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Industrial Applications of Selected JFS Articles

Papers in the *Journal of Food Science* are often reports of specific, constrained subjects. But knowledge derived from these limited-scope projects can be very great indeed, and may have little to do with the actual subject, but much to do with broader areas of food safety, nutrition, or general understanding. This is all the more reason for serious professionals to keep up with the current literature, read or at least skim the papers, and let the information join the store one already has. Information will remind you of itself when you least expect it, and, hopefully, when you most need it.

Modeling Bacterial Spore Inactivation

Equations predicting the amount of bacterial spore inactivation in a system using both moist heat and high pressure are presented. The equations, derived from classic thermodynamic and kinetics principles, explained 86% of the variation of the rate constant data, after verification using 2 independent data sets corresponding to *Clostridium botulinum* and *Bacillus stearothermophilus*, 2 different temperatures, and 2 different pressures. The models are intended for use in comparing high-pressure-processing treatments using different systems, permitting treatments to be as gentle as possible. According to one cited study, bacterial spore deactivation with moist heat is associated with protein denaturation and possible enzyme inactivation. Other studies that suggest part of the trade-offs existing when using moist heat and pressure described the effects of both heat and pressure on protein configuration and aggregation. The key is that the effect of a specific HPP treatment must be explained given the effect of a transient temperature-pressure condition.

The paper includes a list of notations that can be used to clearly understand the equations. The research was carried out by researchers from Baxter Healthcare Corp., the Food and Drug Administration, and the National Center for Food Safety and Technology, Illinois Institute of Technology. The title of the paper is “Model of the Inactivation of Bacterial Spores by Moist Heat and High Pressure.” (p E367-73)

How Green is the Tea, and What Does it Mean

Green tea is green, bright grassy green, when ready to drink. Green tea is being judged on the greenness of the infusion, as more ready-to-consume products appear in clear glass bottles, and the green color of dry tea is of consumer interest as well. Researchers with the Amore-Pacific Corp. and Kyung Hee Univ. studied the color contributors of green tea, finding that chlorophylls and certain flavonoids (catechins and flavonoids, especially quercetin) contributed to the appearance of the tea beverages and the leaves. The paper introduces information about the green-tea evaluations in China and Japan, where green-tea color, aroma, and flavor are judged by panels of experts. The title of the paper is “The Compounds Contributing to the Greenness of Green Tea”.

The scientists used sensory evaluation and assays of chlorophyll by spectrophotometer, and HPLC and assessment of catechins and flavonol concentration in tea infusions by HPLC. It was found that color of the tea leaves does not necessarily predict color of the infusion, confirming the tea traders practice of always infusing the tea leaves before making buying decisions. Specific qualities imparted by flavonols were discussed. Tea judgment panels have always been approached as if there were some special magic involved: This and similar papers help to dispel the magic and replace it with equally compelling knowledge. (p S301-5)

Storage Conditions Affects Cooked Hamburger Color

Premature browning of hamburger patties and high thiobarbituric acid values suggesting rancidity resulted more often in samples stored in high oxygen content than those stored in atmospheres of 0.4% carbon monoxide, 80% oxygen, or vacuum at 2 °C prior to cooking. Because consumers expect ground beef to be cherry red in color before cooking, and expect the beef to brown slowly, the formation of brown metmyoglobin is not acceptable to consumers.

Researchers from Utah State Univ. and the Norwegian Food Research Inst. looked at 3 meat sources, 3 packaging treatments, 3 raw meat storage times, and cooked patty internal temperatures. Their findings were presented in “Comparison of Color and Thiobarbituric Acid Values of Cooked Hamburger Patties after Storage of Fresh Beef Chubs in Modified Atmospheres,” including the findings that raw ground beef held in 80% oxygen maintained desirable color for 7 to 10 d, and began to darken by day 14, and lost all color by day 21, while raw ground beef held the bright red color for 21 d when packaged in 0.4% CO. However, internal color remained somewhat red even at high internal cooking temperature. The pinkness that exists at high cooking temperatures is probably caused by development of heat-denatured CO-hemochrome, instead of undenatured CO-myoglobin. The research was supported by funding from the National Cattlemen’s Association and by the Utah Agricultural Experiment Station. Because of the concern about undercooking of beef patties and the presence of bacterial contamination, research that determines the cause and effect of different handling and cooking temperatures is particularly important to consumers. (p C608-14)

Filleting Production Yields Good Salmon Oil

As the processing of farmed Atlantic salmon into fillets increases in Norway (the rate of production was 450000 tons in 2002, the increase in byproducts to 133000 tons, of which 8000 tons was used for salmon oil), more study of the effects of storage conditions on salmon oil in particular is warranted.
the lipid quality and content of the oil is required. Researchers from NORCONSERV A/S studied the conditions and processes, and reported their findings in a paper titled “Production of Salmon Oil from Filleting Byproducts—Effects of Storage Conditions on Lipid Oxidation and Content of \( \omega-3 \) Polyunsaturated Fatty Acids.”

