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Retention of alkylresorcinols, antioxidant activity and fatty acids following traditional hulled wheat processing

Elisa Giambanelli*, Federico Ferioli, L. Filippo D'Antuono

Department of Agri-Food Science and Technology, Food Science University Campus, University of Bologna, Piazza Goidanich 60, 47521, Cesena, Italy

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ABSTRACT

This study compared alkylresorcinols, fatty acids and antioxidant activity retention following hulled wheat processing by traditional and modern plants. Glume removal and kernel crushing were considered as characterising steps.

Samples were collected from two traditional einkorn wheat bulgur processing plants in Turkey, one emmer wheat processing plant in Armenia and a modern two stage processing plant in Italy, also including pearling.

Whole kernels showed higher alkylresorcinol contents (759–1037 mg kg^{-1} dm) and antioxidant activity with respect to the correspondent crushed products. Following crushing a decrease of total alkylresorcinol content was observed, with lowest amounts detected in the semolina-like fractions. Pearling did not determine a significant decrease of alkylresorcinols of the pearled output. However the waste obtained from pearling, mainly composed of bran parts, showed the highest alkylresorcinol amount (1493 mg kg^{-1} dm) and antioxidant activity. The waste from pearling resulted also the richest fraction of unsaturated alkylresorcinol homologues and unsaturated fatty acids. Among fatty acids, C18:2, C18:1 and C16 resulted the most abundant compounds in all fractions.

All the plants showed similar performance, with higher alkylresorcinol decreases due to the loss of specific parts of kernel, such as germ and bran.

1. Introduction

Whole grains are considered as rich sources of phytochemicals with putative health effects, since epidemiologic studies support the protective role of whole grain consumption on cardiovascular disease and cancer (Slavin et al., 2000; Liu, 2007).

However phytochemical compounds are differently distributed in the caryopses (Liu, 2007), with the highest concentration in bran and germ (Andersson et al., 2014; Adom et al., 2005). Milling generally causes a significant loss of these parts, with a consequent decrease of the associated phytochemical compound content, in the derived food products. Bran and germ have been particularly studied, as milling by-products, for the extraction of high quality oil and vitamin E (Durante et al., 2012). These studies confirmed their richness in phytochemical compounds, increasing the interest towards these by-product.

So the intake of phytochemicals from grains is strictly affected by the process carried out to obtain food products, and by the consumption of whole kernels.

Among *Triticum* species einkorn (*Triticum monococcum* L.) and emmer wheat (*Triticum turgidum* subsp. *dicoccum* (Schrank ex Schubler) Thell) are primitive hulled species generally grown in several south European and Black sea area countries. Consumer interest toward these species is nowadays increasing, and sometimes unconsciously associated with health promotion effects. The processing of hulled species requires glume removal as preliminary step to make their kernels suitable to human consumption. The traditional way for glume removal consists in the use of stone mills that simultaneously crush grains and separate the glumes, that are subsequently removed by ventilation (Giambanelli et al., 2013). So, most product obtained in traditional processing plants is represented by medium and fine groats. Modern technologies allow to separate the glumes from caryopses with very limited grain crushing. In this case whole kernels, the main fraction obtained by glume removal, can be destined either to crushing or pearling, in

* Corresponding author. Department of Agri-Food Science and Technology, Food Science University Campus, University of Bologna, Piazza Goidanich 60, 47521, Cesena FC, Italy.
E-mail address: elisa.giambanelli2@unibo.it (E. Giambanelli).

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dependence on demand (Giambanelli et al., 2013). Pearling is an interesting technique in which the outer layers of caryopses are removed by mean of friction and abrasion operations.

The effects of hulled wheat traditional and modern processing on the retention of tocols, carotenoids, phytosterols and phenolic compounds have been already assessed (Giambanelli et al., 2016).

Among hulled wheat phytochemicals, 5-n-alkylresorcinols are a lesser known but important group, belonging to the class of phenolic compounds, typically found in cereals. Alkylresorcinol content in wheat can range, approximatively, between 200 and 1000 mg kg^{-1} dm, and is highly affected by genotype (Andersson et al., 2008), with higher amounts generally detected in hexaploid species. Alkylresorcinols are mainly located in the bran fraction of kernel and have been suggested as potential markers of whole grain intake (Ross et al., 2004a). The process of glume removal from einkorn and emmer wheat kernels can affect alkylresorcinol content.

Besides alkylresorcinols, also fatty acids have been analysed to discriminate *Triticum* species (Armanino et al., 2002; Suchowilska et al., 2009). The different distribution of monounsaturated and polyunsaturated fatty acids in kernels could affect their content in the fractions generated by glume removal.

