HOSPITALITY INSTITUTE OF TECHNOLOGY AND MANAGEMENT
670 Transfer Road, Suite 21A • Saint Paul, Minnesota 55114 • USA • TEL: (651) 646-7077 • FAX: (651) 646-5984
e-mail: osnyder@hi-tm.com • web site: http://www.hi-tm.com

OXIDATION-REDUCTION POTENTIAL OF FOOD

by O. Peter Snyder, Jr., Ph.D.

Introduction

The FDA Food Code discusses at great length reduced oxygen packaging. If food is put in a reduced oxygen package, it is subject to a HACCP and many other special requirements. This paper shows that essentially all food in a retail food establishment is in a reduced oxygen environment sufficient for the growth of *Clostridium botulinum* types A and B, or non-proteolytic type E.

Actually, the amount of oxygen is not the critical variable; the oxygen-reduction potential is the critical variable. Hauschild (1989) reviewed the necessary oxidation-reduction potential for the growth of proteolytic and non-proteolytic strains of *C. botulinum*, and concluded that it was in the range of +200 millivolts. Once growth is initiated, the E_h of *C. botulinum* cultures declines rapidly below a level of -200 millivolts.

Dr. Donald Kautter (FDA Division of HACCP) in 1993 in a personal conversation, agreed that even at 1/4 inch below the surface of most foods, the oxidation-reduction potential is sufficiently low that *C. botulinum* will multiply. In order to dispel the idea that some food in a vacuum package is more hazardous than food in a pan, two simple experiments were conducted to measure the oxygen-reduction potential of typical foods as prepared in a typical kitchen, to include the home kitchen and that of the retail food establishment.

Experimental Design

Two food products were selected. The first was Hungry Jack Instant Mashed Potatoes, the second was a simple tomato and hamburger casserole. These are shown in ***Figures 1*** and ***2***. An Orion Model 290A pH millivolt meter was used with an Orion E_h electrode to measure the oxidation-reduction potential in the food. The electrode shown in the figures was placed approximately 1/4 inch below the food's surface.

Results

In the mashed potatoes, the oxidation-reduction potential was +56.3 millivolts. In the tomato and hamburger casserole, the oxidation-reduction potential was +44.3 millivolts.

Conclusions

It is not the package that makes the difference as to whether or not *C. botulinum* will grow. It is the configuration of the food as well as the addition of chemical agents to further reduce the oxidation-reduction potential.

If oxidation-reduction potential is to be used as a control element, the only way to know whether or not *C. botulinum* will multiply in food is to measure the oxidation-reduction potential and not make assumptions about the exclusion of oxygen being the critical element of *C. botulinum* growth. There are very simple meters and electrodes such as the Orion 290A and Orion E_h electrode, that can be used to measure and validate food processes for potential *C. botulinum* growth in a food.

The results of this experiment are particularly significant because of the millions of meals that are prepared in the U.S. every day. It is extremely rare that *C. botulinum* multiplies in food to produce toxin and make people ill. Hence, it is easy to conclude that *C. botulinum* grows poorly in foods, compared to other organisms. The critical factor is the non-competitive nature of *C. botulinum* plus the fact that prepared food is usually kept at refrigerator temperatures. (Smoked fish and salted fish products must be kept below 38°F.) Thus, *C. botulinum* rarely causes food safety problems.

References:

FDA. 2005. Food Code. Annex 6. 2. Reduced Oxygen Packaging. http://www.cfsan.fda.gov/~acrobat/fc05-a6.pdf.

Hauschild, A.H.W. 1989. *Clostridium* botulinum. In Doyle, M.P., Ed. Foodborne Bacterial Pathogens. Marcel Dekker, Inc. New York.

Kautter, D. 1993. Personal communication.

Figure 1 Hungry Jack Instant Mashed Potatoes
Orion E_h electrode
mv = +56.3 ~1/4 inch below the food surface

Figure 2 Tomato and Hamburger Casserole
mv = +44.3 ~1/4 inch below the food surface