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Production trials of fresh pasta enriched with phenolic compounds extracted from wheat by KOH-induced hydrolysis

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TITOLO
Prove di produzione di pasta fresca arricchita con sostanze fenoliche estratte dal grano mediante idrolisi con KOH

KEY WORDS
Phenolic extracts, KOH-induced hydrolysis, pasta, bran, functional foods

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Estratti fenolici, idrolisi mediante KOH, pasta, crusca, alimenti funzionali

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Summary
Some critical points may raise during the production of functional foods. Due to their peculiar physic-chemical properties, the functional compounds could alter the normal processing steps and affect the sensory acceptability of the final products. The aim of this work has been to assess the feasibility of the enrichment of fresh pasta with phenolic compounds extracted from wheat. The phenolic extracts were obtained by KOH-induced hydrolysis and were used by replacing all the processing water required for pasta-making. In particular, the aspects referring to the visco-elastic characteristics of dough and sensory properties of final product have been analysed. The obtained results showed that the enrichment negatively interfered with dough formation. In fact, the enriched dough was significantly more consistent than control dough and showed a reduced machinability. Phenol-enriched pasta was significantly browner than control pasta, with a sensory profile characterized by stronger salty and bitter taste than control pasta. The observed technologic and sensory drawbacks indicate a scarce feasibility and do not encourage to expect a good product acceptability. Further work is required to set up an efficient extraction method without any hydrolysis step.

Riassunto
Alcune criticità possono sorgere durante la produzione di alimenti funzionali in quanto le proprietà chimico-fisiche dei composti funzionali aggiunti possono alterare il normale processo produttivo e l'accettabilità organolettica dei prodotti finiti. Lo scopo del presente lavoro è stato quello di determinare la fattibilità dell'arricchimento di pasta fresca con sostanze fenoliche estratte da crusca di grano con un metodo estrattivo che prevede l'uso di KOH, sostituendo l'acqua di impastamento con pari quantità di estratto fenolico. In particolare sono state considerate le caratteristiche visco-elastiche dell'impasto arricchito e il profilo sensoriale della pasta arricchita. I risultati ottenuti mostrano che l'aggiunta di estratto interferiva negativamente con la formazione dell'impasto, più consistente e meno lavorabile del controllo. La pasta arricchita, inoltre, appariva più scura di quella convenzionale e mostrava un più accentuato sapore salato e amaro. Questi risultati inducono a presumere una scarsa fattibilità industriale a causa di una scarsa accettabilità del prodotto. Ulteriori studi dovranno essere condotti per mettere a punto efficienti metodi di estrazione delle sostanze fenoliche che non richiedano idrolisi.

Introduction

In the last years, functional foods and antioxidant components in foods have drawn a lot of attention and interest by food scientists, nutritionists, health professionals, and consumers. Phenolic compounds constitute one of the most numerous and widely distributed groups of substances in the plant kingdom. Interest in plant polyphenols has focused on their favourable effects on human health, arising from their antioxidant activity and capacity to protect critical macromolecules (such as chromosomal DNA, structural proteins and enzymes, low-density lipoproteins, and membrane lipids) from damages induced by active species of oxygen (1, 2).
Major sources of polyphenols are green tea, red wine, and cocoa, as well as several fruits and vegetables (1). However, also the external layers of wheat caryopses contain interesting levels of various phenolic compounds, and bran extracts have a recognised antioxidant activity and are capable to inhibit lipid peroxidation in human low-density lipoprotein in vitro (3, 4). Wheat phenolics are mainly linked to arabinoxylans and, in lower amount, are free soluble compounds (5). These substances can be extracted by various methods which have to include a hydrolysis step aimed to release the linked fraction and to achieve acceptable extraction yields (6).
Some critical points can affect the production of functional foods. Due to their peculiar physic-chemical properties, the functional compounds could affect the normal processing steps, requiring some modifications, or even alter the sensory acceptability of the final products. In a previous work (7), it has been evaluated the use of wheat-derived phenolic extracts in the production of fresh pasta, by replacing 50% of processing water. The extracts used were obtained both in basic conditions, with various solvents, and in absence of hydrolysis. It was pointed out that the basic hydrolysis, by using NaOH, lead to higher concentrations of phenolic compounds. However, the step of neutralization of the same extracting procedure produced NaCl, undesired for its dietary drawbacks.
The aim of this work has been to assess the feasibility of the enrichment of fresh pasta with phenolic compounds extracted from wheat in basic conditions by using a KOH-induced hydrolysis. The phenolic extracts were used by replacing all the processing water required for pasta-making, and the aspects referring to dough characteristics and sensory properties of final product have been analysed.

