TODD SHAVER B.S
JONATHAN HOWARTH PH.D
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Comparative Toxicology of Inorganic Bromide Salts and Certain Organobromo Compounds

Chemical elements can have vastly different properties and toxicological profiles depending on the form or compound they are in. Consider chlorine – everyone uses ordinary table salt in their food, but bleach is a strong oxidizer with disinfectant properties, able to dissolve materials and burn skin. Both compounds are based on the chlorine atom, but they have vastly different properties since the chlorine is adjacent to different atoms in the two compounds.

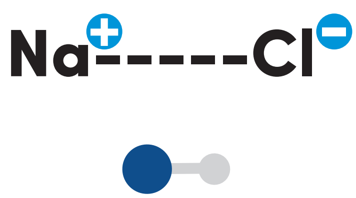

FIGURE 1 Table salt

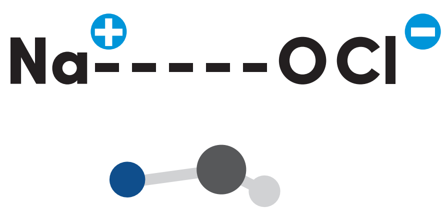

FIGURE 1 Bleach

Chemistry is full of examples like this. The point is, compounds must be analyzed and investigated independently; although trends are often apparent and some properties predictable, chemistry is at its heart an empirical science.

Processed foods often require compounds with certain "technical effects" to accomplish certain challenges such as suspension, emulsification, thickening, etc. Beginning in the 1930s, it was discovered that by attaching bromine atoms to a lipid (oil) molecule, the density of the oil could be precisely controlled and matched to that of a beverage. By dissolving flavor oils in this brominated vegetable oil (BVO), the flavor oil would stay suspended in the drink instead of floating to the surface.

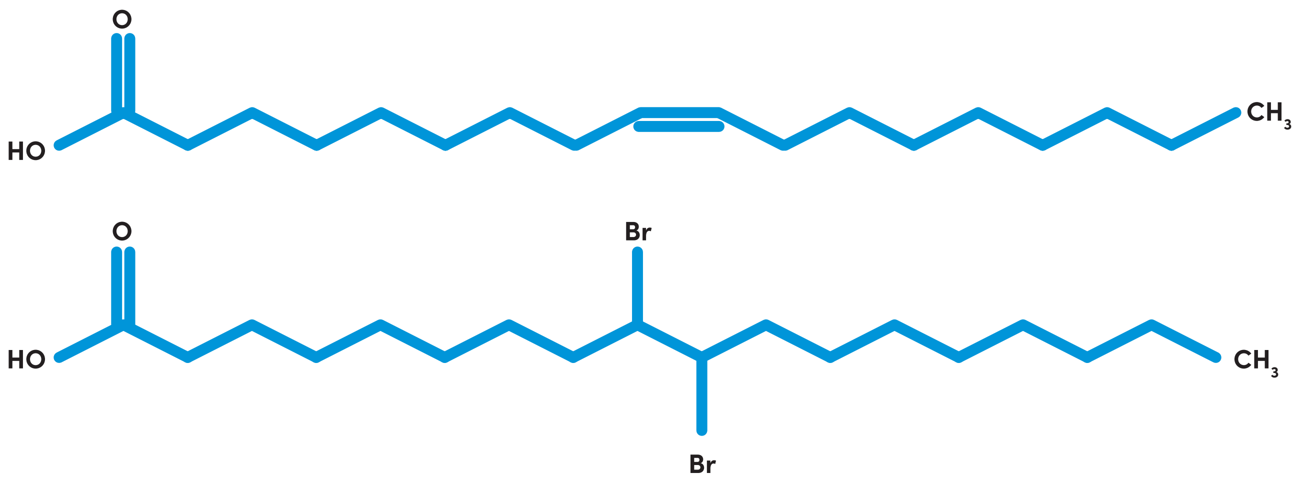

FIGURE 3 Bromination process of oleic acid, a component of vegetable oil.

