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The influential factors in the level of lipid peroxidation of edible butters of animal origin; a review study

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Article Info	Abstract
<p>Article history:</p> <p>Received: 15 March 2024 Accepted: 4 June 2024</p>	<p>Animal butter is very prone to lipid oxidation due to its high fat content. Following the process of lipid oxidation, toxic compounds are produced. In this review study, the factors that affect the level of lipid oxidation in butter were discussed. A search was made in Scopus, PubMed, Science Direct, and Web of Science (WOS) databases with keywords: butter, malondialdehyde, peroxide index, and lipid peroxidation. The obtained results confirmed that the amount of peroxide of butter was completely proportional to their storage conditions. The amount of lipid peroxidation in butters kept at low temperatures and away from light was much lower. Addition of natural antioxidants to butters can be highly effective in reduction of lipid peroxidation. Also, cases of increased lipid peroxidation were seen in traditional butters, indicating the addition of vegetable oils. It can be concluded that this product is sensitive to lipid oxidation and requires special hygienic storage conditions.</p>
<p>Keywords:</p> <p>Antioxidant Butter Lipid peroxidation Malondialdehyde</p>	
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Introduction

Milk and dairy products contain nutrients for people of all ages. Milk fat contains many useful components for human health such as lipid-soluble vitamins, antioxidants, and unsaturated fatty acids. Butter product contains a lot of milk fat (Eghbaljoo *et al.*, 2023; Ghanati *et al.*, 2023; Mahmudiono *et al.*, 2023; Shojaimeher *et al.*, 2023). Butter is considered as one of the most popular dairy products, it is often used in meals and sweets. Also, this earliest dairy product is recognized as a water-in-oil emulsion (Lee *et al.*, 2018). Animal butter has a unique chemical composition compared to other dairy products. It is primarily composed of milk fat, with a minimum fat content of 80% (O'Callaghan *et al.*, 2016). The fatty acid composition of butter encompasses a broad spectrum of fatty acids, with short-chain fatty acids, particularly butyric acid, being a prominent role (Asif *et al.*, 2022). Butter also contains unsaturated fatty acids, including trans-11-C18:1, which is a precursor

for conjugated linoleic acid, a bioactive compound. In terms of cholesterol content, butter has higher levels compared to cheese. Furthermore, butter contains higher protein content compare to cheese, alongside carbohydrates and minerals. Overall, the chemical composition of animal butter differs from other dairy products, making it a unique and nutrient-rich option (Okeke *et al.*, 2016). However, this product is highly susceptible to lipid peroxidation.

Butter is produced traditionally and industrially. Butter should contain at least 80% and maximum 90% milk fat. The type of animal (cow, goat, sheep, and ewes), diet and age of the animal affect the texture and flavor of butter. One of the major problems of butter is its peroxidation, which is usually caused by long-term storage of butter (Akgül *et al.*, 2021). Butter can become rancid due to lipid peroxidation, which can result in the creation of lower molecular weight molecules. Lipid oxidation in animal butter can have a noteworthy influence on its quality and safety. The primary oxidation products such as hydroperoxides, alcohols, aldehydes, free fatty acids, and ketones can lead to butter rancidity. The presence of these

oxidation products can negatively impact the quality and shelf life of the butter, resulting in rancidity and the development of unpleasant odor and taste (Bakirci *et al.*, 2002). Lipid oxidation is a complex set of reactions between lipid compounds and oxygen, and it is the main non-microbial mechanism that leads to the loss of nutritional and sensorial quality of food products, resulting in a decrease in consumer acceptability and potential health risks (Antone *et al.*, 2012). Butter must be produced under controlled and hygienic conditions (Bakirci *et al.*, 2002). The oxidation process is influenced by various factors such as the nature of the lipids, storage conditions, availability of oxygen, light, temperature, and other food components. To prevent lipid oxidation and maintain the quality of butter, strategies such as vacuum packaging, low-temperature storage, and the addition of antioxidants can be employed (Ahmed *et al.*, 2016; Joseph, 2016). In this study, the amount of lipid peroxidation in butter consumed in different countries was reviewed, and the factors affecting this process were discussed.

Materials and Methods

A search was made in Scopus, PubMed, ScienceDirect, and Web of Science (WOS) databases with keywords: butter, malondialdehyde, peroxide index, and lipid peroxidation.

Results and Discussion

Increasing lipid peroxidation in animal butter during production, processing, and storage can be attributed to several factors. Firstly, the higher content of unsaturated fatty acids in milk fat increases the risk of oxidation, which adversely affects the quality and safety of the product (Zhao *et al.*, 2013). Additionally, the temperature and time of storage can also contribute to the higher levels of peroxide in cow butter compared to sheep butter (Méndez-Cid *et al.*, 2017). Furthermore, lipid oxidation is a complex process involving three primary types of oxidative reactions: autoxidation, enzymatic oxidation, and photooxidation (Rustad, 2009). These reactions can occur during the production, storage, and handling of butter, leading to the formation of oxidation products such as hydroperoxides (Bumbadiya *et al.*, 2023).