Materials and methods

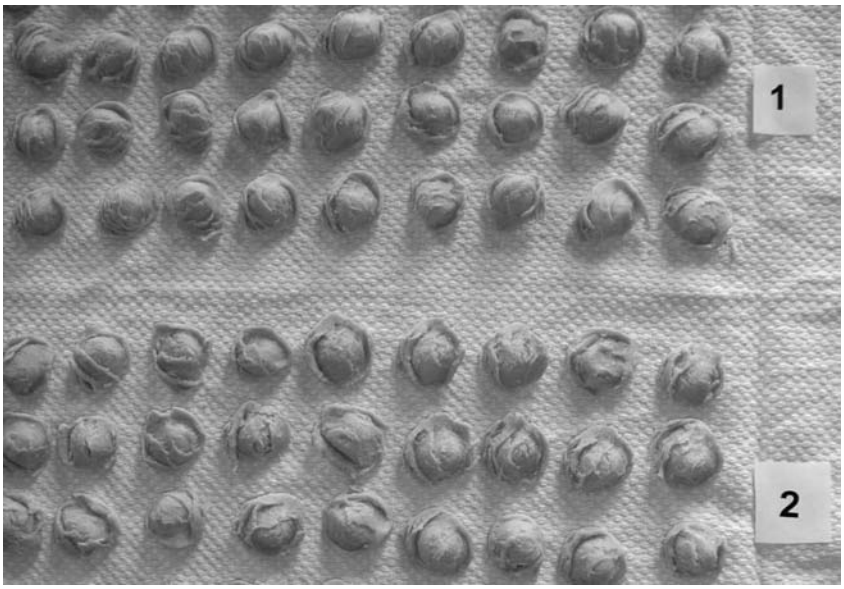
Preparation and quantitative analysis of phenolic extracts

The phenolic substances were extracted from bran according to Hatcher e Kruger (8), with some modifications. Bran was stirred overnight with 1M KOH at room temperature in the ratio 1:10 (w/v), then added of absolute ethanol to a ratio of 70:30 EtOH/H_2O (v/v) and stirred 1 h at room temperature, finally was added of a few drops of 37% HCl to pH 6. After filtration on paper, the hydro-alcoholic extract was concentrated under vacuum at 40 °C by a rotary evaporator, to eliminate ethanol. The extract was stored into brown glass vials at -20 °C until analysis. The concentration of the extracts was spectrophotometrically determined at 765 nm after Folin-Ciocalteau reaction, according to Van Hung et al. (9).

Production of fresh pasta enriched with phenolic extracts

Fresh pasta samples "orecchiette"-shaped (typical of Apulia region, Fig. 1) were hand-made in the laboratory. Control pasta was obtained by kneading durum wheat semolina with water to reach the farinographic absorption (50%), while test pasta was obtained by

Figure 1 - Traditional Italian fresh pasta ("orecchiette") prepared with water (1) and enriched with phenolic extract (2)



replacing water with phenolic extract. Pasta was left to dry a few hours in the air at room temperature to 28-30% moisture.

Qualitative analyses of dough and pasta

Alveographic analyses were adapted to durum wheat as reported by D'Egidio et al. (10) and performed by Chopin alveograph (Chopin, Villeneuve La Garenne, France). Distilled water was used to prepare control dough, while water was entirely substituted by phenolic extract to prepare test dough. Pasta samples, both enriched and control, were submitted to quantitative descriptive sensory analysis according to Pasqualone et al. (11), by evaluating the following descriptors: stickiness, bulkiness, firmness, saltiness, bitter taste, wholemeal smell. Yellow Index (YI, or b^*) and Brown Index (BI, or 100 - L) were determined by Chroma Meter CR-300 colorimeter (Minolta, Osaka, Japan) at different times: immediately after production (t = 0), and after 10', 2h and 24h from kneading.

