Food Microbiology 47 (2015) 99–110

Contents lists available at ScienceDirect

Food Microbiology

journal homepage: www.elsevier.com/locate/fm

Iranian wheat flours from rural and industrial mills: Exploitation of the chemical and technology features, and selection of autochthonous sourdough starters for making breads

Erica Pontonio [a], Luana Nionelli [a], José Antonio Curiel [a], Alireza Sadeghi [b], Raffaella Di Cagno [a], Marco Gobbetti [a], Carlo Giuseppe Rizzello [a, *]

[a] Department of Soil, Plant and Food Science, University of Bari Aldo Moro, 70126 Bari, Italy
[b] Department of Food Science and Technology, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran

ARTICLE INFO

Article history:
Received 19 June 2014
Received in revised form
2 October 2014
Accepted 24 October 2014
Available online 9 December 2014

Keywords:
Lactic acid bacteria
Fermentation
Baked goods

ABSTRACT

This study aimed at describing the main chemical and technology features of eight Iranian wheat flours collected from industrial and artisanal mills. Their suitability for bread making was investigated using autochthonous sourdough starters. Chemical analyses showed high concentration of fibers and ash, and technology aptitude for making breads. As shown through 2-DE analyses, gliadin and glutenin subunits were abundant and varied among the flours. According to the back slopping procedure, type I sourdoughs were prepared from Iranian flours, and lactic acid bacteria were typed and identified. Strains of *Pediococcus pentosaceus*, *Weissella cibaria*, *Weissella confusa*, and *Leuconostoc citreum* were the most abundant. Based on the kinetics of growth and acidification, quotient of fermentation and concentration of total free amino acids, lactic acid bacteria were selected and used as sourdough mixed starters for bread making. Compared to spontaneous fermentation, sourdoughs fermented with selected and mixed starters favored the increase of the concentrations of organic acids and total free amino acids, the most suitable quotient of fermentation, and the most intense phytase and antioxidant activities. Although the high concentration of fibers, selected and mixed starters improved the textural features of the breads. This study might had contribute to the exploitation of the potential of Iranian wheat flours and to extend the use of sourdough, showing positive technology, nutritional and, probably, economic repercussions.

1. Introduction

Since centuries soft wheat (*Triticum aestivum*) and durum wheat (*Triticum durum*) are cultivated in Iran. It seemed that these species and their main genetic diversity originated from this country (Moghaddam et al., 1997). Nowadays, wheat is the most important crop cultivated in Iran (Moghaddam et al., 1997). Because of the geographical position, Iran is considered to be as a dry or semi-dry region, where wheat flowering and grain filling are often subjected to environmental stresses and water deficit (Abdoli and Saeidi, 2012). The composition of the wheat flour is consequently affected. The wheat cultivated in Iran mainly includes primitive cultivars and wheat landraces, consisting of a mixture of genotypes, which evolved under peculiar environmental conditions and natural selection (Moghaddam et al., 1997).

Bread is the most popular staple foods consumed in Iran. Traditional Iranian breads were already described, and appreciated for taste and overall quality (Fazeli et al., 2004). In particular, typical products such as Lavash, Taftoon, Barbari and Sangak breads are manufactured through traditional protocols, which include variable parameters of fermentation and baking, and lead to different and typical sensory and rheology features (Khaniki, 2005). Rural bread making is only or mainly based on spontaneous fermentation. On the contrary, bread making in the urban areas is recently subjected to the expansion of semi-automatic and fast equipment, and

Abbreviations: 2-DE, Two-dimensional electrophoresis; Ban, Bandar Torkaman/Jorgan; Bar, Barbari; UD, Unfermented Dough; DY, Dough yield; FAA, Free amino acids; GI, Gluten index; HMW, High molecular weight; IEF, Isoelectric focusing; Kas, Kashmar; Lav, Lavash; LMW, Low molecular weight; ME, Methanolic extract; Ney, Neyshabur; OPA, *o*-phtaldialdehyde; PCA, Principal Component Analysis; QF, Quotient of fermentation; San, Sangak; SB, Sourdough bread; SLS, Selected sourdough starter; SS, Spontaneous sourdoughs; Taf, Taftoon; Tor, Toroujen; TPA, Texture Profile Analysis; TTA, Total titratable acidity; WSE, Water/salt-soluble extract.

* Corresponding author. Tel.: +39 0805442948; fax: +39 0805442911.
E-mail address: carlogiuseppe.rizzello@uniba.it (C.G. Rizzello).

http://dx.doi.org/10.1016/j.fm.2014.10.011
0740-0020/

chemical leavening. The use of sodium bicarbonate almost replaced sourdough (Fazeli et al., 2004). As the consequence of chemical leavening, the shelf-life of baked goods markedly decreased, which leads to a huge waste of bread (Fazeli et al., 2004). A further nutritional consequence of chemical leavening concerns the high content of phytic acid into the breads, also due to the high flour extraction rates, which markedly decreases the mineral bioavailability (Didar, 2011).