The byproducts include heads, frame, bones, skin, and downgraded fish that are processed for lipid material. The samples of oil that had been held under different storage conditions were tested for lipid quality. It was found that storage temperatures had a significant effect on quality parameters, with colder temperatures producing lower peroxide, anisidine, and Totox values, which were significantly higher at 23 °C than at 4 °C. Storage under \( \text{N}_2 \) atmosphere produced a higher level of eicosapentanoic acid and docosahexanoic acids than did air storage. When stored under appropriate conditions, it is found that salmon oil is a stable product that can be used in a variety of products. (p E417-21)

**Fish Allergies in Ingredients are Evaluated**

Codex Alimentarius recommended that member countries adopt a list of commonly allergenic foods and ensure that ingredients from common foods such as fish, shellfish, and other foods appear on labels. Most ingredients are not listed in most countries, while some countries—such as Australia and New Zealand—have moved to adopt the list. The paper “Fish Allergy: Fish and Products Thereof” discusses the several widely used food ingredients derived from fish. The researchers from the Univ. of Nebraska developed a list of ingredients derived from fish, including fish gelatin, isinglass, fish maws, ice-structuring protein, fish oil, and Worcester-shire sauce. The Codex Commission recommended the labeling of all fish-derived ingredients, however, according to authors of this paper, the allergenicity of ingredients derived from fish have not been proven by clinical research in most cases.

The point is interesting, in that Codex is supposed to be science-based, and these scientists appear to question how science-based the recommendation is. (p R175-80)

**Fatty Acids Released into Milk from Bacteria**

Bulk-cooled milk has the ability to permit the growth of psychotropic bacteria, which then produce heat-resistant enzymes that can concentrate in cream and remain active in butter, cheese, and thermally processed products like condensed milk, dried milk, and ultra-high-temperature processed milk. According to “Fatty Acids Released from Milk Fat by Lipoprotein Lipase and Lipolytic Psychrotrophs,” the 13 strains of bacterial enzymes produce various off-flavors and off-odors in varying amounts depending on the numbers and specific psychrotrophs present.

The researchers categorized the psychrotrophs as Category 1: a group that grew well and released large quantity of fatty acids, Group 2: that grew well and released smaller quantities of fatty acids, and Group 3: two strains that did not grow well in heat-treated milk and released small amounts of free fatty acids during the 10-d monitoring period. Some of the free fatty acids released are known to alter milk flavor, including butyric acid, caproic and caprylic acid, and lauric acid. The research team that reported on the work is from Kansas State Univ. (p C659-64)

**Keeping the Spots off Shrimp at Sea**

Blackspot in shrimp is a defect that consumers believe predicts spoilage, so even when spoilage is avoided, many consumers will reject the spotted shrimp. Shrimp fishermen know that the development of the off-color spots are not dangerous to the public, but puts a hole in the shrimp industry’s collective pocketbook. The spots are formed when colorless quinones polymerize, after the quinones are formed by the action of an enzyme, polyphenoloxidase, oxidizing phenols to quinines. The condition is more likely to occur in fall and winter, when food is scarce, and the animals are molting. Refrigeration on ship slows the formation of blackspot, but doesn’t prevent it because the enzyme is still active at cold temperatures. The process of forming blackspot is called melanosis, and is treated with sulfites—particularly metabisulfite, which apparently works best in amounts that can exceed legal limits.

Researchers from Inst. del Frio in Madrid measured the effectiveness of formulations including 4-hexylresorcinol onboard ship, and reported their findings in “Effectiveness of Onboard Application of 4-Hexylresorcinol in Inhibiting Melanosis in Shrimp (Parapenaeus longirostris).” The researchers found that the resorcinol compound with added acids (citric, ascorbic, and acetic) produced the best-looking shrimp at the end of 10 d, and found that different amounts of product were required at different seasons, and that different species of shrimp reacted differently. (p C643-7)
Dear Dr. Lund,

The Journal of Food Science has always maintained a high quality standard, and published relevant and scientifically sound original research. However, I am concerned about the methodology used in an article recently made public on the web, and would like to bring this to your attention.