Statistical analysis

Data were submitted to statistical analysis by XLStat software (Addinsoft SARL, New York, NY, USA).

Results and discussion

The use of ethanol/water solutions coupled with KOH-induced cold hydrolysis enabled to obtain 7 mg phenolic compounds per g dry bran (expressed as ferulic acid). They were represented by the soluble fraction of grain phenolic acids, both free and esterified, and part of the insoluble fraction cross-linked to arabinoxylans (8).
Due to the presence of KCl derived from the acidification carried out after the basic hydrolysis, the enrichment negatively interfered with dough formation and dough visco-elastic properties, as showed by alveographic analysis (Fig. 2). In fact, the enriched dough was significantly more consistent than control dough and showed a reduced machinability, with a significantly higher tenacity to extensibility value (P/L), and lower strength (W).
The colorimetric analysis (Fig. 3) showed that enriched pasta was significantly browner than control, but its BI remained unvaried until 2 h, while control pasta become significantly darker 10 min after kneading. Twenty-four h after processing both enriched pasta and control were browner than after 2 h, due to the enzymatic action of polyphenol oxidase (12). This enzyme acted on the phenolic substances intentionally added to the enriched dough and those

Figure 2 - Alveograph parameters (W and P/L) of control pasta and of pasta enriched with phenolic extract. Different letters on the bars indicate significant difference at $p < 0.001$

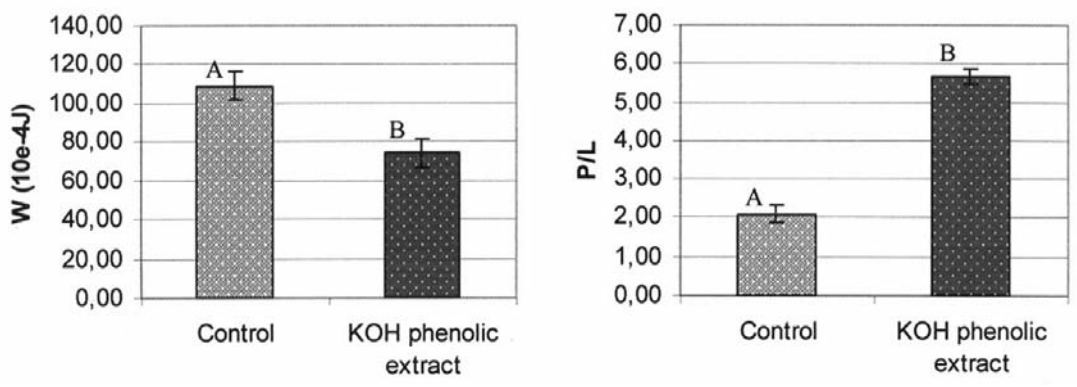
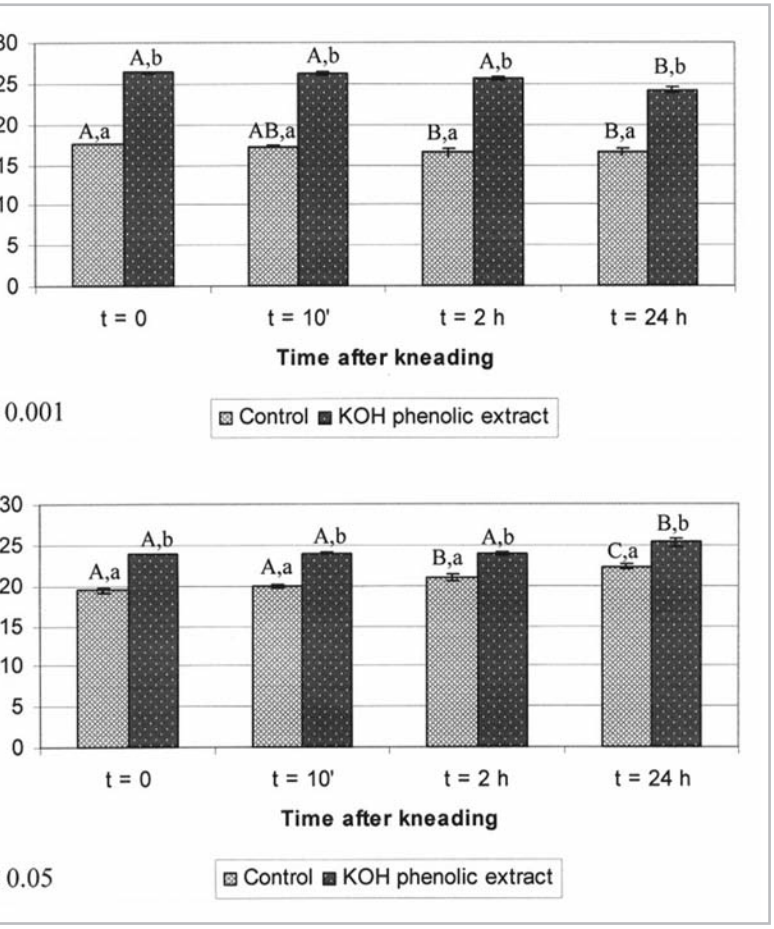


