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Physico-chemical properties and sensory profile of durum wheat Dittaino PDO (Protected Designation of Origin) bread and quality of re-milled semolina used for its production

Virgilio Giannone[a], Mariagrazia Giarnetti[b], Alfio Spina[c], Aldo Todaro[a], Biagio Pecorino[d], Carmine Summo[b], Francesco Caponio[b], Vito Michele Paradiso[b], Antonella Pasqualone[b,*]

[a] Department of Agricultural and Forest Sciences, University of Palermo, Viale delle Scienze Ed. 4, 90128 Palermo, Italy
[b] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via Amendola, 165/A, 70126 Bari, Italy
[c] Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Centro di Ricerca per la Cerealicoltura e le Colture Industriali, Corso Savoia 190, 95024 Acireale, Italy
[d] Department of Agriculture, Food and Environment (Di3A), University of Catania, Via Santa Sofia 100, 95123 Catania, Italy

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ABSTRACT

To help future quality checks, we characterized the physico-chemical and sensory properties of Dittaino bread, a sourdough-based durum wheat bread recently awarded with Protected Designation of Origin mark, along with the quality features of re-milled semolina used for its production. Semolina was checked for Falling Number (533–644 s), protein content (12.0–12.3 g/100 g d.m.), gluten content (9.7–10.5 g/100 g d.m.), yellow index (18.0–21.0), water absorption (59.3–62.3 g/100 g), farinograph dough stability (171–327 s), softening index (46–66 B.U.), alveograph W (193×10^{-4}–223×10^{-4} J) and P/L (2.2–2.7). Accordingly, bread crumb was yellow, moderately hard (16.4–27.1 N) and chewy (88.2–109.2 N × mm), with low specific volume (2.28–3.03 mL/g). Bread aroma profile showed ethanol and acetic acid, followed by hexanol, 3-methyl-1-butanol, 2-phenylethanol, 3-methylbutanal, hexanal, benzaldehyde, and furfural. The sensory features were dominated by a thick brown crust, with marked toasted odor, coupled to yellow and consistent crumb, with coarse grain and well-perceivable sour taste and odor.

1. Introduction

In many areas of the world, while taking into account the developments of new production methods and materials, farmers and food producers have tried to keep traditions alive, in terms of local artisanal processing methods. The cultural and gastronomic heritages are important factors contributing to the diversity of agricultural food productions and, besides the social aspects, a certain economic impact has been established. In fact, during the last decades, consumers have shown an increasing appreciation of traditional and typical foods, thus inducing the European Union to regulate this subject.

According to the EU Regulation No. 1151/2012, "traditional" is the claim used for foods that historically – i.e. for a period of at least 30 years, that allows transmission between generations – are part of the cultural heritage of people living in a specific geographical area (European Parliament & European Council, 2012). "Typical" is the attribute of food whose quality features strictly depend on the geographical area of production, due to the combined effect of soil and water physico-chemical characteristics, climate, microflora, and local processing techniques (D'Amico, 2004). In particular, the "Protected Designation of Origin" (PDO) identifies a product originated and totally produced in a specific geographical area, whereas to obtain the "protected geographical indication" (PGI) mark, less stringent than PDO, is sufficient that at least one of the production steps takes place in the defined geographical area (European Parliament & European Council, 2012).

At European level, few breads have been awarded by PDO recognition: the Italian breads "Pane di Altamura" (Altamura bread), "Pagnotta del Dittaino" (Dittaino bread), and "Pane Toscano" (Tuscany bread), and the Swedish bread "Upplandskubb" (European Commission, 2016a), registered by the European Regulations Nos. 1291/2003, 516/2009, 303/2016, and 843/2014, respectively (European Commission, 2003, 2009, 2014a, 2016b). Among them, Altamura PDO bread and Dittaino PDO bread, although being produced using different cultivars and in different areas, are both obtained from durum wheat re-milled semolina, according to a bread-making tradition

* Corresponding author.
E-mail address: antonella.pasqualone@uniba.it (A. Pasqualone).

