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# GRAPE ANTIOXIDANTS IN MEAT AND MEAT PRODUCTS

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***Abstract:*** *Lipid oxidation is one of the biggest important problems that reduce the shelf life of meat and meat products. Delaying the oxidation of lipids and development of unpleasant odors, as well as improving color stability is done with the help of antioxidants. Antioxidants are divided into two groups - natural and synthetic. Synthetic antioxidants intake leads to cancer and acute toxicity. Therefore, in recent years, the food industry prefers natural to synthetic antioxidants. This review presents current trends in the use of antioxidants from grape extracts to inhibit lipid oxidation of meat and meat products. The results show that grape seed contains effective antioxidants for use in meat and meat products and those natural antioxidants can completely replace synthetic ones.*

***Keywords:*** *lipid oxidation, meat, meat products, antioxidants, grape seed*

## INTRODUCTION

The quality characteristics of meat products deteriorate due to the oxidation of lipids during their processing and storage. Fat oxidation (turning rancid) is the attachment of oxygen atoms to unsaturated bonds in fat chains and the formation of free radicals and lipid peroxides. Lipid peroxides are additionally susceptible to oxidation or decomposition to secondary oxidizing products, such as aldehydes, ketones and other oxidizing compounds, which do not have a good effect on the properties of the product. (Maqsood and Benjakul 2011), and which may cause health hazards and economic losses due to lower product quality (Naveena et al. 2008). Antioxidants are compounds that effectively minimize rancidity, slow down the oxidation of lipids without damaging their sensory or nutritional properties, which leads to maintaining the quality and shelf life of meat products. Synthetic antioxidants are widely used in the meat industry, but consumer concerns about their toxicity and safety and are prompting the food industry to look for natural antioxidants from natural sources (Coronado et al. 2002). The growing awareness of consumers about the severe toxicity, carcinogenicity and potential health hazards of synthetic antioxidants is increasing the interest in the use of natural antioxidants in the food industry (Bulambaeva et al. 2014).

## EXPOSITION

### 1. Lipid Oxidation in Meat and Meat Products

Lipid oxidation is described as the oxidation of saturated and unsaturated fatty acids. This modification of fatty acids is carried out mainly by an autocatalytic mechanism of free radicals, called auto oxidation and consisting of 3 phases: initiation, reproduction and termination. Lipid oxidation can take place in 3 stages: before slaughter (live muscle), during slaughter (conversion of muscle into meat) and after slaughter (processing and storage), Table 1. In living animals, there are inherent factors that can control the oxidative reaction in muscle tissue, such as enzymes (superoxide dismutase, catalase, etc.) and certain proteins and their mechanisms (transport proteins) or antioxidants that disrupt the oxidative reaction (vitamin E and C), (Thurnham 1990). After slaughter, these factors lose their antioxidant potential due to various post-slaughter conditions, such as anaerobic environment, presence of pro-oxidants and lack of enzymatic antioxidant mechanisms (Carlsen et al. 2005). Hemoglobin and myoglobin, which are also considered pro-oxidants (Maqsood and Benjakul 2011b; Maqsood et al. 2012), together with other processing parameters, lead to lipid oxidation during processing and storage of meat and meat products. The

complex process of lipid oxidation is influenced by many factors, such as the chemical structure of the meat, access of oxygen and light, storage temperature, and some technological procedures during processing. It is necessary to monitor these factors not only in the raw material, but also during its processing and storage of the finished product.

Table 1. Factors affecting the oxidative stability of meat at various stages

| **1. After slaughtering** | **2.During processing** | **3. During storage** |
|---|---|---|
| Anaerobic condition | temperature | atmospheric conditions – vacuum,aerobic, MAP etc. |
| loss of intrinsic antioxidant mechanisms | pressure | packaging conditions antioxidant active etc. |
| loss of intrinsic antioxidant enzymes activity | presence of $O_2$ | temperature |
| presence of pro-oxidants | cutting/chopping (shear rate) | lighting conditions – fluorescent, UV, sunlight, dark etc. |
| composition of meat | ingredients (NaCl) | antioxidant treatment |
| degree of unsaturation | processing equipment | |
| myoglobin/hemoglobin content | antioxidant treatment | |
| vitamin E/C content etc. | | |

