Antioxidant Impact of Condensed Natural Smoke

When man first started cooking his meat over a wood fire, he found that the partial cooking and smoking protected his meat from the usual spoilage problems of souring or putrefaction which he experienced with unprocessed meat.

Wood smoke contains numerous smoke flavor compounds, derived from the wood lignin, a plant antioxidant. The high-boiling phenolic fraction provides the primary antioxidant properties of smoke.8 These smoke flavor compounds are the primary source of smoke's flavor and aroma properties. A certain number of these components have antimicrobial properties, particularly against Listeria, Staphylococci, Bacilli and yeasts. Smoke flavor compounds possessing the highest level of antioxidant properties include: Syringol (2, 6-dimethyloxyphenols), Eugenol (4-Allyl-2-methoxyphenol), Catechol, Iso-eugenol, and the 4-substituted Syringols.9 These smoke flavor compounds are similar in chemical structure to the commonly used synthetic antioxidants such as BHA, BHT, and TBHQ: each contains an aromatic ring with hydroxyl (-OH) groups containing "mobile" hydrogens. These hydrogen groups can efficiently scavenge peroxyl free radicals and reduce and chelate the ferric ion, hence, their power to inhibit the catalysis and propagation of oxidation.10

Definition of Oxidation: The oxidation of unsaturated fatty acids and phospholipids is a primary factor affecting the quality and acceptability of muscle foods.1,2 Oxidation of lipids, as well as amino acid components of proteins, the heme group of myoglobin, and tissue vitamin components results in discoloration, drip losses, off-odor and off-flavor development (rancidity), texture defects, nutrient loss, and the production of potentially toxic compounds.1,2,3

Oxidation of the muscle food's fat content involves a lengthy series of reactions that are initiated with the reaction of oxygen to the double bond of an unsaturated fatty acid. The initiation reaction creates a free radical as a hydrogen atom which is extracted from the carbon atom adjacent to the fatty acid's double bond. A free radical is a highly reactive atom, ion, or molecule having unpaired electrons.4 Initiators of the oxidation sequence include heat, light, metal ions, freezing, salt, oxygen, enzymes, and alkaline conditions.

Following initiation, a propagation reaction occurs in which the free radical reacts with an oxygen molecule to form a peroxyl radical. This radical, in turn, extracts a hydrogen from another fatty acid, thus, propagating the autoxidative reaction.5 Each single free radical formed can stimulate 500 more propagation cycles.6 The hydro peroxides, which are formed from this propagation reaction series, are the major initial oxidation products.

The peroxides then decompose into aldehydes and ketones – compounds that are responsible for the rancid and warmed-over flavors of muscle foods.5,7 Factors that can influence the rate of lipid oxidation in such foods include: grinding; exposure to oxygen, salt and associated impurities; unbound water, spices and other pro-oxidants; mineral content of added water; heme (pigment) and non-heme iron; heating; freezing; and exposure to light.1

Oxidation Prevention: Various processes and ingredient applications can provide protection against or delay the onset of oxidative rancidity. These include:

- Eliminating oxygen through vacuum blending and packaging.
- Reducing oxidative "initiators." Use sequestrants or chelating ingredients such as polyphosphate blends, citrates, ascorbates, etc. to bind or tie up the pro-oxidant metal cations such as iron and copper.
- Using feed supplements such as vitamin E which will stabilize tissue phospholipids, a significant source of rancidity.

- Avoiding raw materials that may already have gone into the "initiation" phase.

- Using synthetic (propyl gallate, BHA, BHT, TBHQ) or natural (rosemary, green tea, sage, and other) botanical extracts having antioxidant properties. These antioxidants inhibit lipid oxidation by scavenging free radicals.

- Using Condensed Natural Smoke™ internally in products that are to be smoke processed.

Not all smoke flavor compounds are equal in their antioxidant ability. More research is necessary to identify the impact of separate smoke flavor compounds on the oxidative process in meats. From earlier Red Arrow studies9, CharOil® and AroSmoke P-50, tested at levels of 0.2% and 0.4% and 0.04% and 0.02% respectively, provided equal to or better protection against oxidation in a pork fat system, than did the synthetic antioxidants, BHA (0.02%), BHT (0.02%), and Propyl Gallate (0.1%).

However, when 0.2% levels of singular natural smoke flavor compounds were compared to 0.02% each of the antioxidants BHT and BHA, the synthetic antioxidants were more effective than the singular and more concentrated smoke flavor compounds. Apparently, mixtures of the smoke flavor compounds, as contained in a standard Red Arrow Condensed Natural Smoke™, provide a synergistic antioxidant impact greater than that of a higher load of a single smoke flavor compound.

Other research has shown significant antioxidant activity in salmon treated with Condensed Natural Smoke™ and traditional smoke.11,12 USDA-ARS scientists, in studying the impact of hickory smoking (traditional) on the storage quality of oils extracted from salmon, found that the smoking process (five hours at 45-95°C) provided antioxidant protection for the polyunsaturated oils (PUFA), greater than that provided by the synthetic antioxidants ethoxyquin (EG) and butylated hydroxytoluend (BHT). Additionally, they found that the smoke process imparted valuable antioxidant potential to the extracted oils. The USDA results suggest that smoking will extend the usefulness of these marine oils for nutritional supplement (EPA & DHA) and flavoring applications.

Likewise, the smoke processing may permit processors additional time to extract valuable marine oils.12 As an extension of the USDAARS work, the University of Maine has begun research on applications of the USDA-produced smoked salmon oils as a nutritional supplement to value-added foods. To date, they have successfully produced a cheese product of industry interest – one that improved the antioxidant properties of the cheese-making process.13

To better understand the impact of our internal Condensed Natural Smoke™ on the oxidative stability of smoked, food-service non-MAP bacon, Red Arrow has initiated a storage studyto evaluate the impact of AroSmoke™ 8068 (0.09% internal) on the oxidative quality of the bacon (frozen storage to 120 days).
This study was commissioned to support the premise that bacon containing AroSmoke™ 8068 internally and drenched with CharSol® 5105 externally, in addition to traditional smoke, would yield bacon that would retain a more fresh flavor (less oxidized and rancid tasting) and be more consistent than bacon not containing these ingredients. The approach was to review the bacon both subjectively and objectively through analytical testing for TBA (a common chemical measure for oxidative rancidity).

Bacon containing the AroSmoke™ 8068 at the 0.09% in going level and drenched with CharSol® 5105 had significantly less ($P<0.01$) oxidized/rancid off flavors than bacon originating from the same bellies absent these natural liquid smoke condensates. Furthmore, the bacon containing the liquid smoke condensate had a much lower statistical variance ($P<0.01$) among samples when compared with samples not containing it. This data was derived from sensory panelists skilled at identifying oxidate rancidity.

Further, using an analytical measure for oxidative rancidity, the Condensed Natural Smoke™ not only delayed the onset of rancidity as reflected in the TBA data, it depressed it throughout the entire life cycled of the product ($P<0.01$). It is important to recognize that because of biological variation which can contribute skewing results, this data was generated from bellies were split in half so an individual belly served as both treatment and control

the test design.

With certainty, one can conclude that Condensed Natural Smoke™ incorporated into bacon was effective in reducing/eliminating oxidative rancidity as perceived by very experienced bacon tasters, reduced the variation, and further, the chemical assessment of the fat was consistent with the taste panel results.
Therefore, consistency and desirability are both increased as result of inclusion of the Condensed Natural Smoke™ (AroSmoke™ 8068) in bacon.

References:

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