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COMBINED EFFECT OF HEAT TREATMENT AND HUMIDITY ON THE TOTAL POLYPHENOL CONTENT OF TARTARY BUCKWHEAT WHOLE FLOUR

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Minor crops are gaining new interest due to the high content of bioactive compounds available in their grain and the consequent opportunity to be employed as ingredients for the production of healthy foodstuff. Tartary buckwheat (*Fagopyrum tataricum* Gaertn.) grain is rich in flavonoids, the most important being represented by rutin, a compound possessing a high health value. When processing bakery products added with Tartary buckwheat whole flour, the key point is to prevent rutin from being hydrolysed to quercetin. In this view, a combination of heat treatment and controlled humidity level was applied for different lengths of time, in the attempt to deactivate the enzymes catalysing the reaction. Tartary buckwheat grain contains other polyphenols also capable to confer health properties. This class of compounds has been associated with the prevention of cardiovascular diseases, cancers, neurodegenerative diseases, diabetes, and osteoporosis. In this study it was observed how the physical treatments meant to preserve rutin would influence the overall content of polyphenols in Tartary buckwheat whole flour and dough.

Keywords: Tartary buckwheat, total polyphenol content

Introduction

It is widely accepted by the scientific community that diet has a major impact on human health and well-being. The European Food and Nutrition Action Plan 2015-2020 (EUR/RC64/14), recently issued by the World Health Organization (WHO), identifies the improvement of the population's diet as the most efficient strategy to counteract the insurgence of diet-related non-communicable chronic diseases. Together with a regular physical activity, dietary habits can significantly contribute to maintaining a good state of health. In this view, minor crops may represent a valid opportunity, since the high content of bioactive compounds in their grain make them potential ingredients for the preparation of healthy foodstuff. Among such crops, buckwheat deserves special attention thanks to the wealth of health beneficial properties related to its grain components, several of which attributed to the flavonoid rutin (Christa and Soral-Śmietana, 2008). Compared to common buckwheat (*Fagopyrum esculentum* Moench), Tartary buckwheat (*Fagopyrum tataricum* Gaertn.) is characterised by a much higher rutin content of the grain and therefore has been utilised as ingredient for the preparation of novel healthy food products (Brunori *et al.*, 2010). Nevertheless, when Tartary buckwheat whole flour is mixed with water, rutin tends to be hydrolysed to quercetin. To avoid this, various physical treatments are under investigation in the attempt to deactivate the enzymes involved. More polyphenols other than rutin are available in buckwheat whole flour, which could also be affected by physical treatments.

The aim of the present study was to evaluate the effect of a combination of heat treatment and controlled humidity level, meant to preserve rutin during processing with water, on the total amount of polyphenols in Tartary buckwheat whole flour and dough.

Materials and methods

Tartary buckwheat was cultivated at the experimental site of San Polo Matrice in Central Italy for two running years (2013 and 2014).

Whole flour samples were obtained from clean grains by the use of a FOSS TECATOR CYCLOTEC 1093 sample mill and were subsequently placed in a Climacell 111 at 80°C and 50% humidity for either 30 minutes or 20 hours. Untreated whole flour was also utilised as control.

Table 1. Whole flour samples obtained from Tartary buckwheat grain cultivated in two running years (2013 and 2014), subjected to different physical treatment.

Sample code	Year of cultivation	Length of physical treatment
1	2014	Untreated
2	2014	30 minutes
3	2014	20 hours
4	2013	Untreated
5	2013	30 minutes
6	2013	20 hours

All samples obtained (Table 1) were utilised to prepare dough, by mixing 20 g of whole flour with 20 ml of distilled water. Dough samples were in turn placed in a Climacell 111 adopting the same experimental conditions as previously applied to whole flour samples (80°C and 50% humidity for either 30 minutes or 20 hours). Untreated samples of dough were also prepared, thus testing 18 different experimental conditions (Table 2).

