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Glycyrrhiza glabra L. leaves as functional ingredients in bakery

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Abstract: Calabria is a very significant biodiversity heritage due to its geographical, morphological and climatic conditions. Many plant species grow wild and are rich in active compounds with specific beneficial activities on human health. Among these plants, licorice (*Glycyrrhiza glabra* L.) have a particular importance. The valorization of plant wastes, still rich in their active ingredients, in healthcare and human nutrition is increasingly having a big impact in smarter waste management and circular economy for more sustainable development. Licorice leaves were pulverized and then used in the formulation of 4 different types of flour: at 2.5%, 5%, 7.5% and 10% leaf content. Sensory, rheological and total polyphenol content tests were carried out to evaluate its antioxidant and/or anti-inflammatory activity even after the cookies were prepared and baked.

• Introduction

The use of waste plant materials plays a key role in circular economy to have more sustainable development and smarter waste utilization. To enhance the leaves, they can be used in the nutraceutical field by using them to prepare functional foods, such as cookies. Bakery products, in addition to being a type of food consumed daily by people of all ages, are an affordable commodity for everyone. Flour is the main ingredient in these baked goods, and their properties are that they are high in carbohydrates but have little fiber and other oligonutrients. Therefore, the use of other compounds could go to enrich the nutrient content of the product. In this case, licorice leaves were used, which are known to have high phenolic acid content and good antioxidant, anti-inflammatory, and antiproliferative activity. The addition of licorice leaves in flour, however, should not go to alter the rheological characteristics of the product. In the present study, the characteristics of flour and flour-leaf mixes will be compared and contrasted to evaluate the effectiveness of choosing to enrich a product and make it come out a functional food with better characteristics.

• Material and method

Biological materials. The flour used was white wheat type 000, bought in Timisoara, Romania. Licorice leaves were harvested in Cammarata, a district of Castrovillari, in the province of Cosenza, Italy.

The technological process to obtain licorice biscuits. The biscuits were obtained in 4 experimental variants, with FL 2.5 (wheat flour with 2.5% licorice leaves), FL 5 (wheat flour with 5% licorice leaves), FL 7.5 (wheat flour with 7.5% licorice leaves), FL 10 (wheat flour with 10% licorice leaves) biscuit with white flour as a control (C).

Sensorial analysis of biscuits. Samples of licorice leaf cookies were evaluated by 20 male and female persons, aged 19 to 50 years. The cookies were presented in food bags coded with C, 1, 2, 3 and 4. A hedonic scale was used to assess consumer liking: 1= extremely disliked; 2= slightly disliked; 3= neither dislike nor like; 4= slightly like; 5= extremely like.

Assessment of Total Phenolic Content (TPC). The total phenolic content (TPC) of flour composites and biscuits with different percentages of licorice leaves flour was analyzed according to the modified Folin-Ciocalteu method. The results were expressed in mg gallic acid equivalent (GAE) per 100 g of samples. The calibration curve was established in the range of concentrations of 2.5–250 g/mL. All determinations were made in triplicate.

Preparation of composite flour. The flours were prepared as follows: 97.5 g white flour + 2.5 g licorice leaves (LF 2.5); 95 g white flour + 5 g licorice leaves (LF 5); 92.5 g white flour + 7.5 g licorice leaves (LF 7.5); 90 g white flour + 10 g licorice leaves (LF 10). Thus, four types of flours were used: 2.5 percent licorice leaf (LF 2.5), 5 percent licorice leaf (LF 5), 7.5 percent licorice leaf (LF 7.5) and 10 percent licorice leaf (LF 10).

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The MIXOLAB rheological profile. The primary parameters of the composite flours with different proportions of LF were analyzed: water absorption (WA,%), stability (ST, min), mechanical weakening (C1, Nm), minimum torque (C2, Nm), peak torque (C3, Nm), heating stability (C4, Nm) and decline (C5, Nm). The angle between the ascending and descending curves (α , β , γ and δ) was also calculated, which correspond to the arc-tangent of the four curve angles. The index scores defined by Mixolab Profiler were also determined: water absorption index (WAI), mixing index (MI), gluten+ index (GI), maximum viscosity during heating expressed as viscosity index (VI), starch stability or amylolysis index (AI) and starch degradation - degradation index (RI).

