

Popular Article

Role of Plant Based Antioxidants in Meat Products

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Introduction

In addition to serving as structural elements of muscle membranes, triacylglycerol storage droplets between muscle fibres, and adipose tissue, lipids and their byproduct fatty acids are found in muscles. In the end, the sensory and nutritional quality of meat products is determined by the kind and nature of these fatty acids, which also determine colour stability, drip loss, and the onset of oxidative rancidity (Baer and Dilger, 2014). After perceived economic value, the meat's appeal to the consumer is primarily determined by color and flavor (Bryhni *et al.*, 2002). Meat gets brown as it matures because myoglobin is changed into metmyoglobin (MetMb: oxidised form). This is the fundamental reason why consumers reject meat and meat products. The lipid oxidation rate is directly proportional to the unsaturation of fatty acids, which ultimately decides the color and oxidative stability of meat products (Gatellier *et al.*, 2010). Antioxidants are added to stabilize free radicals there by delaying lipid and protein oxidation, retard development of off-flavors and improve color stability.

Oxidation in Meat: Oxidation is process in which a chemical substance changes because of the addition of oxygen. Oxidation of muscle lipid includes mainly unsaturated fatty acids in triacyl-glycerols. Lipid oxidation is described as an oxygen dependent oxidative deterioration of saturated and unsaturated fatty acids.

Mechanism of Lipid Oxidation: Three phases- Initiation, Propagation and Termination

1. Initiation: In this, the presence of prooxidants (P₀), or reactive oxygen species (ROS), or any other oxidation-favorable condition, results in the loss of a hydrogen radical from unsaturated fatty acids. In the absence of such oxidation-favorable conditions, the reaction between fatty acids and oxygen molecules cannot occur because of the unequal electronic state and spin barrier posed by these ground states. Thus, the ROS or other P₀, after thermal, redox, or light reaction can produce free radicals, and thus starts the primary reaction of lipid oxidation.

Radical formation



Initiation



2. Propagation: In this, molecular oxygen reacts with the alkyl radical of an unsaturated fatty acid and results in peroxide radical formation. In a subsequent reaction, the formation of hydro peroxides occurs because of the adverse conditions present in the muscle foods the hydro peroxides become susceptible to further free radical chain reactions, such as isomerization and decomposition. Thus producing the secondary products; pentanal, hexanal, 4-hydroxynonenal, and malondialdehyde (MDA).

Propagation



3. Termination: The last stage is known as termination reaction, during which the free radicals react in various combinations to form stable products. Other unstable compounds are also formed during the termination reaction, which also affect the quality of meat products and give rise to an unpleasant flavor (taste and odor) (Masuda *et al.*, 2010).

Termination



Stages of Lipid Oxidation

According to Thurnham (1990), there are 3 stages where lipid oxidation can take place:

1. Pre-Slaughter (live muscle), In live animals, intrinsic factors are available that can control the oxidation reaction in muscular tissues, such as enzymes (superoxide dismutase, catalase, and so on) and certain proteins and their mechanisms (transport proteins), or oxidative reaction-breaking antioxidants (Vitamin E and C) (Thurnham, 1990).

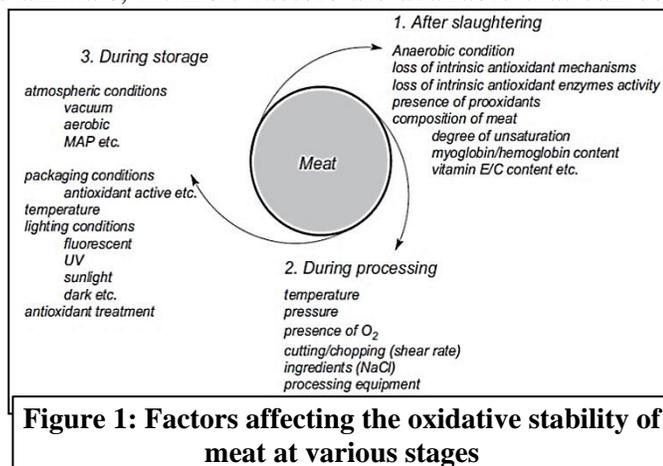


Figure 1: Factors affecting the oxidative stability of meat at various stages

2. **During Slaughtering** (conversion of muscle to meat), After slaughtering, these factors lose their anti-oxidative potential due to various post-slaughter conditions, such as anaerobic environment, presence of pro-oxidants (P_0), and lack of enzymatic anti-oxidative mechanisms (Carlsen *et al.*, 2005). Hemoglobin and myoglobin, which are also considered as pro-oxidants (Chan *et al.*, 1997), along with other processing parameters, result in lipid oxidation during processing and storage of meat and meat products.

3. **After Slaughtering** - processing and storage

Natural Antioxidants

Antioxidants are compounds that inhibit oxidation, a chemical reaction that can produce free radicals and chain reactions that may damage the cells of organisms. These are added to different meat products to prevent lipid oxidation, retard development of off flavors and improve color stability. They can be divided into natural and synthetic antioxidants.

Compound	Source
Vitamin C	Citrus fruits
Vitamin E (Tocopherol)	Cereal grains, oil, green vegetables
β -carotene	Carrot, papaya
Flavonoids	Tea, red wine, vegetables
Anthocyanin	High in Red wine, blueberry, blackberry,
Polyphenols	Tea, grape juice
Lycopene	Tomato, watermelon etc
coQ10	Wheat bran, fish.

Figure 2: Sources of different Natural Antioxidants

Table 1: Mechanism of Action of Natural Antioxidants

Antioxidant Class	Mechanism	Examples
Proper antioxidants	Inactivating lipid free radicals	Phenolic compounds
Hydro Peroxide Stabilizers	Decomposition of hydro peroxides into non free radicals	Phenolic compounds
Synergists	Promoting activity of proper antioxidants	Citric acid, ascorbic acid
Metal Chelators	Binding heavy metals into active compounds	Phosphoric acid , Maillard, Citric Acid
Single oxygen quenchers	Trans forming Singlet oxygen into triplet oxygen	Carotenes
Substances reducing hydro peroxides	Reducing hydro peroxides in a non-radical way	Proteins, amino acids

Table 2: Commercially available natural antioxidant

S.N.	Extracts	Meat and meat products
1.	Grape seed extract	Raw and Cooked pork patties
2.	Proteases	Dry cooked pork sausage
3.	Rosemary extract	Liver pate
4.	Ammonium hydroxide	Ground buffalo meat patties

Conclusion

Synthetic antioxidant has been confirmed for their toxicological and carcinogenic effects whereas natural antioxidants are the sources to replace synthetic antioxidants because of the negative health consequences. Thus, meat industry is demanding antioxidants from natural sources to replace synthetic antioxidants as it will also increase the consumer acceptability of the product along with the prevention of oxidation, it can prevent cancer, heart problems and plaques formation.

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