Determining the influence of grapeseed oil, linseed oil and extra virgin olive oil on the quality of finished bread

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Abstract The growing interest in functional bakery products has stimulated research on the use of vegetable oils rich in bioactive compounds that can be applied in bakery production. The main objective of this review article is to examine the influence of grape seed oil (GSO), linseed oil (FO) and extra virgin olive oil (EVOO) on the quality characteristics of finished bread. GSO, obtained as a by-product of wine production, is distinguished by its high content of linoleic acid, vitamin E and polyphenols, which improve oxidative stability and extend shelf life. FO provides a unique source of alpha-linolenic acid (ALA) and lignans, improving the nutritional profile of bread with valuable omega-3 fatty acids. The article summarizes the results of recent studies on the effects of these oils on the volume, texture, color of the crust and crumb, taste and aroma of the finished product. The comparative analysis shows that each oil provides different technological and nutritional benefits. The conclusion is that the targeted inclusion of mixtures of GSO, FO and EVOO can be added to improve functional and organoleptic quality, offering innovations in bread production..

1. Introduction

Bread is a staple food consumed daily worldwide and is an essential part of the human diet. With increasing awareness of health and well-being, bread is increasingly being reformulated to provide additional nutritional and functional benefits. Functional foods, defined as those that offer health benefits beyond their basic nutritional value, are a rapidly growing sector in the food industry [1–3].

Oils and fats play a critical role in bread formulation, influencing dough rheology, bread volume, bread crumb structure, sensory quality and shelf life. They also serve as carriers of essential fatty acids and bioactive compounds, improving the nutritional profile of the product, but also responding to consumer demand for healthier baked goods [5–10].

2. Oil composition and bioactivity

2.1 Grapeseed oil

Grapeseed oil (GSO) is extracted from the seeds of Vitis vinifera, a by-product of winemaking. Its lipid profile is dominated by linoleic acid (60–70%) and oleic acid (15–20%), with few saturated fatty acids. In addition, GSO contains vitamin E (tocopherols), phytosterols and polyphenols, which contribute to its strong antioxidant activity. These compounds help stabilize lipids during baking, extend the shelf life of bread and maintain oxidative stability, while imparting a light texture and pleasant taste [1–4].

2.2 Flaxseed oil

Flaxseed oil (FO) is one of the richest plant sources of alpha-linolenic acid (ALA), which can constitute up to 55% of the fatty acid profile. Along with ALA, FO contains linoleic acid, oleic acid, and lignans with antioxidant and estrogenic activity. Although its high unsaturation makes FO nutritionally valuable, it is also susceptible to oxidation. In bread, FO improves nutritional quality by providing omega-3 fatty acids, softening the crumb, and increasing fiber content when combined with flaxseed meal [5–7].

2.3 Extra virgin olive oil

Extra virgin olive oil (EVOO) is obtained mechanically, without chemical treatments, preserving phenolic compounds such as oleuropein, hydroxytyrosol and oleocanthal. It is composed mainly of oleic acid (70–80%), together with linoleic acid and light saturated fatty acids. EVOO is widely recognized for its cardiovascular and anti-inflammatory benefits. In breadmaking, it improves dough handling, crumb moisture and sensory quality, while its antioxidant content contributes to

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delayed staling and improved shelf life [8–10].

The main chemical composition of the oils is compared in Table 1.

Table 1. Main chemical composition of grape seed oil, flaxseed oil, and extra virgin olive oil.

Oil	Major Fatty Acids	Polyphenols / Bioactives	Other Key Compounds
Grape Seed Oil	Linoleic acid (60–70%), Oleic acid (15–20%)	Catechins, Procyanidins, Resveratrol	Vitamin E, Phytosterols
Flaxseed Oil	Alpha-linolenic acid (55%), Linoleic acid (15%), Oleic acid (20%)	Lignans (SDG), Phenolic acids	Proteins, Fibers (if cake used)
Extra Virgin Olive Oil	Oleic acid (70–80%), Linoleic acid (10–15%)	Oleuropein, Hydroxytyrosol, Oleocanthal	Tocopherols, Squalene

3. Applications in bread production

The incorporation of functional oils into bread production has been extensively studied, as these ingredients influence both nutritional and sensory properties. Grapeseed oil has been tested at levels up to 10% of flour weight, showing positive effects on antioxidant content and flavor without significant compromise in bread volume. Linseed oil and butter cakes have been successfully used in gluten-free formulas, improving nutritional value and consumer acceptance. Extra virgin olive oil, traditionally used in Mediterranean breads, contributes to stronger flavor, aroma, and moisture [1–4].

Each oil has unique techno-functional effects. GSO improves oxidative stability and extends shelf life, FO enriches bread with omega-3 fatty acids and improves bread center softness, while EVOO improves dough processing and overall sensory appeal [5–7].

Recent studies suggest that combining these oils in certain proportions can provide a balance between sensory quality and nutritional enrichment, creating promising opportunities for innovation in functional bakery products [8–9].

4. Influence on the quality characteristics of bread

The influence of oils on bread quality can be assessed by several key characteristics. Bread volume is maintained when GSO is used at levels up to 5%, while higher concentrations can reduce gas retention. FO usually slightly reduces bread volume due to its high degree of unsaturation, but this effect can be mitigated by dough improvers. EVOO, on the other hand, usually maintains or increases bread volume [1–3].

