# Characterization and shelf-life evaluation of gluten-free biscuits enriched with Chestnut flour


Antonella Cavazza[a], Daniela Carà[a], Emma Chiavaro[c], Maria Grimaldi[a], Paola Ornaghi[b], Maria Paciulli[c], Massimiliano Rinaldi[c], Claudio Corradini[a]

[a] Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Università di Parma, Parco Area delle Scienze 17/A, 43124 Parma, Italy. [b]Velp Scientifica srl, via Stazione 16, 20865 Usmate (MB) Italy. [c]Dipartimento di Scienze degli Alimenti e del Farmaco, Università di Parma, Parco Area delle Scienze 47/A, 43124 Parma, Italy.
E-mail: antonella.cavazza@unipr.it


## INTRODUCTION

Manufacturing of gluten-free products is usually characterized by the need of optimizing specific technological processes aimed at obtaining properties to fulfill consumer expectations, since the raw material used often gives poor results in terms of taste, aroma, consistency and nutritional properties. For these reasons, lately, different alternative ingredients are being tested with the aim of improving the final result.

Chestnut flour is a promising ingredient in this field, containing high quality proteins with a very good content of essential amino acids (4-7%), fibers (4-10%), and low fat (2-4%). Besides, it also contains vitamins and microelements (1).

It has been successfully used in few cases for bread and pasta production. Nevertheless, few data are at present available regarding the technological characterization and the shelf-life of chestnut based products (2).

This work was aimed at the optimization of a recipe for the production of gluten-free biscuits. Different samples were prepared by mixing chestnut flour and gluten-free flour in different proportions. The obtained products were evaluated by the analysis of the chemical-physical properties, colorimetric measures and sensory analysis. The behavior of the biscuits during 60 days of shelf-life has also been monitored.

Since oxidative stability is an important parameter affecting food shelf-life, the product was submitted to analysis by Oxitest (VELP Scientifica, Italy), a reactor based on the use of high temperature and over-pressure of oxygen that allows to easily measure a sample oxidative stability by accelerating the oxidation process. It has been shown to be a very useful tool for testing many types of food (3).

## MATERIALS AND METHODS

Samples: two lots of biscuits were prepared in the lab by using different flour mixtures:

- **M100** (only mixture): mixture (100.0) sugar (50.0) water (30.0) butter (30.0) baking powder (1.0) salt (1.0);
- **M20C80 -** (mixture+chestnut flour): mixture (20.0) chestnut flour (80.0) sugar (50.0) water (30.0) butter (30.0) baking powder (1.0) salt (1.0);
- **M50C50** (mixture+chestnut flour): mixture (50.0) chestnut flour (50.0) sugar (50.0) water (30.0) butter (30.0) baking powder (1.0) salt (1.0);
- **C100** (only chestnut flour): chestnut flour (100.0) sugar (50.0) water (30.0) butter (30.0) baking powder (1.0) salt (1.0).

The ratios chestnut flour/gluten-free mixture were selected based on preliminary experimentations.

All the ingredients (water at 20 °C) were mixed by using a Kitchen-Aid Professional mixer with a dough hook. Subsequently, the dough was allowed to rest at 4 °C for 5 min and then rectangular biscuits with 2x5 cm dimensions and 0.8 mm thickness were obtained. Finally, the biscuits were cooked at 180°C for 15 min in a ventilated electrical oven. Two productions were performed for each formulation.

The **hardness** of the samples (N) was measured by means of Texture Analyzer TA-TX2i (Stable Microsystem, UK), using a cutting test with guillotine blade.

The **color** analysis was performed using a Minolta CM2600d colorimeter .

The **rheological properties** of the dough, measured as G' and G'', were conducted by means of a ARES rheometer and the **degree of starch gelatinization** by a DSC Q100 (TA Instruments, New Castle, DE, USA).

The **oxidative stability** was evaluated by accelerating the oxidation process using the Oxitest (VELP Scientifica, Italy), a reactor based on the use of high temperatures and over-pressure of oxygen (Figure 1). The Oxitest technique is based on the change in the absolute oxygen pressure in a closed and thermostatic chamber, assumed as the oxygen uptake by reactive substances.

Measures were performed on samples (Figure 2) after 60 days of storage.

| |
|---|
| Temperature: 100 °C |
| Oxygen pressure: 6 bar |
| 30 g of sample in each reaction chamber |

**Table 1-** Oxitest working conditions

**Figure 1-** Oxitest reactor and oxidation chambers


**Figure 2** – Image of the four samples

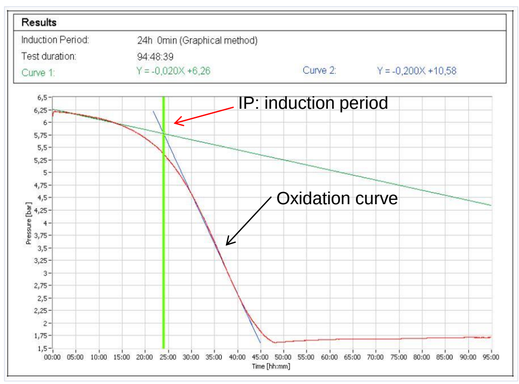


**Figure 3** - Typical oxidation curve

The oxidation curve produced by the Oxitest is characterized by an Induction Period (IP) as the time required to reach an end point of oxidation corresponding to either a level of detectable rancidity or a sudden change in the rate of oxidation (Figure 3).