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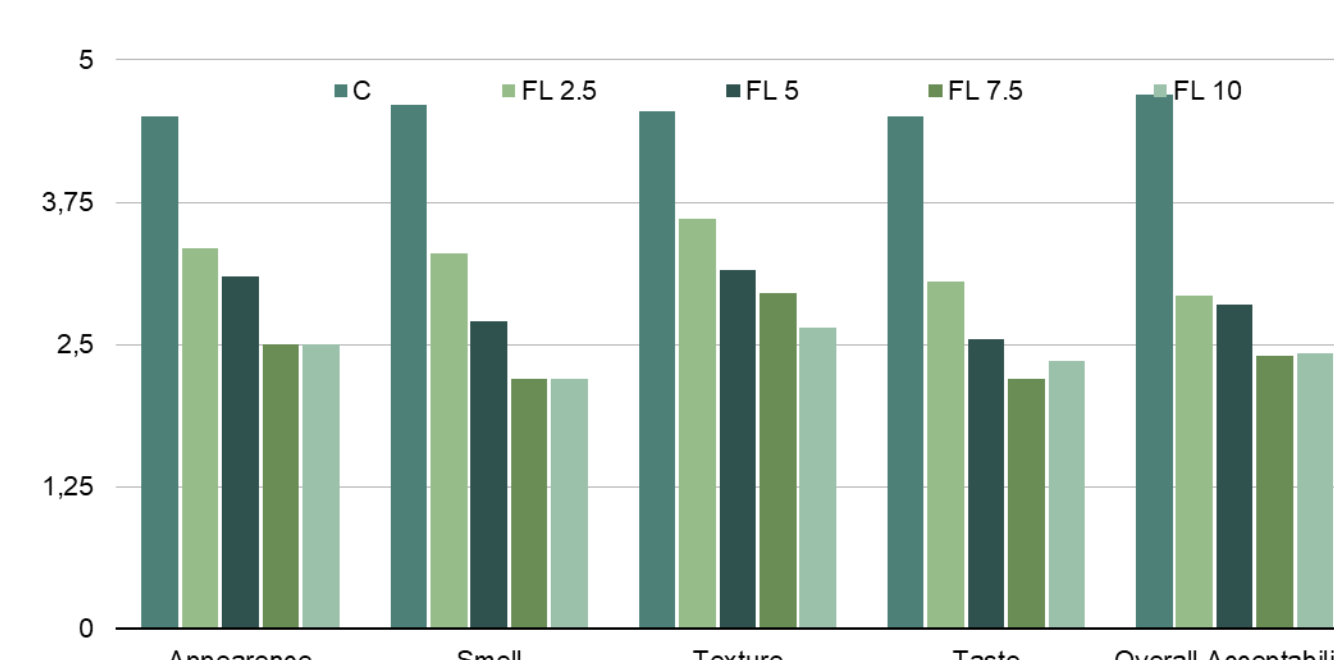
Fig.1 Licorice leaves flours



