Antioxidant capacity of common dietary supplements

Ana Figuereo[1], Marie Roche[1], Chelsea Trost[1], Leonardo Albertini[2], Luis C. Fernandez-Torres[1,*]
[1]School of Science, St. Thomas University, Miami Gardens, FL 33054, USA
[2]Miami Dade College, North Campus, Miami, FL, USA
*****Author to whom correspondence should be addressed; E-Mail: Lfernandez-torres@stu.edu
Tel.: +1-305-474-6014; Fax: +1-305-628-6706.

Received: / Accepted: / Published:

Abstract: Today's health-conscious society consumes a wide variety of dietary supplements in order to improve quality of life. An increasing number of these supplements are marketed as antioxidants. Therefore, it is of great importance to understand the performance of these supplements as antioxidants. This investigation presents the antioxidant capacity of several common dietary supplements using the Briggs-Rauscher (BR) oscillatory reaction. The antioxidant species scavenge free radicals formed in the BR reaction, lengthening the time intervals of the reaction's oscillations; the higher the antioxidant capacity, the longer the oscillation delays. The samples experimented, Beta carotene, Lutein, Quercetin, Folic Acid, and L-Glutathione, all exhibit antioxidant activity. Trolox, a water-soluble form of vitamin E, was established as the standard to assess each supplement's antioxidant capacity. It was noted that the time delay within the BR reaction oscillations was significantly affected with increasing concentrations of each substance. Also, sodium iodate proved to be better than potassium iodate in the BR reaction, as precipitation was not a factor that altered results in the BR reaction. In addition the antioxidant capacity was quantified by the calculation of the Relative Antioxidant Performance (RAP), which measures the sample slope over the standard slope or the slope of Trolox. Finally, we observed that exposure to light can affect the antioxidant capacity.

Keywords: *antioxidants, oscillatory reaction, Briggs-Rauscher reaction, Trolox, and supplements.*

Introduction

An imbalance between free radicals (oxidants) and antioxidants, can potentially lead to disease such as heart attack, Alzheimer's disease, and tumors. Free radicals can lead to a variety of problems. In particular, they react with – and damage – lipids, proteins and nucleic acids, including DNA. Our marketplace is flooded with supplements marketed as antioxidants, but their purported benefits are the subject of ongoing investigations.

The Briggs-Rauscher (BR) reaction is an oscillating reaction that changes between two cycles back and forth until it reaches equilibrium. The two cycles the reaction oscillates between correspond to a radical state and a non-radical state. The BR reaction is mostly used as demonstration.[1] Recently, Cervellati reported its use as a method to assess antioxidant capacity.[2] In this method, the presence of an antioxidant increases the oscillation time in the BR reaction. In this short communication we test if the Briggs-Rauscher oscillating reaction can determine antioxidant performance. In order to do this, we first established the use of Trolox as a standard for antioxidant capacity within the Briggs-Rauscher reaction. We measured the antioxidant capacity of L-glutathione, folic acid, β-carotene, and lutein, and finally determined the Relative Antioxidant Performance (RAP) of the L-glutathione, folic acid, β-carotene, and lutein using Trolox as a standard.

Methods and Results

A typical preparation of the Briggs Rauscher reaction was utilized.[3] When all stock solutions were prepared the solvents were tested as follows. Take 5mL of the sodium iodate solution, 5mL of starch solution, and 10mL hydrogen peroxide. Once a stir bar has been placed in a 100mL beaker, start to mix the sodium iodate solution and starch solution in the beaker over a stirring plate. Then add the peroxide; the solution turns amber yellow then dark blue. Start the timer when the first dark blue color appears until the next dark blue appears. This is the oscillation time (usually 13-18 seconds).