In the study by Abdeldaiem *et al.* (2014), the peroxide of butter obtained from two species of cattle and buffalo was different. The peroxide of butters obtained from buffalo milk was higher than that of cows (Abdeldaiem *et al.*, 2014). In a study conducted by Ghasemloy Incheh *et al.* (2017) in Iran, they

investigated the amount of peroxide in traditional animal butters. The amount of peroxide in 58.3% of the butters was higher than the permissible limit compared to the national standard of Iran. By further examining the butters, the presence of vegetable oils and contamination with microorganisms was observed (Ghasemloy Incheh *et al.*, 2017). Gonçalves *et al.* (2012) studied on cow butter from 66 butter samples in Brazil. The amount of peroxide was evaluated. The level of peroxides varied from 1.80 to 0.35 mEq/kg. With the exception of one brand, all samples were within the national standard of Brazil. In this study, butter samples that were exposed to oxygen, the amount of peroxide increased significantly and reached the value of 9.9 mEq/kg. It is worth mentioning that the amount of peroxide in the samples at the beginning of the study was 0.61 mEq/kg (Veberg *et al.*, 2007). Strategies such as maintaining products in a dark environment, removing oxygen by creating a vacuum in the packaging, and using antioxidant compounds can help prevent butter oxidation (Koontz, 2016).

A study by Krause *et al.* (2008) in America was conducted on animal butter stored in a refrigerator (temperature of 5 degrees) and frozen. There was no change in the amount of peroxide in butter kept at -18° C after a period of 12 months, and it did not change in butter that was kept at 5 degrees of refrigerator after a period of 14 weeks. It has been observed that increasing the temperature during storage increases the speed of the oxidative process (Méndez-Cid *et al.*, 2017).

The implementation of various techniques to minimize lipid peroxidation in animal butter, including its production, storage, and handling, has shown promising results. Among these techniques, the utilization of natural antioxidants has proven to be highly effective. Natural antioxidants such as potato peel, fenugreek seeds, ginger rhizomes, grape seed extract, grape peel extract, spice extracts, rosemary extracts, clove, cinnamon extracts, tea extracts, grains, oilseeds, sage, cloudberry, beetroot, willow herb, rapeseed, pine bark, and black pepper extract, have been identified as suitable options for this purpose. Incorporating these natural antioxidants into the butter oil treatments has been found to significantly inhibit lipid oxidation and enhance the overall stability of the food product (Yonis *et al.*, 2017; Mahmoud *et al.*, 2021).

Tafreshi *et al.* (2013) employed a polymeric film that was coated with rosemary extract, a natural antioxidant, at varying concentrations of 0.1%, 0.15%, and 0.2% in order to assess its efficacy in inhibiting lipid oxidation in butter samples. Coating of extract on

the surface of polymeric films significantly reduced the peroxide value and free fatty acids in samples. Film coated with the concentration of 0.1% extract showed the most desired oxidative stability and sensory properties. Also, polypropylene film demonstrated greater efficacy in enhancing the oxidative stability of the product compared to polyethylene film. A study carried out by Asha *et al.* (2015) displayed that orange peel can be a rich source of natural antioxidants which can be utilized in fat rich food products such as ghee (butter oil) to delay oxidative deterioration. In addition, the impact of storage temperature on the formation of peroxides in ghee samples exhibited a notably greater influence when compared to the effect of treatment (orange peel extract and BHA) and storage period (21 days). Aydin *et al.* (2020) evaluated the impact of garlic crushed at concentration of 2.5%, 5%, 7.5%, 10%, and synthetic antioxidant (50 ppm) incorporated to butter on both quality properties and oxidation stability through the storage period. The findings indicated that the sample of butter with 5% garlic is the most preferred in terms of sensory characteristics, delaying oxidation and extending shelf life. Pv has been reduced from 0.13 to 0.06 meq/kg oil by adding 5% garlic extract. As whole, garlic can be utilized as an alternative to synthetic antioxidants and can be evaluated as a source providing aroma and natural antioxidants in butter.

According to Abid *et al.* (2017) investigation, tomato processing by-products extract added to traditional Tunisian butter has been shown the most protective role against lipid peroxidation over 60 days at storage temperature of 4°C. This natural extract contained significant amount of antioxidants including lycopene and phenolic content, which was highly effective in extending butter shelf-life up to two months.

Many factors can affect the chemical composition of the butter sample. Production methods and observance of sanitary conditions in the production process, environmental conditions and storage, storage in cold conditions until consumption are among the effective factors. By implementing these strategies, the quality and shelf life of animal butter can be preserved. Butters enriched by natural antioxidants have been shown high resistant against lipid peroxidation. There is a special demand for the consumption of traditional products; therefore, continuous control over the production and maintenance of these products should be carried out.

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Conflict of Interest

The authors do not have any potential conflict of interest to declare.

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