Cereal fermentation processes depend on specific determinants, which have to be strictly controlled to get standardized and agreeable products (Hammes and Gänzle, 1998). Among these determinants, the type of flour is one of the most important. It affects the technology features and the nutritional value of the baked goods and, more in general, the microbial fermentation through the level and type of fermentable carbohydrates, nitrogen sources and growth factors (Hammes et al., 2005). Overall, the use of industrial starter cultures for cereal fermentations is limited, and, when used, starter cultures often lack of biochemical properties to differentiate the products and to exploit the potential of the various flour matrices (Coda et al., 2014). Mainly based on the above considerations, the manufacture of bakery products with local flours and tailor made starter cultures for specific raw ingredients is deserving a marked interest to get new niche products (Coda et al., 2014). Nowadays, the chemical and technology characterization of Iranian flours, and the selection of lactic acid bacteria suitable for industrial or artisanal bread making would represent an useful tool to better address the biotechnology choices of the Iranian bakery industries.

This study aimed at characterizing the chemical and technology features of eight Iranian wheat (*T. aestivum* and *T. durum*) flours. Suitable autochthonous lactic acid bacteria strains were selected for sourdough fermentation. A comparison between spontaneous and selected sourdough fermentations was made, and the main features of related breads were determined.

Table 1
Chemical and technological characteristics of the Iranian wheat flours.

Flours	Origin	Type	Moisture (%)	Protein (% of d.m.)	Ash (% of d.m.)	Starch (% of d.m.)	Fat (% of d.m.)	Fibers (% of d.m.)	Dry gluten (% of d.m.)	Gluten Index	Falling number (sec)
Lav	Commercial blend designed for making Lavash bread, purchased from an industrial mill in Mashhad area, Iran	*Triticum aestivum*	12.7 ± 0.8^{b}	12.3 ± 1.0^{d}	0.83 ± 0.10^{c}	66 ± 5^{b}	1.45 ± 0.10^{c}	6.70 ± 0.43^{e}	11.0 ± 1.3^{b}	100 ± 9^{a}	450 ± 32^{a}
San	Commercial blend designed for making Sangak bread, purchased from an industrial mill in Mashhad area, Iran	*Triticum aestivum*	11.7 ± 0.6^{c}	16.4 ± 1.3^{a}	0.82 ± 0.07^{c}	67 ± 6^{b}	1.45 ± 0.09^{c}	2.65 ± 0.20^{f}	12.2 ± 1.0^{a}	96 ± 7^{b}	410 ± 24^{b}
Bar	Commercial blend designed for making Barbari bread, purchased from an industrial mill in Mashhad area, Iran	*Triticum aestivum*	9.3 ± 0.5^{e}	12.2 ± 1.2^{d}	0.77 ± 0.03^{d}	69 ± 6^{a}	1.31 ± 0.11^{c}	7.43 ± 0.32^{d}	11.5 ± 0.9^{b}	96 ± 9^{b}	417 ± 30^{d}
Taf	Commercial blend designed for making Taftoon bread, purchased from an industrial mill in Mashhad area, Iran	*Triticum aestivum*	12.2 ± 1.2^{b}	12.4 ± 1.2^{d}	0.78 ± 0.2^{d}	64 ± 4^{c}	1.31 ± 0.14^{c}	9.30 ± 0.65^{c}	11.3 ± 1.5^{b}	99 ± 3^{a}	400 ± 27^{b}
Ney	Blend purchased from an artisanal mill in the rural area of Neyshabur, Iran	*Triticum aestivum* and *Triticum durum*	10.2 ± 0.9^{d}	14.4 ± 1.3^{b}	1.99 ± 0.21^{a}	57 ± 6^{e}	4.70 ± 0.24^{a}	11.71 ± 1.09^{a}	12.4 ± 1.7^{a}	96 ± 6^{b}	85 ± 9^{c}
Tor	Blend purchased from an artisanal mill in the rural area of Toroujen, Iran	*Triticum aestivum*	12.2 ± 0.9^{b}	12 ± 0.8^{d}	1.05 ± 0.08^{b}	64 ± 7^{c}	1.70 ± 0.15^{b}	9.04 ± 0.47^{c}	11.1 ± 0.8^{b}	98 ± 5^{a}	446 ± 22^{a}
Kas	Blend purchased from an artisanal mill in the rural area of Kashmar, Iran	*Triticum aestivum* and *Triticum durum*	8.0 ± 0.3^{e}	13.9 ± 0.9^{c}	1.94 ± 0.11^{a}	61 ± 4^{d}	4.7 ± 0.31^{a}	10.46 ± 1.79^{b}	8.6 ± 0.5^{d}	78 ± 5^{c}	72 ± 6^{c}
Ban	Blend purchased from an artisanal mill in the rural area of Bandar Torkaman/Jorgan, Iran	*Triticum aestivum*	13.6 ± 1.1^{a}	10.9 ± 1.1^{e}	0.62 ± 0.09^{e}	66 ± 5^{b}	1.24 ± 0.08^{d}	7.60 ± 0.52^{d}	9.9 ± 0.8^{c}	97 ± 8^{b}	408 ± 29^{b}

The data are the means of three independent experiments ± standard deviations ($n = 3$).
$^{a–e}$Values in the same column with different superscript letters differ significantly ($P < 0.05$).