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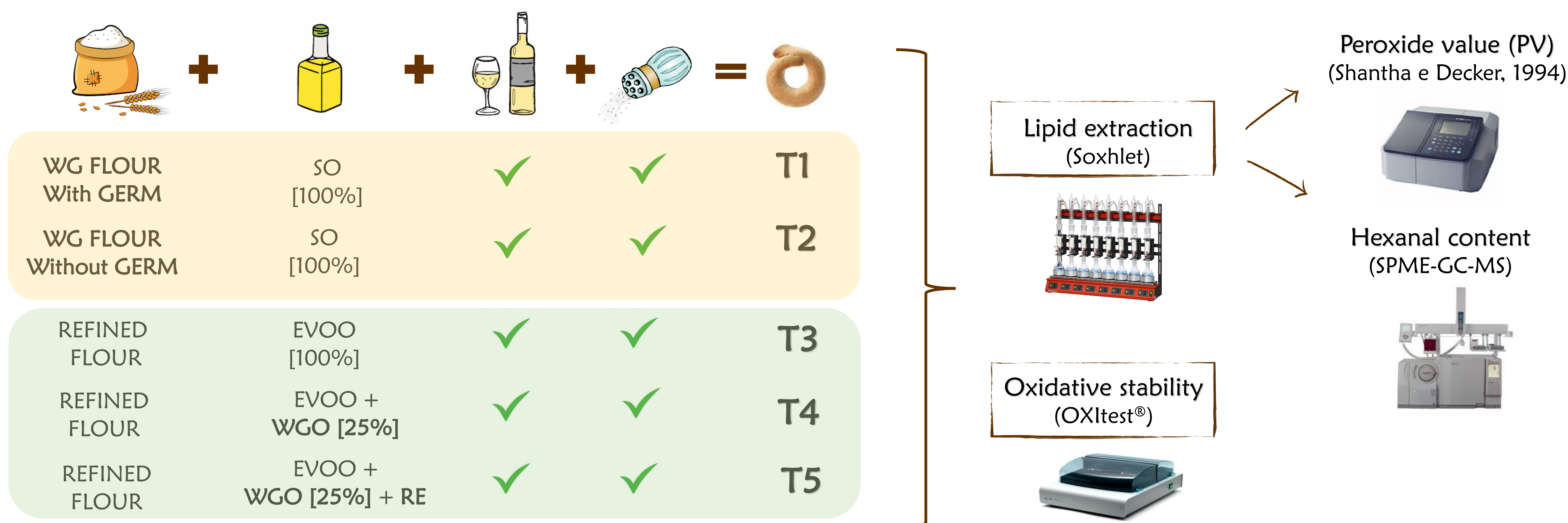
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INTRODUCTION

The lipid fraction in baked products plays a fundamental role not only in determining the structural and sensorial characteristics, but also in influencing the oxidative stability and overall shelf life of the final product. Given the well-known health benefits of Whole Grain (WG) consumption, consumers are increasingly demanding WG versions of many cereal-based products. For these reasons, the bakery industry is more and more interested in developing WG products but the presence of the germ and bran also introduces a higher proportion of unsaturated lipids (linoleic, linolenic, and oleic acids) and oxidative enzymes (lipase and lipoxygenase), making WG flours and products more susceptible to lipid degradation, reducing shelf life. Therefore, lipid stability is a critical quality parameter of wholegrain wheat flour and products. For these reasons, this study explores the oxidative behavior of "taralli", savory baked products of the Italian tradition, formulated with different flours and fats characterized by the presence of wheat germ (WG flour or WG oil). In addition to the effect of the WG in the formulation, the study highlights how different fats used in formulations can affect the final quality of the baked product, influencing the shelf life of the final product.

MATERIALS AND METHODS.

Two different batches of taralli were produced and tested: the first batch was formulated with WG flour, with or without germ, and sunflower oil (SO), the second one with refined flour and extra virgin olive oil (EVOO) blended with wheat germ oil (WGO) and rosemary extract (RE) as antioxidant. Their oxidative state was evaluated, focusing on the main primary and secondary oxidative compounds, such as peroxide value and hexanal content, and their oxidative stability by an accelerated oxidation test.

