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Review

Main characteristics of peanut skin and its role for the preservation of meat products

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ABSTRACT

Background: The produced peanuts by-products are a huge challenge, but they are recognized to be a source of valuable nutrients, including natural antioxidants and antimicrobials. Antioxidants are considered as necessary ingredients in food to prevent oxidative reactions and their undesirable effects in food quality during processing and storage. However, the use of such compounds is regulated due to their harmful effects revealed by *in vitro* and *in vivo* studies. The use of natural antioxidants appears as an interesting alternative for food producers, particularly meat industries.

Scope and approach: Peanut skin (PS), a by-product of peanut processing in agro-industries, constitutes an under-explored source of natural antioxidants. Thus, this review was focused on both the reuse of peanuts by-products and societal health, reducing the use of synthetic antioxidants and antimicrobials.

Key findings and conclusions: Proanthocyanidins are the main compounds in PS that are associated with the antioxidant activity *in vitro* and its protective effect in meat products. Studies in recent literature strengthen the role of PS as a natural source of antioxidants wherein oxidative reactions involving mainly pigments, lipids and proteins are delayed.

1. Introduction

The concepts and goals involved in production of meat and meat products have been evolving during the last decades partially due to consumer´s growing knowledge about the relationship between food composition and health. General quality and safety became expected characteristics while the preference for natural additives instead of chemical ones, the perception of potential harmful effects of chemical additives and the general health interest gained more importance in purchase intention of meat and meat products (Fernandes, Trindade, Lorenzo, & de Melo, 2018; Hung, de Kok, & Verbeke, 2016; Jayasena & Jo, 2013).

To attend consumer's expectations regarding healthy aspects, food manufacturers, producers and researchers are constantly searching for natural alternatives to synthetic additives (Fernandes et al., 2017; Lorenzo et al., 2018). One of the main food additives involved in this context are the antioxidants, which are widely used in food industry to delay oxidative reactions during processing and storage (Agregán et al., 2017). However, the consumption of synthetic antioxidants such as butylated hydroxytoluene and butylated hydroxyanisole (BHT and BHA, respectively) is suggested to be limited due to harmful effects reported in several *in vitro* and *in vivo* studies (EFSA, 2011; EFSA, 2012).

In this context, replacing synthetic antioxidants by natural compounds is considered as a useful strategy to prevent lipid oxidation of meat products (Fernandes et al., 2016a; Pateiro, Lorenzo, Amado, & Franco, 2014). The group of phenolic compounds, naturally present in plant tissue and widely distributed in nature, plays a central role in this strategy. Beverages, vegetables, fruits and legumes are main sources in the human diet (Shahidi & Ambigaipalan, 2015). However, residues from agro-industry rich in phenolic compounds are discarded worldwide and thus, a relevant amount of natural antioxidants that could be used as high added value products is lost (Moure et al., 2001;

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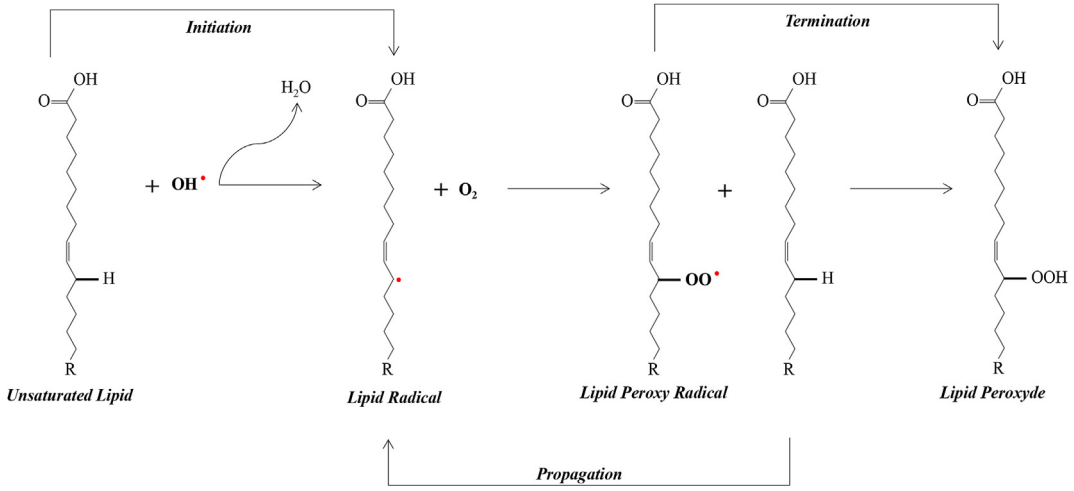

Fig. 1. Process of lipid oxidation of unsaturated fatty acids.

Munekata, Franco, Trindade, & Lorenzo, 2016).