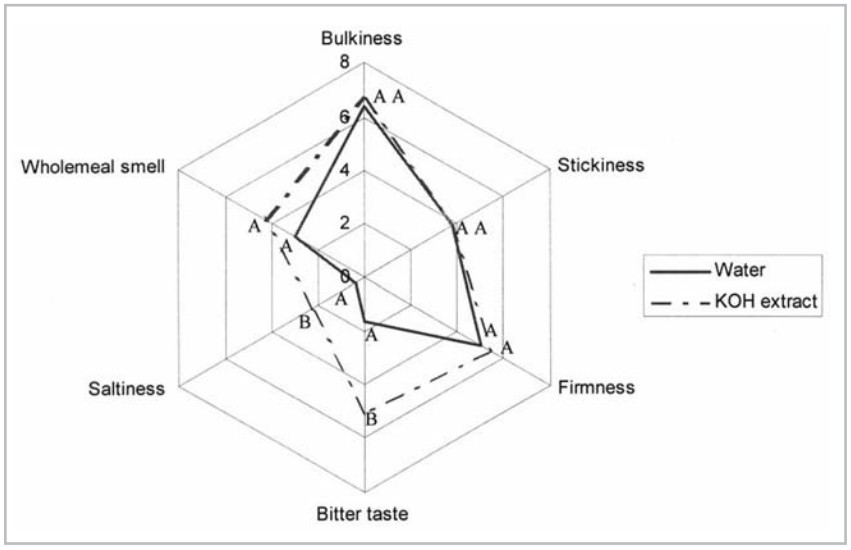
Figure 3 - Yellow Index (top) and Brown Index (bottom) of control pasta and of pasta enriched with phenolic extract. Different letters on the bars indicate significant difference (capital letters were used to compare different times, lower case letters to compare different pasta types)



accidentally present, as residues of bran derivation (5), in control, oxidising them to brown quinones. The YI, imputable to carotenoids of semolina, was significantly higher in enriched pasta and decreased over time, due to oxidative phenomena, with a slower rate than control pasta demonstrating the protective action of phenolics.

The evaluation of the sensory properties showed that the enriched pasta was significantly different from control (Fig. 4). In particular, it was characterized by stronger salty and bitter taste, imputable to KCl. Hence, although interesting for the antioxidant effect, the use of wheat-derived phenolic extracts obtained by KOH-induced hydrolysis had some technologic and sensory drawbacks that indicate a scarce feasibility and do not encourage to expect a good product acceptability. Further work is required to set up an efficient extraction method without any hydrolysis step.

Figure 4 - Sensory profiles of control pasta and of phenol-enriched pasta. Different letters indicate significant difference at $p < 0.05$



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