Table 2. Dough samples obtained utilising Tartary buckwheat whole flour samples described in Table 1, in turn subjected to different physical treatments

Sample code	Code of Tartary buckwheat whole flour sample utilised	Length of physical treatment
1.1	1	untreated
1.2	1	30 minutes
1.3	1	20 hours
2.1	2	untreated
2.2	2	30 minutes
2.3	2	20 hours
3.1	3	untreated
3.2	3	30 minutes
3.3	3	20 hours
4.1	4	untreated
4.2	4	30 minutes
4.3	4	20 hours
5.1	5	untreated
5.2	5	30 minutes
5.3	5	20 hours
6.1	6	untreated
6.2	6	30 minutes
6.3	6	20 hours

Water soluble polyphenols content was estimated by the Folin-Ciocalteu method (Singleton and Rossi, 1965) with some modifications. 0.100 g of each whole flour and oven-dried (40°C for 24 hours) mortar powdered dough sample were extracted with 1 ml of distilled water and centrifuged at 10.000 rpm for 10 minutes at 4°C. Three aliquots (0.25 ml) per extract were mixed with 4 ml of distilled water, 0.5 ml saturated Na_2CO_3, 0.25 Folin-Ciocalteu reagent (diluted with water 1:1 v/v). Reagents were allowed to interact at room temperature for 25 minutes, then sample tubes were centrifuged for 10 minutes at 5000 rpm. Absorbance of supernatants was measured at 725 nm in triplicate with a standard deviation ±5%. A standard curve was prepared with Gallic acid (3,4,5-Tri-hydroxybenzoic acid). The results were expressed as Gallic acid equivalents (GAE)/g of dry weight of sample.

Chemicals were purchased from Sigma-Aldrich (St- Louis, MO) and Reanal Fine Chemical Co. Water content of samples was determined by Sartorius M 50 Aquatest instrument.

Results and discussion

In a comparison between the two years of cultivation, the total polyphenol content of Tartary buckwheat whole flour samples resulted higher in the material obtained from grain harvested in 2013 (Figure 1). This could be related to the longer period of storage, as it is reported that in various fruits and vegetables phenol content may either increase or decrease during storage (Moosavi Dolatabadi *et al*., 2015). Alternatively, the cultivation of Tartary buckwheat in different years at the same location or with different sowing timings in the same year affected the grain content of phenolic compounds such as rutin (Brunori *et al.*, 2010).

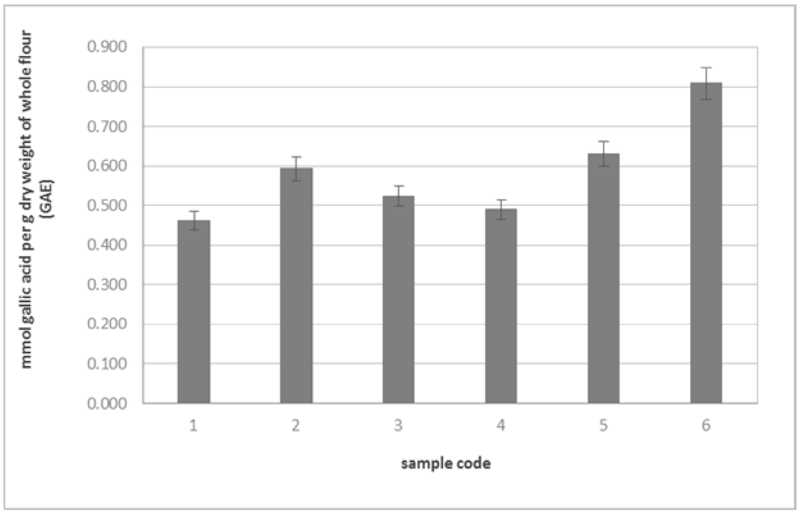

Figure 1. Total polyphenols content of Tartary buckwheat whole flour samples

The application of different thermal treatments (roasting, pressure steam-heating, and microwaving) to raw Tartary buckwheat flour may lead to a significant decrease of total phenolic content and antioxidant activity (Zhang *et al.*, 2010), while only a slight decrease was evidenced when common buckwheat flour was roasted at 200°C for 10 minutes (Sensoy *et al*., 2006). In contrast, exposure to heat may increase significantly the total polyphenol content in eggplant (Chumyam *et al*., 2013). Similarly, samples of 2013 showed total polyphenols values rising steadily with increasing the duration of physical treatment, whereas samples of 2014 did not show a similar trend, although treated samples showed higher values compared to the untreated ones (Figure 1).