Fig.2 Biscuits with licorice leaves flours and control

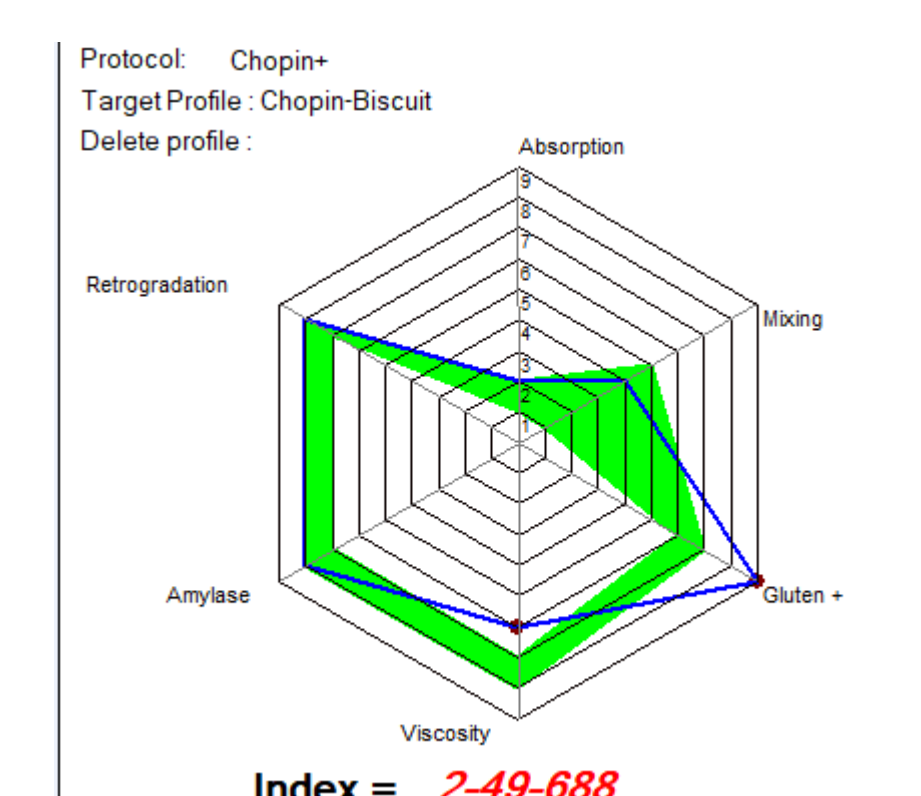
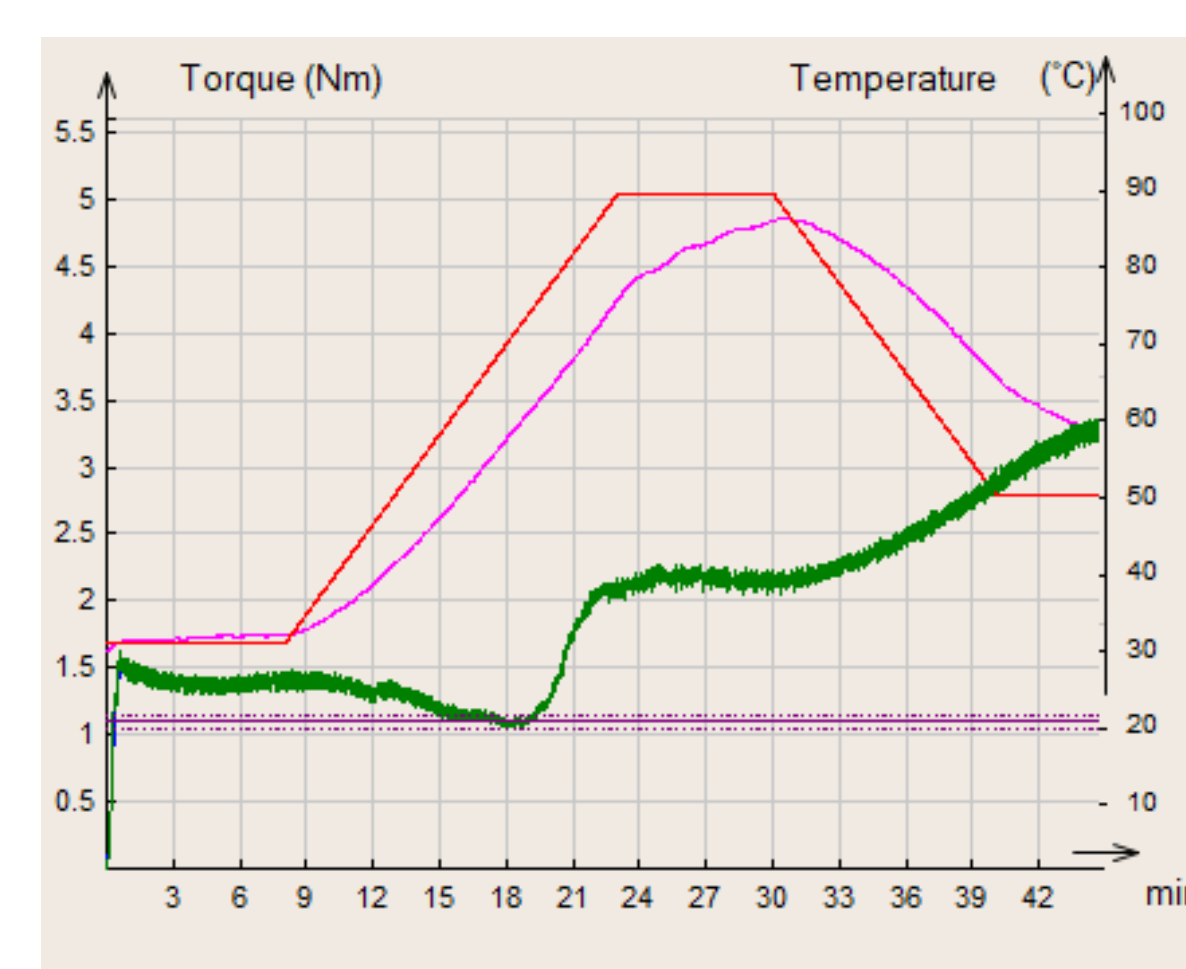
• Results and discussions

Sensorial analysis of biscuits



Total Phenolic Content (TPC)

Samples	TPC (mg GAE 100 g)
F	18,25 ± 0,03
FL	305,87 ± 11,83
FL 2.5	185,23 ± 4,33
FL 5	237,95 ± 4,33
FL 7.5	250,21 ± 4,17
FL 10	275,77 ± 5,74
BL	81,63 ± 0,071
BFL 2.5	133,75 ± 0,16
BFL 5	202,09 ± 0,37
BFL 7.5	237,49 ± 1,81
BFL 10	257,35 ± 6,38



Mixolab profile of composite flours

Tests have shown that in compound flours the amount of polyphenols is very high, and this figure remains unchanged even after baking in cookies. As for the sensory analysis carried out, the four types of cookies were found to be unappetizing compared with the regular cookie used as a control. The rheological analysis based on the MIXOLAB profile shows a good behavior of the dough when kneading and an optimal readiness for the preparation of biscuit dough.

• Conclusions

Licorice leaves, a production waste material, rich in polyphenols, thus having antioxidant, anti-inflammatory and antiproliferative activities, used for the production of composite flours and then used in the production of cookies, have retained their characteristics both added in various percentages in flour and after baking with the production of cookies. Further rheological, sensory and nutritional composition studies will be needed to arrive at a final product that can be included in functional foods.