## 2. Antioxidants used in Meat and Meat Products

Antioxidants as compounds are capable of producing hydrogen (H) radicals (Masuda et al. 2001) to pair with other available free radicals to prevent the propagation reaction during the oxidation process. Synthetic antioxidants are still widely used in food industry. In industrial processing, the most commonly used synthetic antioxidants are butylated hydroxyanisole (BHA), butylated hydroxyl toluene (BHT), propyl gallate (PG), which are added to delay lipid oxidation, prevent adverse reactions and to increase the shelf life of the meat. The advantages of natural antioxidants are as follow: improving the overall quality and nutritional value of meat by slowing or inhibiting lipid oxidation, providing healthy food, not damaging the desired sensory characteristics for the consumer, extending the shelf life by inhibiting the growth of food pathogens and prevention of economic losses (Barbosa-Pereira et al., 2015). An important advantage of natural oxidants is the fact that they have got not only antioxidant but also antimicrobial activity (Reham et al. 2017). As natural antioxidants, in the meat processing industry, can be used plant extracts - fruits, vegetables, herbs and spices, such as those containing phenolic compounds. For meat and meat products the antioxidants derived from extracts of grape seeds, skins, and grape juice are very suitable.

## 3. Natural antioxidants from grape used in Meat and Meat Products

Different types of grapes contain different types of antioxidants, in different amounts. Red grapes have more antioxidants than white grapes, but add a red color to the products. In addition, there is a variation of antioxidants in grape juice, seeds and husks. A direct comparison of polyphenols analyzed in grape skins and seeds with those found in their respective grapes reveal that they have different qualitative and quantitative profiles. The seeds show a total phenolic number ranging between 3313.5 and 825.80 mg/100 g gallic acid equivalents, which are approximately 20 times higher than that determined in grapes. The values of the total phenolic number for grape skins are significantly smaller than those of seeds, vary between 64.50 and 351.97 mg/100 g equivalents of gallic acid, but are about 2 times higher than those found in grapes. The seeds are especially rich in monomeric flavan-3-ols: (+) - catechin, (-) -epicatechin, epicatechin

gallate and dimers of procyanidins B2, B3 (Table 2). Grape skin extracts contain mainly flavanol glycosides. Among the glycosides, quercetin- 3-O-galactoside is in the largest amount, while quercetin- 3-O-glucolyside and quercetin-3-O-rhamnoside are in smaller amounts. The stilbenes trans-resveratrol and e-viniferin are present in relatively small amounts in skin extracts. Many authors prove that grape seeds and skins are rich in phenolic compounds with high antioxidant and antimicrobial activity (Guendez et al. 2005).

Table 2. Antioxidants from red grape seeds and skins

| Grape seeds | Grape skins |
|---|---|
| dimers of proanthocyanidins B2, B3<br>oligomers of flavan-3-ol:<br>(+) - catechin,<br>(-) - epicatechin,<br>epicatechin gallate | quercetin- 3-O-galactoside<br>quercetin- 3-O-glucolyside<br>quercetin-3-O-rhamnoside<br>trans-resveratrol and e-viniferin |

Grape seeds and skins are by-products of wine production. In wineries, residues represent approximately 30% of the total volume of grapes and waste poses serious problems in their storage, processing and disposal in environmental and economical terms (Rockenbach et al. 2008). The utilization of these waste products for inhibition of lipid oxidation of meat and meat products is a very significant advantage. Antioxidants from red grape seeds and skins are suitable for red meat, as their red color does not interfere with or impair the sensory characteristics of meat products. For this reason, they are important for preserving the organoleptic properties of raw-dried sausages for a longer period of time, and thus for extending their shelf life, as they have the ability to slow down the fat oxidation (rancidity) processes in meat. Grape seeds are preferred because they contain more phenolic compounds. They are extracted as a by-product of grape juice and wine production. They are ground, dried and an extract containing phenolic compounds is extracted from them (Lau et al. 2003). Clinical data show that the antioxidant potential of grape seeds is twenty-five times greater than that of vitamins E and C (Shi et al. 2003).