Texture improvements are strongly associated with fat addition. EVOO significantly improves the softness and elasticity of bread crusts, FO increases water retention and contributes to a softer bread crust structure, while GSO provides a lighter and more aerated texture [4–5].

The color of the crust and crumb is influenced by Maillard reactions during baking. GSO and FO can darken the crumb due to polyphenols, while EVOO is often associated with a golden brown crust with attractive visual qualities [5].

Shelf life extension is another major benefit of including oil. Both GSO and FO help reduce lipid oxidation, delaying rancidity and maintaining freshness, while EVOO adds additional antioxidant protection and prolongs the shelf life of bread [7–8].

Sensory characteristics also play a key role in consumer acceptance. EVOO imparts its characteristic Mediterranean taste and aroma, GSO adds light nutty notes, and FO introduces subtle earthy tones that can be balanced with other flavorings to improve overall acceptance [9–10].

Overall, these oils provide technological and sensory benefits that meet consumer expectations for healthier, more flavorful, and longer-lasting breads [11]. A comparison of bread qualities using the mentioned oils can be seen in Table 2.

Table 2. Reported effects of oils on bread quality attributes.

Oil	Volume	Texture	Shelf-life	Sensory
Grape Seed Oil	Maintained up to 5% inclusion	Lighter crumb	Improved oxidative stability	Mild nutty flavor
Flaxseed Oil	Slight decrease at high levels	Softer crumb, higher moisture retention	Antioxidant activity extends freshness	Nutty/ earthy notes
Extra Virgin Olive Oil	Generally maintained or increased	Softness and elasticity	Polyphenols delay staling	Rich flavor and aroma

5. Comparative analysis

Comparative analysis shows that each oil offers different benefits:

- Nutritional benefits: FO provides essential omega-3 fatty acids; GSO contributes vitamin E and polyphenols; EVOO supplies monounsaturated fatty acids and bioactives associated with cardiovascular health [2–4].
- Technological benefits: GSO improves oxidative stability, FO modifies dough hydration and softness, EVOO improves handling and sensory appeal [5–7].
- Limitations: FO is susceptible to oxidation and requires protective packaging; GSO availability may depend on wine production; EVOO is more expensive, limiting large-scale application [8–9].

In bakery industry innovations, strategic blending of these oils can maximize both nutritional and technological advantages, offering sustainable and consumer-friendly products [10–11].

6. Technological and nutritional considerations

From a technological perspective, the incorporation of oils into bread requires careful consideration of dough rheology, gluten development, and stability under baking conditions. GSO, FO, and EVOO affect dough processing and final product quality in different ways [1–2].

Nutritionally, these oils provide essential fatty acids, antioxidants, and bioactive compounds that contribute to health benefits [3–5]. However, industrial challenges remain, including oxidative stability, cost-effectiveness, and ensuring consistent consumer acceptance [5].

Opportunities lie in the sustainable valorization of by-products such as GSO and FO, as well as in the premium positioning of EVOO-enriched breads for health-conscious markets [7–8]. Future research should focus on optimized formulations, encapsulation strategies to protect sensitive fatty acids, and detailed sensory evaluations among different consumer groups, ensuring both technological efficiency and broad market appeal [9–10].

7. Technological influence and concentration

The choice of oil concentration in the recipe usually varies between 2% and 10% by weight of flour, with optimal results for most indicators observed at levels of 3% to 5% [20].

- Grapeseed oil (GSO): Highly valued for its high content of vitamin E and linoleic acid. At levels up to 5%, it improves the specific volume of bread and acts as an antioxidant [21].
- Flaxseed oil (FO): A major source of α-linolenic acid (Omega-3). Due to its high unsaturation, it is susceptible to oxidation, so it is often used in lower doses or in combination with antioxidants [22].
- Extra virgin olive oil (EVOO): Acts as a powerful crumb softener and inhibits starch retrogradation (bread staleness). Due to its intense flavor, concentrations above 8% can dominate the sensory profile [19]. Table 3 compares the concentrations indicated on key quality parameters.

Table 3. Synthesized effects of different concentrations on key quality parameters

Oil	Concentration (%)	Impact on Volume	Impact on Hardness
Grape Seed Oil	3% - 5%	Increase of ~10-15%	Significant decrease
Flaxseed Oil	2% - 4%	Minimal increase	Decrease within first 48h
Extra Virgin Olive Oil	5% - 10%	Stabilizes porosity	Maintains softness up to 5 days

8. Conclusion

The review confirms the role of grapeseed, linseed and extra virgin olive oils in improving bread quality. Each oil shows benefits that correspond to consumer demand for healthier bakery products. Grapeseed oil contributes with its increased antioxidant activity, thus potentially extending the shelf life of the finished product. Linseed oil provides enrichment with omega-3 unsaturated fatty acids and fiber, while extra virgin olive oil improves the organoleptic characteristics of the product and the easier digestibility of the finished product. Combining the three oils could optimize the technological operations in the production of bread enriched with them and increase the health benefits. Future directions are aimed at investigating the influence of each of the oils separately on the organoleptic characteristics and the full chemical composition of the enriched bread. Studies will be carried out to determine the influence of the oils on the bread-making process, for example, on the rising time and other technological parameters. This is a review article and it is not possible to state the effect of the studied oils on the sensory characteristics of bread, whether it could be positive or negative.

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