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consolidated in Southern Italy (Pasqualone, 2012). Altamura PDO bread has been extensively studied (Bianchi, Careri, Chiavaro, Musci, & Vittadini, 2008; Brescia et al., 2007; Chiavaro, Vittadini, Musci, Bianchi, & Curti, 2008; Pasqualone, Alba, Mangini, Blanco, & Montemurro, 2010; Pasqualone, Summo, Bilancia, & Caponio, 2007; Raffo et al., 2003). On the contrary, no research has been aimed until now to the quality characterization of Dittaino PDO bread, apart the inclusion of its sourdough in an array of samples for a survey on microbiotas used for traditional/typical Italian breads (Minervini et al., 2012).

Starting from durum wheat cultivation, all processing steps of Dittaino PDO bread take place within the area closely surrounding the Sicilian town of Enna (Italy), along the Dittaino river. Bread production follows a very simple and genuine recipe exclusively based on re-milled semolina, water, sourdough, and sea salt, without the addition of sugar, malt or malt extract, fats, anti-staling ingredients or any other additive. More specifically, durum wheat cultivars Simeto, Duilio, Arcangelo, Mongibello, Ciccio, Colosseo, Bronte, Iride, and Sant'Agata, grown in the Dittaino area, have to be used, alone or in combination, for at least 70% of the total semolina. The fermentation of dough is based on the dynamic equilibrium between yeasts and lactic bacteria of traditional sourdoughs (Type I) (De Vuyst & Neysens, 2005), with *Lactobacillus sanfranciscensis* (*Lactobacillus brevis* ssp. *lindneri*), *Candida milleri* and *Saccharomyces exiguus* as principal microbial species (European Commission, 2014b; Minervini et al., 2012). Dittaino PDO bread is finally baked at 230 °C for 60 min, traditionally as a round loaf of hearth bread weighing between 500 g and 1.100 g, characterized by a well-developed dark brown, highly consistent crust, and by pale yellow, uniformly porous crumb.

The official technical sheet of Dittaino PDO bread reports the main physico-chemical characteristics of starting durum wheat, semolina and bread (European Commission, 2014b). In particular, re-milled semolina must have protein content ≥10.5% (d.m.), ashes = 0.70–0.90% (d.m.) and Falling number = 480–800 s. Bread loaves must have a 3–4 mm thick crust and a moisture content ≤38%. However, a more detailed quality characterization of the end-product and its raw material could improve technical awareness by producers, overcoming empirical knowledge, and could even enhance quality and consumer appreciation. In this framework, the aim of this research was to characterize the physico-chemical properties and sensory profile of Dittaino PDO bread, along with the quality features of re-milled semolina used for its production.

2. Materials and methods

2.1. Sample collection

Samples of durum wheat Dittaino PDO bread, along with the starting re-milled semolina certified for PDO bread production, were collected in five samplings (coded A–E) that were carried out, within the period of two months, in local bakeries of the Dittaino area (Enna, Sicily, Italy). At each sampling, three bread loaves and two re-milled semolina samples were collected. Breads were produced according to the official procedure of Dittaino PDO bread (European Commission, 2014b), that requires the use of natural sourdough (Type I) (De Vuyst & Neysens, 2005) derived from a daily renewed starter. The renewal procedure involves mixing sourdough starter, re-milled semolina, and water at 1:4:2 ratio (2.5 kg sourdough starter, 10 kg re-milled semolina, 5 L water), and resting for 12–14 h at approximately 15 °C, so as to double the volume. The final dough contained durum wheat re-milled semolina (100 kg), water (62.5 L), renewed sourdough (about 18 kg), and NaCl (2 kg). After 10–12 min mixing by means of diving arm mixers, the dough was rested in bulk for 1 h at room temperature, then was scaled into portions weighting about 1100 g (to take into account the weight loss due to water evaporation during baking). The portions were then shaped as round loaves and proofed for 2.5 h at 32–34 °C. Baking was carried out at 240 °C for 60 min in gas fueled ovens.

