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Processing and characterization of durum wheat bread enriched with antioxidant from yellow pepper flour

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ABSTRACT

The effect of the addition of yellow pepper flour on bread physico-chemical and sensorial properties was addressed in this study. In particular, vegetable flour concentration was set at 25%; in order to optimize the bread sensorial properties, yellow pepper flour was separately hydrated at three different water content levels. Texture analysis were carried out on both dough and bread samples to evaluate their firmness. Furthermore, tomographic analysis was performed on the same samples in order to provide a more detailed view of their texture. Estimation of the glycemic response, determination of the carotenoids content and sensory analysis of the fortified bread were also determined. Results highlighted that the highest glycemic index was achieved in bread sample having the highest water content and that showed the worst results in terms of texture. Among the studied samples, bread with medium hydration level showed good structural characteristic, double anti-oxidant content compared to the control bread (CTRL S) and the highest sensorial quality.

1. Introduction

Bread is a food produced using simple ingredients such as wheat flour, salt, yeast and water, but despite this, is one of the most consumed cereal products in many countries and a food at the basis of the diet of many people around the world. Precisely because of its simplicity and its wide consumption, the bread is suitable to be enriched and fortified with ingredients that can bring benefits to the consumer in terms of health. In fact, nowadays consumers prefer to eat healthier foods in order to prevent non-communicable diseases (Hathorn, Biswas, Gichuhi, & Bovell-Benjamin, 2008).

Among the ingredients that could be included in bread formulation there are vegetables, which are important part of the human diet. Pepper (*Capsicum annum*) is a vegetable of the Solanaceae family, native of South America, whose cultivation has spread around the world. Its fruits are rich in vitamins, mineral salts, and carotenoids (a class of antioxidants primarily found in yellow or red vegetables able to neutralize free radicals in cell membranes) such as beta-carotene, lutein and capsantin (Holmes & Kemble, 2009; Mateos et al., 2003) and other substances beneficial to health. So the incorporation of yellow pepper flour would improve the nutritional value of bread. Current researches have confirmed that foods rich in antioxidants play an essential role in the prevention of cardiovascular diseases, cancers and neurodegenerative diseases, as well as inflammation and problems caused by cell and cutaneous aging (Fan, Zhang, Yu, & Ma, 2006). Studies have been carried out to find potential sources of natural carotenoids in food, in particular, as pointed out by Hidalgo, Brandolini, and Pompei (2010), durum wheat flour used for the production of bread, baked products and pasta, provides a significant carotenoid contribution to the human diet. Because of the high levels of carbohydrates in bread, the determination of glycemic index (GI) of yellow pepper flour enriched bread seemed to be an important criterion to take into account when evaluating the so-called nutritional and physiological advantages of this product. According to the definition given by the Food and Agriculture Organization/World Health Organization (FAO/WHO, 1998), this index corresponds to the incremental area under the blood glucose response curve of a 50 g carbohydrate portion of a test food expressed as a percentage of the response to the same amount of carbohydrate from a standard food taken by the same subject (FAO/WHO, 1998).

The knowledge information regarding the effects of vegetable flours on dough and bread physico-chemical properties are few. Pumpkin seed products were incorporated into wheat flour to

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manufacture fortified bread (El-Soukkary, 2001; Giami, Mepba, Kiin-Kabari, & Achinewhu, 2003). The effect of the vegetable ingredients on the dough and bread quality as well as on the nutritional composition of the obtained bread was evaluated. Also Ptitchkina, Novokreschonovaa, Piskunova, and Morris (1998) explored the effect of addition of pumpkin powder to a standard wheat bread formulation. The most recent study is that of Mastromatteo, Danza, Guida, and Del Nobile (2012b), where the manufacturing of vegetable flour loaded bread was optimized acting on the flour hydration process. However, due to the high temperature of the drying process, the vegetable flour used had a low carotenoid content, as also highlighted by Padalino, Mastromatteo, Lecce, Cozzolino, and Del Nobile (2013). This may represent a serious limitation to the wide use of vegetable flour fortified bread.

In this direction, the aim of the work was the manufacturing of durum wheat bread added with yellow pepper flour obtained by means of a mild drying process. In particular, the production methodology proposed by Mastromatteo et al. (2012b), was used in this study to obtain a carotenoids-enriched durum wheat bread with good physico-chemical and sensorial properties. To this aim the following analysis were run: textural analysis of the dough samples and the manufactured bread, sensorial analysis, estimation of the glycemic response and determination of the carotenoids content.