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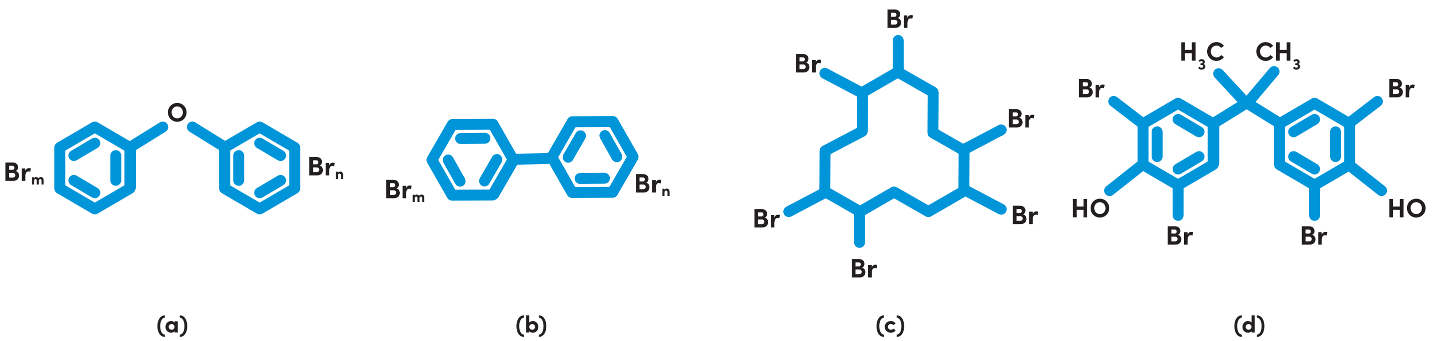

FIGURE 4 Example bromine-based flame retardants. (a) PBDE, (b) PBB, (c) HBCD, (d) TBBPA.

Additionally, brominated products such as polybrominated diphenyl ethers (PBDEs), polybrominated biphenyls (PBBs), hexabromocyclododecane (HBCD) and tetrabromobisphenol A (TBBPA) have found widespread use as flame retardants.

What all of these bromine products have in common is that they are based on a backbone of carbon atoms and are known as organobromines. A common theme in chemistry is that "like dissolves like" (i.e. non-charged compounds such as oils dissolve other oils, charged compounds such as water dissolve other charged compounds such as many salts), so it may come as no surprise that studies have indicated that these carbon-based bromine compounds tend to bioaccumulate (that is, are selectively stored and build up) in the fatty tissues of the body, specifically the heart and liver (Jones 1983; Munro 1972; Farber 1976; Crampton 1971). Around this same time, a number of studies drew correlations between use of BVO in certain countries and an elevated level of lipid-bound bromine in those countries' inhabitants (Bendig 2012). It is for this reason that many countries have banned the use of BVOs or limited their use to very low levels.

However, while the main breakdown product of hypobromous acid (the active molecule in Enviro Tech's HB2® antimicrobial product) is bromine based, it is entirely inorganic, meaning it is not a large carbon based compound. Hypobromous acid naturally decomposes to bromide ion after it has been sprayed on an animal carcass. Thus, it is analogous to common sodium chloride table salt, consisting of simply sodium ion and bromide ion and possessing a very low documented acute toxicity on par with that of table salt (approx. 3500-7000 mg/kg) (van Leeuwen 1983; EMEA 1997). Perhaps for this reason then, more important than any acute toxicity effects are chronic toxicity effects. The same previously mentioned reports establish a no observable effect level (NOEL) of 4 mg/kg/day, and consequently an acceptable daily intake (ADI) of 0.12-0.4 mg/kg.

For a small 18 kg child and using the lowest ADI estimate of 0.12 mg/kg, this would be equivalent to eating 2.0 kg of HB2® treated beef per day. For an 80 kg adult, this would be 8.7 kg of HB2® treated beef per day. Furthermore, this is a worst-case scenario regarding inclusion of bromide on the beef, assuming all of the beef eaten by these people came from the outermost treated surface of the meat.

While there is the potential for very minor breakdown products or disinfection byproducts of bromine biocides, careful analysis as part of a dietary safety assessment has indicated that if present, these occur at insignificant levels (Turnbull 2011)

Indeed, bromide ion is already a component of the human diet. Due to natural occurrence of bromide in minerals and seawater, the estimated typical daily dietary intake from natural sources in the United States is already 2-8 mg (Nielsen 2009), while in the Netherlands that level may be as high as 8.4-9.4 mg/day (EMEA, 1997). These levels are already much higher than would be expected from consumption of HB2® treated beef. Extensive research on acute, subchronic, and reproductive toxicity, as well as effects on humans, led the World Health Organization (WHO) to conclude that "bromide ion has a low degree of toxicity; thus, bromide is not of toxicological concern in nutrition." Furthermore, they added that some findings even indicate that bromide may be "nutritionally beneficial." (WHO 2009)

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