This is due to the high content of proanthocyanidins and oligomers of flavan-3-ol units, especially catechin and epicatechin, present in grape seed extract (Yilmaz et al. 2004). The antioxidant activity of grape seed extracts has been reported in several reviews (Shi et al. 2003, Rockenbach et al. 2008). There are publications describing the antimicrobial properties of grape seed extracts against gram-positive and gram-negative bacteria (Jayaprakasha et al. 2003). Grape seed extract effectively reduces the number of *E. coli*, slows the growth of *S. typhimurium* and on *L. monocytogenes* in cooked minced beef (Ahn et al. 2007). From a healthy point of view, grape seed extract has been shown to act as an anti-carcinogen (Roy et al. 2002) and a cardio-protective agent (Shafiee et al. 2003).

A relatively small number of publications are known on the application of antioxidants from grape seeds in various types of meat and meat products. Lau and King 2003 found that grape seed extract added in quantities of 10 and 20 g/kg in turkey meat reduced lipid oxidation tenfold compared to the control sample. The authors suggest that the optimal amount of grape seed extract added to turkey meat is between 1 and 10 g/kg of turkey meat. Other authors have studied the effectiveness of four concentrations of grape seed extract (0.0, 0.4, 0.8 and 1.6 g/kg) in delaying the oxidative rancidity of cooked turkey meat. (Mielnik et al. 2003). The addition of grape seed extract before cooking significantly improves the oxidative stability of minced turkey meat during heat treatment and storage. The ability of grape seed extract to prevent lipid oxidation depends on the concentration. The vacuum packaging significantly improves the oxidative stability of the meat, despite the low concentration of the grape seed extract used. It has been found that grape seed extract can be very effective *for* inhibition of lipid oxidation of cooked turkey meat during cold storage. It has been proven, that extracts of red grape seeds show good antioxidant properties on the lipid oxidation of chicken dumplings (Brannan, et al., 2008).

Experiments were also conducted with beef and veal. Garcna-Lomillo et al. (2017) indicate that beef scallops treated with red grape seeds and skins extract have low lipid oxidation. The

extracts have also been reported to improve the oxidative stability of boiled beef (Ahn et al., 2002). Colindres and Brewer, 2011, study the inhibition of oxidation of raw and cooked beef dumplings from grape seed extract. They found that the studied extract was much better than the protective properties of BHA and BHT.

Grape seed extract is very suitable to be added to minced meat and sausages. Kulkarni et al., 2011 compare the action of grape seed extract (GSE) with ordinary antioxidants in a pre-cooked, frozen, preserved meat model (systemic sausage) made from lean beef (70%), lard (28%) and salt (2%). Antioxidants from grape seed extract (100, 300 and 500 ppm) were added to the minced meat. For comparison, samples were taken with ascorbic acid (100 ppm fat) and propyl gallate (100 ppm fat) and a control sample. The product is formed into rolls, frozen, cut into thin pieces, cooked on a flat grid to 70°C, wrapped in PVC, and then stored at -18°C for 4 months. Samples with grape seed extract and propyl gallate retain the odor and aroma of fresh beef longer than the control sample and the ascorbic acid sample during storage. Sasse et al. 2009 prove that grape seed extract has the potential to inhibit the lipid oxidation of pork sausages equal to the potential of the currently used synthetic antioxidants. Lorenzo et al. 2013, 2014 tracks the impact of grape seed extract on the quality of dried sausages "chorizo". It has been found that the quality of the sausage improves and the shelf life of the product increases. The effect of grape seed extract and chestnut and synthetic antioxidant (butylated hydroxytoluene) on physicochemical indicators, lipid oxidation, microbial and sensory characteristics of dry fermented sausages were studied during the ripening period (Mielnik et al. 2006). The results show that grape seed is an effective antioxidant and that natural antioxidants are more effective than synthetic antioxidants. This study proves that grape seed extracts can be used in the production of dried sausages to improve their quality and provide safer products.

## CONCLUSIONS

Finally, when used as antioxidants for product quality preservation, these natural compounds can also be regarded as nutraceutical ingredients or supplements for health promotion. Indeed, plant derived antioxidants provide meat processors with the flexibility to develop novel products with enhanced nutritional value and health benefits and an attractive overall quality profile.

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