This is also the control time for each trial. Repeat the step above and when the second deep blue color appears, add 1mL of sample solution. Measuring the time from the second blue to the third blue appearance determines any solvent effects. All samples were dissolved in water or water/ethanol mixtures. Addition of ethanol does not affect the BR oscillations.[4]

Among the several testing methods available to determine the relative antioxidant activity of pure compounds, plant extracts, drinks, etc., the Trolox Equivalent Antioxidant Capacity (TEAC) assay is the most commonly used. We were able to establish Trolox as a standard for the BR reaction method (Fig 1). It is noted that for the substances L-Glutathione, Folic Acid and Quercetin the concentration greatly affects the level of antioxidant effect. Utilizing Lutein that had been stored in amber flasks which protected it from direct light and limiting air exposure provided more consistent results.

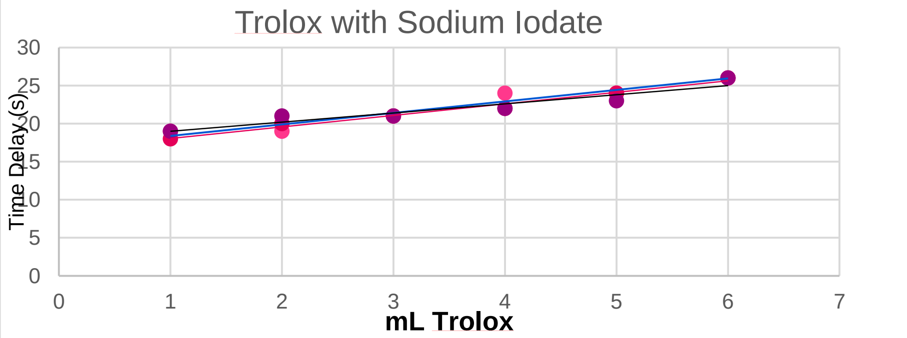

Fig. 1: Effect of Trolox on the oscillation time of the BR reaction. A saturated aqueous solution of Trolox was used.

$$\text{RAP} = \frac{\text{slope of sample}}{\text{slope of standard}}$$

The relative antioxidant performance (RAP) of the different supplements was determined using Trolox as a standard (table below). We measure the time the BR oscillation was delayed as a function of increasing concentration; the higher the concentration, the longer the delay. A best-line fit produced a slope for each of the samples. Our observations show that quercetin has the best antioxidant performance of the tested supplements.

RAP Lutein	RAP β-carotene	RAP L-glutathione	RAP Folic acid	RAP Quercetin
0.41	0.4	0.0009	0.61	2.31

Conclusions

The Briggs-Rauscher oscillating reaction is effective detecting antioxidant presence. The time delay which represents the antioxidant strength significantly increases with increased concentrations. Determining the Relative Antioxidant Performance (RAP) of the various supplements demonstrated highest performance in Quercetin. Performing the Briggs Rauscher reaction with sodium iodate provided more consistent results. Trolox can be used as a standard within the Briggs Rauscher Oscillatory Reaction, but ethanol is a better solvent for it than water.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

Authors want to thank St. Thomas University SRI 2016, and STEM-TRAC grant P03C110190.

References and Notes

1. Briggs, T.; Rauscher, W. An oscillating iodine clock. *J. Chem.Educ.* **1973**, *50*, 496.
2. Cervellati, R., Renzulli, C., Guerra, M. C., Speroni, E. Evaluation of Antioxidant Activity of Some Natural Polyphenolic Compounds Using the Briggs-Rauscher Reaction Method. *J. Agric. Food Chem.* **2002**, 50, 7504-7509.
3. Shakhashiri, B.Z. *Chemical Demonstrations* Volume 2. **1985**, Madison WI, USA: University of Wisconsin.
4. Fernandez-Torres, L.; Trost, C.; Figuereo, A.; Roche, M.; Albertini, L. Solvent Variations of the Briggs-Rauscher Reaction. *In Proceedings of the MOL2NET, International Conference on Multidisciplinary Sciences*, 5 December 2016–25 January 2017; Sciforum Electronic Conference Series, Vol. 2, 2016.