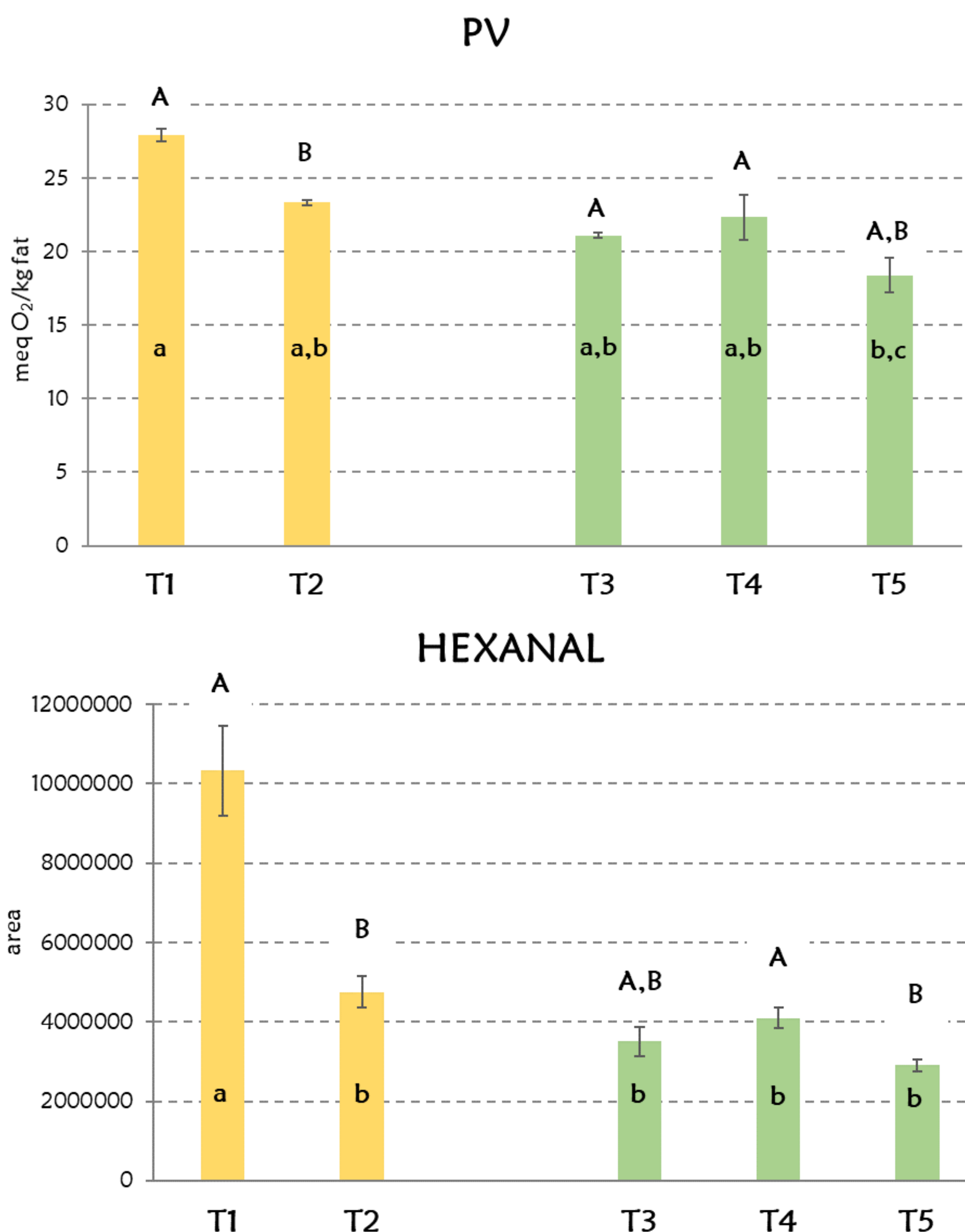


RESULTS.