Hulled wheats are nowadays positively considered in the sector of healthy foods, However, research about the effects of specific unit operations characterising their processing scheme on final product composition are still lacking. This paper reports the effect of three traditional and a more update processing scheme for glume removal, grain crushing and, in one case, pearling, on alkylresorcinol, antioxidant activity and fatty acids contents of the derived dehulled wheat and wastes fractions.

2. Materials and methods

2.1. Materials

The processing plants, flow charts and the analysed grain fractions, already described in a previous work, mainly aimed at evaluating and comparing the yield factors of traditional and modern plants (Giambanelli et al., 2013), are represented in Fig. 1, whereas the list of the samples is reported in Table 1.

Two Turkish plants, using stone mills to crush einkorn wheat bulgur (TR1BL and TR2BL), were considered. Bulgur is represented by emmer wheat kernels, cooked while still in glumes, then dried. Cooked einkorn wheat bulgur must therefore be subject to glume removal. In plant 1 four different final products were obtained: TR1F4: coarse groats and unbroken kernels; TR1F5: medium-size groats; TR1F6: smaller groats; these fractions remained above one of the three sieve series used in the plant; TR1F8: semolina-like material, passing through the third mechanical sieve and remaining above the last manual sieve. In plant 2, three fractions were obtained as output of a completely manual sieving procedure: TR2F4-F5: larger or medium size groats + unbroken kernels; TR2F6: smaller groats; TR2F8: semolina-like material, respectively, remaining above one of the four manual sieves.

Raw emmer wheat represented the input of the Armenian and the Italian plants (ARF5 and ITF1, respectively). In the Armenian plant a stone mill was still used to crush emmer wheat spikelets, giving the following products as final output: ARF6: whole dehulled kernels; ARF7: coarse groats; ARF8: fine groats. A more update technology was used to process emmer wheat spikelets in the Italian plant, that included also pearling of kernels. In this case emmer wheat spikelets were firstly fed into a teflon rotative impeller dehulling equipment, removing glumes, with minimum kernel break; the resulting material was sorted by sieving, to yield the following fractions: ITF2 and ITF4, respectively, smaller and larger whole kernels, destined to crushing, and ITF3, medium-size whole kernels, destined to pearling. In the Italian plant the step of crushing was therefore separately carried out in a second phase by means of hammer mills to yield: ITF7: fine groats (farricello), and ITSP, a waste consisting of finer material. Alternatively, pearling was carried out by means of abrasive discs, to partially remove the pericarp, yielding: ITF6: pearled kernels, ITF5: kernels broken during the pearling process and destined to crushing, and ITPR: a waste, exclusively composed of bran.

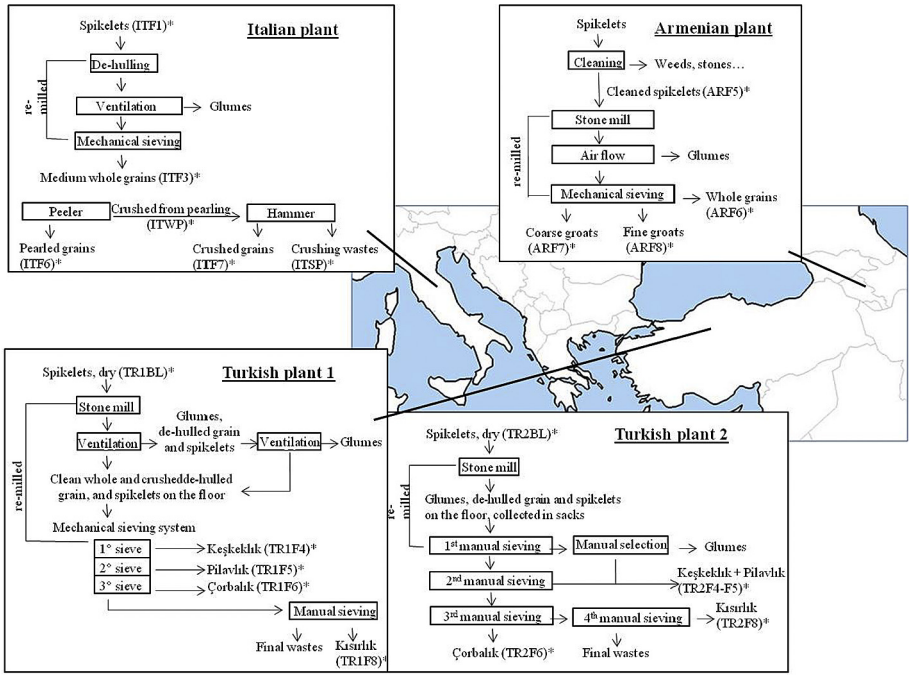

Fig. 1. Graphical scheme resuming the samples and the sampling points.