, percent pressure loss was 76 and 96 %, respectively, when compared to the negative control (fresh soda).

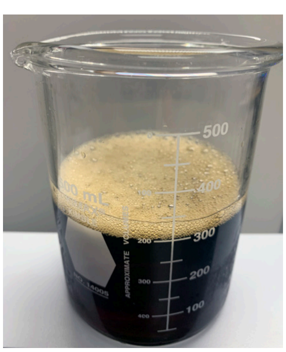

Figure 9: Pre-Processing photo of Cola sample. Note the presence of CO_2- generated effervescence in the form of foamy-bubbles.

Figure 10: Post-processing photo of Cola sample. Note the lack of CO_2- generated effervescence.

Conclusions

Rotor-stator based technology is an effective method in reducing pressure and dissolved CO_2 volume in carbonated soda beverages by mechanically disrupting the beverage sample. In doing so, the resulting homogenate is suitable for further downstream testing using analytical workflows to test presence/absence of analytes of interest.

Using the experiments outlined above as proof-of-concept, methodologies can be translated from a handheld rotor-stator based homogenizer to an automated rotor-stator based sample preparation system using the Omni Prep 96 automated homogenizer workstation or Omni LH 96 automated homogenizer workstation with liquid handling and reformatting capabilities for high-throughput decarbonation of beverage samples.

References

Maes, P., Monakhova, Y. B., Kuballa, T., Reusch, H., & Lachenmeier, D. W. (2012). Qualitative and quantitative control of carbonated cola beverages using ^{1}H NMR spectroscopy. Journal of agricultural and food chemistry, 60(11), 2778-2784. https://doi.org/10.1021/jf204777m