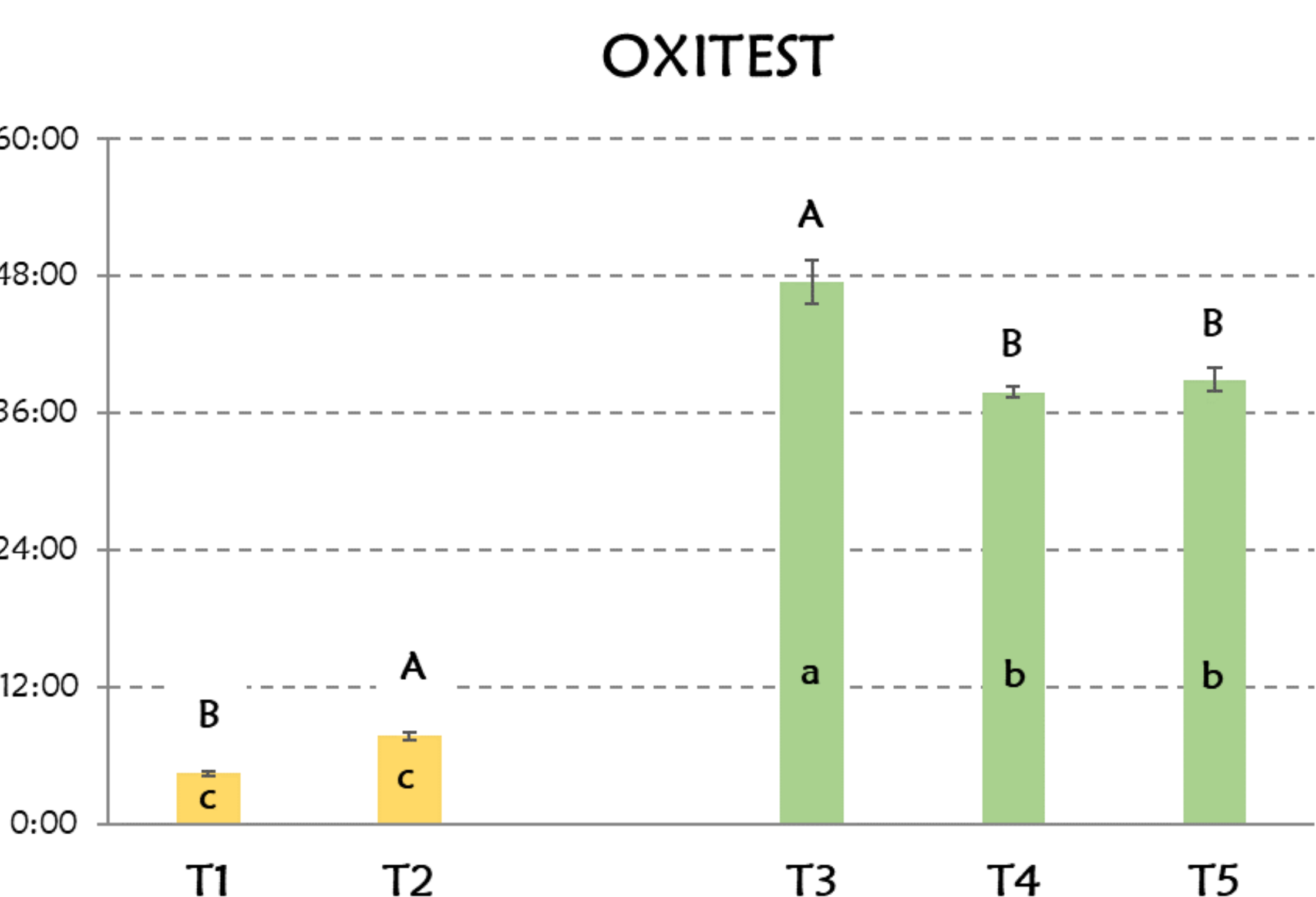
Regardless of the type of oil and flour used in the formulation, the **fat content** of all samples ranged from 22.8 (T1) to 24.2 (T4) without significant differences ($p < 0.05$).

The **PV** showed values higher than or very close to the legal limit for foods (20 meq of O_2/kg): T1 (WG flour with germ) had the highest value (27.9), significantly higher than T2 (WG flour without germ) and taralli produced with EVOO. T5, formulated with rosemary extract, presented the lowest PV content.

The secondary oxidation products evaluation is often focused on some volatile compounds of oxidative origin, such as **hexanal**. In particular, T1 showed the highest hexanal content, significantly different from the corresponding tarallo produced with germ-free flour (T2). Among the samples of the second batch, the tarallo WGO 25% (T4) had the highest content, although not significantly different from the 100% EVOO sample (T3); while a lower content was detected in the tarallo enriched with rosemary extract (T5).



Lowercase letters show significantly different mean values among all the samples; capital letters show significantly different mean values within each batch of samples (yellow and green)



An overall screening of the oxidative state of the samples was carried out with the **OXITEST**. The IP value (Induction period), which is the time in hours necessary to completely oxidize the food, was statistically much shorter for the taralli with germ (T1) than for the one without germ (T2) and both these samples had a much lower IP compared to the taralli formulated with EVOO. In this case, the tarallo with 100% EVOO (T3) presented the greatest oxidative resistance (47h), highlighting how the antioxidant compounds that characterize EVOO, mainly polyphenols, have an important effect on the protection from the lipid oxidation.

CONCLUSIONS.

Knowing that the presence of the germ adds greater susceptibility to lipid oxidation and therefore greater "fragility" to the final product, in order to produce a real Whole Grain product (with germ) it is important to pay attention to the fat used in formulation with the possibility of enriching it with antioxidants which improve the oxidative stability and the shelf life of the baked good.