Problem: The term “respiration rate,” used throughout the article, is actually a measure of the static accumulation of CO2 (%) over an extended period divided by product weight, which is incorrect.

“Respiration rate” is the measure of a flux of energy, liberated as CO2 (Nobel 1991), which therefore requires a calculation of gas volume, converted to a molecular basis or weight, per product weight, per unit time (for example. mg • kg–1 h–1) (Kays 1997). The presented data are % CO2 per 100 g taken from jars containing 50 g tissue, which were held in a static state for up to 12 d. The caption of Figure 1 “Changes in headspace CO2” indicates this. This was, therefore, a passively modified atmosphere.

In order to calculate respiration, one would need to convert percentages into a weight basis, and divide all these values by the appropriate time, for example: CO2 g • kg–1 h–1 (increase in CO2 %) • (free space volume, mL) / (fruit weight, kg) • (time closed, h)

If data presented in Figure 1 were used to calculate respiration using the formula for static systems the respiration rate would decrease from day 1 to day 12.

Estimations based off graphed data (Figure 1):

Day 1 control = (4.2/100)(450 mL)/(0.05 kg)(24h) = 15.75 mg • kg–1 h–1

Day 7 control = (22.5/100)(450 mL)/(0.05 kg)(24h) = 12.05 mg • kg–1 h–1

Day 12 control = (26/100)(450 L)/(0.05 kg)(24h) = 8.13 mg • kg–1 h–1

Most of the references cited by Dr. Holcroft, and her argument against the use of the closed system for respiration measurement, are based on intact uncut produce. Physiological and biochemical changes that occur in the uncut fruit that are typically distributed over a molecular basis or weight, per product weight, per unit time (for example. mg • kg–1 h–1) (Kays 1997). The presented data are % CO2 per 100 g taken from jars containing 50 g tissue, which were held in a static state for up to 12 d. The caption of Figure 1 “Changes in headspace CO2” indicates this. This was, therefore, a passively modified atmosphere.

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However, holding a living, respiring product in a static state results in a depletion in oxygen and an accumulation in carbon dioxide and ethylene, effectively reducing respiration (Beaudry and others 1992; Cameron and others 1994; Cameron and others 1995). For this reason, the static system is usually used only for brief periods (hours, not days), and the CO2 accumulation should not exceed 0.2% (Saltveit 2004). In addition, by day 7 the “modified atmosphere” established in the jars exceeded the CO2 range recommended for storing fresh-cut cantaloupe (Kader 2002). Therefore, the respiration data reported in this paper are incorrect and any conclusions drawn from these data are therefore invalid.

Sincerely,

Deidre M. Holcroft, Ph.D.
Dole Fresh Vegetables
Salinas, California, USA

References

Dear Dr. Lund:

Thank you for the opportunity to respond to the Dr. Holcroft’s letter regarding our article.

We would like to make the following corrections to the published work:

1. Figure 1: The correct unit for the Y-axis is CO2 (%).
2. Results and Discussion (first sentence) should be: Headspace CO2 increased considerably after 7 days storage of the cut fruit at 10 °C (Figure 1).

Our rationale for measuring headspace CO2 in sealed Mason jars is based on the fact that fresh-cut fruits are typically stored and retained in sealed containers unlike uncut fruit, that are exposed. While increase in accumulated CO2 may not be linear under this condition, the change in gas composition is essentially from respiration of the fruit and differences in headspace CO2 and O2 content between treated and control experiments are indicative of their respective respiration rates. We are simply using differences in headspace gas composition as indicators of changes in respiration rates.

Most of the references cited by Dr. Holcroft, and her argument against the use of the closed system for respiration measurement, are based on intact uncut produce. Physiological and biochemical changes that occur in the uncut fruit that are typically distributed over a molecular basis or weight, per product weight, per unit time (for example. mg • kg–1 h–1) (Kays 1997). The presented data are % CO2 per 100 g taken from jars containing 50 g tissue, which were held in a static state for up to 12 d. The caption of Figure 1 “Changes in headspace CO2” indicates this. This was, therefore, a passively modified atmosphere.

In order to calculate respiration, one would need to convert percentages into a weight basis, and divide all these values by the appropriate time, for example: CO2 g • kg–1 h–1 (increase in CO2 %) • (free space volume, mL) / (fruit weight, kg) • (time closed, h)

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