2. Materials and methods

2.1. Raw materials

Durum wheat flour was bought from Tandoi mill (Molini Tandoi S.p.A., Corato, Bari, Italy), yellow pepper flour was purchased from Farris farm (Troia, Foggia, Italy), whereas guar seed flour was supplied from Farmalabor s.r.l (Canosa di Puglia, Bari, Italy). Fresh compressed yeast, salt and extra virgin olive oil were bought from a local market, dried sourdough was supplied from Bongiovanni mill (Molini Bongiovanni S.p.A., Villanova Mondovi', Cuneo, Italy). The fresh vegetable, the yellow pepper, was subjected at a mild drying process, in particular it was dried at constant temperature of 65 °C for 460 min. The moisture content of the fresh vegetable was about 90 g moisture/g dry matter, whereas that of the yellow pepper flour after the mild drying process was about 13 g moisture/g dry matter. Moreover, the vegetable flour presented for the centesimal composition, g/100 g dry matter, respectively: protein 3.1; soluble dietary fiber 8.7; insoluble dietary fiber 13.3; total dietary fiber 22.1. The water absorption capacity of the yellow pepper flour is about 35%.

2.2. Breadmaking process

Dough mixing, processing and baking were performed on laboratory-scale equipment. Durum wheat bread formulated without yellow pepper flour was used as first reference sample (CTRL S); while a second reference sample consisted of durum wheat bread with the addition of no-hydrated yellow pepper flour (CTRL P). The breadmaking process parameters and the ingredients amount were chosen according to a well-defined recipe followed by the same authors in a previous study (Mastromatteo, Danza, Guida, & Del Nobile, 2012a, 2012b). Regarding the other investigated bread samples, yellow pepper flour previously hydrated by using different amounts of hot water (0.4, 0.7, 1.0 L) was added to the dough formulation in order to obtain another three bread samples named as P-0.4, P-0.7, P-1.0. Also in this case, the recipe and the breadmaking process were the same used in a previous work (Mastromatteo et al., 2012a, 2012b).

After baking, bread samples were cooled down for about 2 h at room temperature and were submitted to instrumental, chemical and sensory analyses. Baking process was performed in triplicate. All the dough samples investigated are listed in Table 1.

2.3. Textural properties

2.3.1. Dough texture analysis

The tensile properties of the investigated doughs were measured by using a Texture Analyzer Zwick/Roell model Z010 (Zwick Roell Italia S.r.l., Genova, Italia) equipped with a dough tensile testing device. Dough samples for the texture analysis were prepared as those used in breadmaking process without adding any yeast to the formulation to avoid bubble interference. Before beginning the analysis, the material to be tested was placed between the molding and compression plates, so that inside the press samples with suitable size analysis were formed. After this stage, each sample was individually resting on a support table, which was inside the materials testing machine. The material testing machine starts in the tensile direction and the tensile hook recorded the test load. Pre-load of 0.01 N, load cell of 50 N and crosshead speed constant of 50 mm/min were the trial specifications.

2.3.2. Crumb texture analysis

All bread loaves were uniformly sliced to a thickness of 15 mm and the loaf crust was cut off allowing only crumb texture measurements. Cylindrical crumb samples (280 mm diameter) were cut from the center of each bread loaf using a circular cutter. Compression tests were carried out by using a Texture Analyzer Zwick/Roell model Z010 (Zwick Roell Italia S.r.l., Genova, Italia). An insert plate fixed in the universal work platform ($100 \times 90 \times 9$ mm) and compression die (75 mm diameter) were the parallel plates inside which the cylindrical breadcrumb samples were placed. The force required to compress slices of bread to a predetermined level of penetration against a rigid back plate using a cylindrical plunger was recorded for each sample tested. Pre-load of 0.3 N, load cell of 1 kN, maximum percentage deformation of 50% and a constant crosshead speed of 100 mm/min were the experimental conditions.

2.4. Tomographic analysis

For X-ray microtomographical analysis (μCT) the dough and bread samples were imaged under the same conditions, using the Skyscan 1172 high-resolution desktop X-ray microtomography system (Skyscan, Belgium). The dough samples were analyzed after 105 min of leavening but, in order to inactivate the yeast and therefore avoid the continuous rising of the dough during scanning, the samples were placed in cold storage (4 °C) for 20 min. In both cases, dough and bread samples were prepared as those used in

Table 1
Formulations of the investigated bread samples.

Sample	[a]Semolina flour (g/100 g)	[a]Yellow pepper flour (g/100 g)	[a]Guar Gum (g/100 g)	[b]Water content (L)	Total water content (L)
CTRL S	100	–	–	–	2.9
CTRL P	75	25	2	–	2.9
P-0.4	75	25	2	0.4	3.3
P-0.7	75	25	2	0.7	3.6
P-1.0	75	25	2	1.0	3.9

[a] g/100 g flour basis.
[b] Water content used to hydrate the vegetable flour before the breadmaking process.