Dough samples made with Tartary buckwheat whole flour of 2014 confirmed lower amounts of total polyphenol when compared to those prepared with material from 2013 (Figures 2 and 3).

Within the samples prepared with whole flour of 2014, the top scores were obtained when dough made with treated whole flour was in turn subdued to physical treatment for 30 minutes (samples 2.2 and 3.2 Figure 2). Dough samples made with untreated whole flour showed an opposite trend, with total polyphenol content diminishing as the length of the treatment increased (Figure 2).

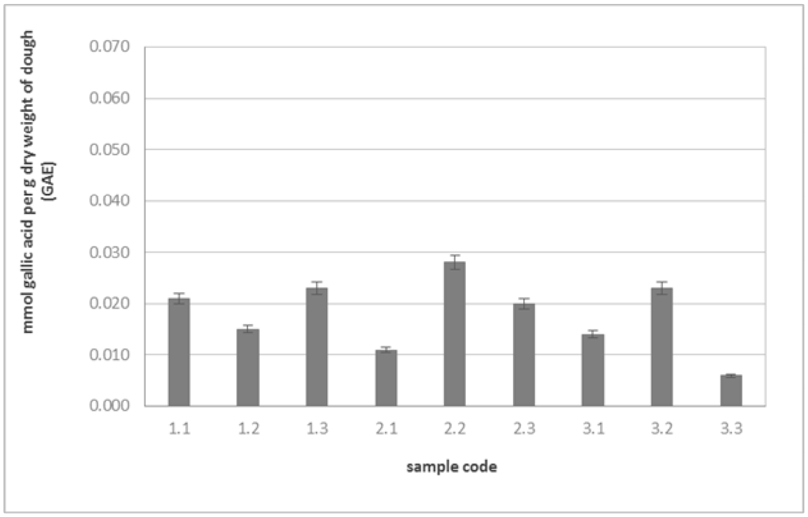

Figure 2. Total polyphenols content of dough samples made with Tartary buckwheat cultivated in 2014

Among the dough samples made with whole flour from 2013, the best combination appeared when dough, prepared with whole flour subjected to 20 hours of physical treatment, was left untreated (sample 6.1 Figure 3).

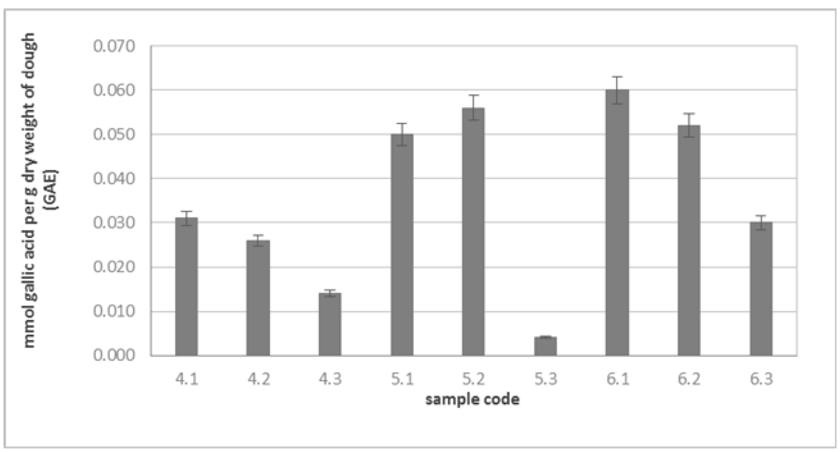

Figure 3. Total polyphenols content of dough samples made with Tartary buckwheat cultivated in 2013

Conclusions

In this study, Tartary buckwheat whole flour treated samples always presented higher amounts of total polyphenols compared to untreated ones, in contrast with previous experiences made with the same species, though in agreement with studies reporting a significant increase of the total polyphenol content in eggplants.

In the case of dough samples, those made with untreated whole flour appeared to be negatively affected by the treatments applied, whereas those prepared with treated whole flour often showed an increase of the total polyphenol content when exposed to a short time treatment (30 minutes).

Overall, the obtained results suggest that it is reasonable to further investigate in order to identify the best combination of physical treatment capable to preserve rutin during processing Tartary buckwheat whole flour with water, without negatively affecting the total polyphenol content of the end product.

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