Nowadays, the peanut is consumed all over the world due to its unique flavor and versatility in processing. According to the United States Department of Agriculture (USDA), the production of peanuts has increased. The current global production is 42.29 million metric tons, being China the main producer, followed by India, Nigeria, and the United States of America (USDA, 2017). Over 0.93 million metric tons of peanut skins (PS) are produced annually worldwide as a by-product of the peanut processing industry (Davis & Dean, 2016, pp. 289–345). PS is the nontoxic pink-red layer that covers peanuts and is the primary residue of peanut processing, which represents less than 3% of peanut weight. This by-product has limited applications in industry due to its low commercial value. In addition, the use of PS in animal feed is limited to a minor component due to their high content of tannins and low-calorie level (Francisco & Resurreccion, 2009; Sobolev & Cole, 2004). On the other hand, hazelnut skin, which is a by-product of roasting, is a source of phenolic compounds and possess stronger antioxidant activities than those of their kernel and other tree nut by-products and can be considered as a value-added for nutraceutical, cosmeceutical and pharmaceutical applications (Alasalvar et al., 2009; Alexandru et al., 2014; Contini, Baccelloni, Massantini, & Anelli, 2008; Del Rio, Calani, Dall'Asta, & Brighenti, 2011; Locatelli et al., 2010).

Recent research has shown that PS is an excellent source of phenolic compounds, particularly proanthocyanidins, among peanut constituents (skin, hull and kernel) (Win et al., 2011). In folk medicine, PS is commonly used in China to treat hemorrhage and bronchitis (Lou et al., 1999). Regarding sensory properties, Hathorn and Sanders (2012) indicated that the addition of 1% PS did not change intensity of descriptors in the sensory profile. However, the addition of 5% PS resulted in significant differences in bitter and astringent descriptors and 10% PS addition resulted in significant differences in most attributes toward more negative flavour, indicating a potential limited application for PS. Due to the potential use of peanut skin as natural antioxidant, this review provides an overview of the studies regarding the phenolic composition, antioxidant and anti-microbial potential of peanut skin and their effects in ground meat and meat products.

2. Oxidative reactions and quality loss in meat and meat products

The quality of meat and meat products decays during storage (Lorenzo, Pateiro, García Fóntan, & Carballo, 2014a). Microbiological growth and oxidative reactions play a central role in meat and muscle products deterioration resulting in unacceptable products from a sensory and microbiological point of view (Lorenzo, Batlle, & Gómez, 2014b). The microbial growth in meat leads to visual perception of slime and colonies, discoloration (reducing of redness), formation and accumulation off-flavors and off-odors, gas production (microbial metabolism) and pH decrease (Gómez & Lorenzo, 2012).

On the other hand, oxidative reactions degrade lipids and proteins due to the formation of free radicals (high reactivity intermediate compounds). The reduction/loss of characteristic cherry-red color, accumulation of volatile and non-volatile compounds which confer rancid odor and off-flavor, loss of protein and lipid stability and functionality, reduction in nutritive value and accumulation of compounds with potential harmful effect have been related to oxidative reactions in lipids and proteins (Falowo, Fayemi, & Muchenje, 2014).

In lipid oxidation, the first stage is known as *initiation* and is characterized by the formation of alkyl free radicals due to reaction of unsaturated fatty acid with oxygen radicals and transition metals. In the second stage (*propagation*), alkyl radicals react with triplet oxygen and generate peroxyl radicals. These radicals are highly reactive and abstract hydrogen atoms from unsaturated fatty acids that form hydroperoxides and new alkyl free radicals. The production of new alkyl radicals is the center of propagation stage and disseminates the oxidation of unsaturated fatty acids with an increasing rate. Finally, the *termination* is the last stage of lipid oxidation wherein radicals form non-radical products that are more stable than free radicals involved in the *propagation* stage (Berton-Carabin, Ropers, & Genot, 2014) (Fig. 1).

The progress of lipid oxidation, particularly due to decomposition of hydroperoxides, can lead to remarkable changes in flavor of meat and meat products. The hydroperoxide decomposition forms several compounds such as aldehydes that contribute, in some extension, to characteristic flavor of meat and meat products (Purriños, Franco, Bermudez, Carballo, & Lorenzo, 2011). However, the accumulation of such compounds can be sensorial perceived as undesirable rancidity (Frankel, 1991). So, the follow up of volatile compounds accumulation have been commonly used to evaluate the oxidative stability of meat and meat products (Lorenzo, Bedia, & Bañon, 2013). Aldehydes are the main compounds involved in this context due to fast increase of both total aldehyde and individual compounds (*e.g.* heptanal and hexanal) content in meat products (Fernandes, Trindade, Lorenzo, Munekata, & De Melo, 2016b; Jayasena & Jo, 2014; Ross & Smith, 2006).

Similarly to flavor, color is an important attribute in meat and meat products particularly related to freshness perception by consumers (Gonzalo et al., 2015). The characteristic color of fresh meat is attributed to myoglobin. Depending on the iron oxidative state and ligands in the center of the molecule, myoglobin can be found in one of the following three main states: deoxymyoglobin, oxymyoglobin and metmyoglobin. Myoglobin is denominated deoxymyoglobin when iron is in ferrous (+2) form, which renders a purplish-red color. The