## RESULTS

Increasing percentages of chestnut flour lead to an improvement of color, but too high percentages resulted in excessively hard texture, in relation to the rheological properties of the dough, and the degree of starch gelatinization. About the moisture content, at time 0 M20C80 samples presented the highest value followed by C100 and by both M100 and M50C50: probably the combination of gluten-free mixture and chestnut flour at 20/80 ratio represented the best compromise for the water retention during cooking process as the recipe of biscuits was the same.

During shelf life the colour of biscuits remained almost constant without significant differences compared to time 0 day, confirming the stability of colour obtained by adding chestnut flour to bakery products (4).

The moisture content, monitored during 60 days (Figure 4) revealed that all the biscuits absorbed water from the ambient and showed an increase in moisture content as expected and, particularly, M100 and M50C50 showed the highest moisture increase during the first 7 days of storage. At the end of shelf life (60 days), M100 and M20C80 presented the highest moisture content values. The hardness values didn't follow during shelf life the moisture content behaviour, showing in some cases hardening, probably because of the high deformability of the samples before breaking.

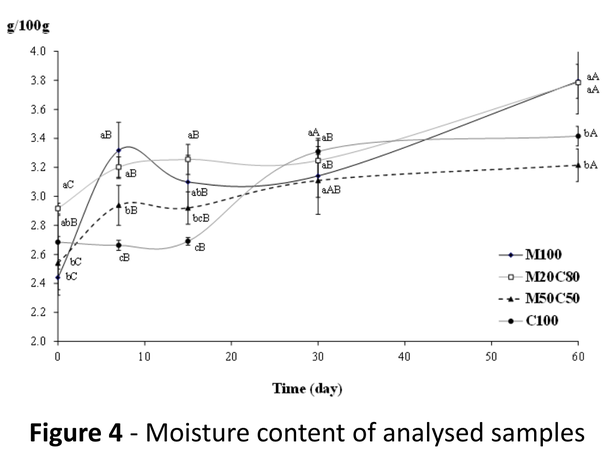


**Figure 4** - Moisture content of analysed samples

| SAMPLE | LOT 1 Induction Period (min) | LOT 2 Induction Period (min) |
|---|---|---|
| 100% Gluten free flour (M100) | 603±39 | 578±32 |
| 100 % Chestnut flour (C100) | 1073±49 | 1273±47 |
| 50:50 Gluten free/chestnut flour (M50C50) | 1529±69 | 2040±41 |
| 20:80 Gluten free/chestnut flour (M20C80) | 1559±43 | 1855±33 |

**Table 2**. Results of oxidative stability on biscuits after 60 days of storage

Data recorded by Oxitest on biscuits after 60 days of storage (Table 2) showed higher oxidative stability in samples containing chestnut flour.

IP values of biscuits made only of chestnut flour resulted significantly higher compared to those obtained from gluten free mixture probably thanks to the antioxidant content of chestnut flour.

Mixing the two flours gave IP values even higher than C100 probably because on one hand gluten free mixture contributed to reduction of the unsaturated fatty acids' content while on the other chestnut flour gave antioxidant compounds.

## CONCLUSIONS

Obtained data showed good and promising results since the increase of percentage of chestnut flour in the dough lead to a product with improved colour, harder texture, better taste and enhancement of the oxidative stability, opening new perspectives in the use of chestnut flour for preparation of gluten-free products.

## REFERENCES


(**1**) Chenlo F., Moreira R., Pereira G., Silva C.C. (2007). Evaluation of the rheological behaviour of chestnut (castanea sativa mill) flour pastes as function of water content and temperature. *Electronic Journal of Environmental Agriculture and Food Chemistry* 6 (2), 1794–1802.

(**2**) Dall'Asta C., Cirlini M., Morini E., Rinaldi M., Ganino T., Chiavaro E., (2013). Effect of chestnut flour supplementation on physico-chemical properties and volatiles in bread making, *LWT - Food Science and Technology* 53- 233-239.

(**3**) Cavazza A., Corti S., Mancinelli C., Bignardi C., Corradini C. (2015). Effect of the addition of chili pepper powder on vegetable oils oxidative stability. *Journal of the American Oil Chemistry Society*, 92:1593-1599.

(**4**) Paciulli M., Rinaldi M., Cirlini M., Scazzina F., Chiavaro E. (2016). Chestnut flour addition in commercial gluten-free bread: a shelf-life study. *LWT-Food Science and Technology*, 70, 88-95.



This work was undertaken within the project BIOCAST – La bio-funzionalità della filiera del castagno dalla farina agli scarti funded by the Italian Ministry of Agriculture, Food and Forestry Policies.