2.2. Physico-chemical analyses of re-milled semolina

Protein content was determined by means of Infratec 1241 Grain Analyzer 148 (Foss Tecator, Höganäs, Sweden), based on Near Infrared Transmittance. A calibration curve (range 8.3%–15.3%) was previously set up on the results of Kjeldahl nitrogen method and validated according to ISO 12099:2010 method (ISO, 2010) on a large set of samples.

Ash and moisture content were determined according to the AACC 44-19 and AACC 08-01 methods (AACC, 2000), respectively.

Dry gluten was determined by using a Glutomatic System consisting of Glutomatic 2200, Centrifuge 2015, Glutork 2020 (Perten Instruments AB, Huddinge, Sweden), according to the UNI 10690 method (UNI, 1979).

The α-amylase activity was determined by using the Falling Number 1500 apparatus (Perten Instruments AB, Huddinge, Sweden), according to the ISO 3093:2009 method (ISO, 2009).

The color parameters in the color space L^*, a^*, b^* were determined by Chromameter CR-300 (Minolta, Osaka, Japan), under the illuminant D65. Brown index was calculated as $100 - L^*$.

The farinograph indices were determined according to the AACC 54-21 method (AACC, 2000) by a farinograph (Brabender instrument, Duisburg, Germany), equipped with the software Farinograph® (Brabender instrument, Duisburg, Germany). Water absorption needed to achieve the dough consistency of 500 ± 20 Brabender Units (B.U.) (A), dough development time (B), dough stability (CD), and consistency drop off after 12 min (E12) were measured.

Alveograph trials were performed according to the AACC method 54-30A (AACC, 2000) using an alveoconsistograph, equipped with the software Alveolink NG (Tripette et Renaud, Villeneuve-la-Garenne, France).

Damaged starch was determined enzymatically-spectrophotometrically according to AACC 76-31.01 method (AACC, 2000) using the Megazyme starch damage assay kit (Megazyme, Bray, Ireland), and was expressed as percentage of flour weight on fresh weight (f.w.) basis.

The particle size distribution was analyzed by a LabSifter (KBF7SN, Buhler, Switzerland). Re-milled semolina (100 g) was sifted for 5 min on sieves with opening of 300, 200, 180, and 160 μm.

All the analyses were carried out in triplicate.

2.3. Physico-chemical analyses of bread

Moisture content of bread crumb was determined by oven drying at 105 °C until constant weight. Water activity (a_w) was determined by Hygropalm 40 AW (Rotronic Instruments Ltd, Crawley, UK) according to manufacturers' instructions. For these determinations, three bread slices (11 ± 1 mm thickness) were used, and one square crumb sample (40 mm × 40 mm) was taken from the center of each slice.

The Texture Profile Analysis (TPA) of bread was carried out by means of an Universal Testing machine (model 3344, Instron, Norwood, MA, USA), equipped with 5.0 cm diameter cylindrical probe, 2000 N load cell, and Bluehill® 2 software (Instron, Norwood, MA, USA), in the conditions reported in Giannone et al. (2016).

Specific volume was determined by rapeseed displacement, as in AACC method 10-10 (AACC, 2000).

Color parameters of crumb and crust in the color space L^*, a^*, b^* were determined by Chromameter CR-300 (Minolta, Osaka, Japan), under the illuminant D65. Brown index was calculated as $100 - L^*$.

Total carotenoid pigments were determined according to AACC approved method 14-50.01 (AACC, 2000) with slight modifications: bread crumb was lyophilized and ground in a mortar, then 1 g of each sample was extracted with 5 mL of water-saturated *n*-butyl alcohol on