RUTIN IN TARTARY BUCKWHEAT BREAD

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ABSTRACT

In the present work it was analysed how the concentration of rutin and quercetin changes due to the bread making procedure. Breads were prepared with different amounts of tartary buckwheat flour, i.e. 30%, 50% and 100%. Bread made of 100% wheat flour was used as a control. All other ingredients were the same (water, yeast, salt) and in the same amounts. Rutin and quercetin concentrations were analysed in methanol abstracts of dough sampled 35 and 60 minutes after kneading and in bread using HPLC. The results show that concentration of rutin and quercetin increased with the growing percentage of tartary buckwheat flour in bread mixture. Rutin concentrations decreased with the addition of water to bread mixture and continued to decrease during the bread baking process. Concentration of quercetin was more stable. After baking, rutin (0.47 mg/g) was present only in the bread made of 100% tartary buckwheat flour along with 4.83 mg/g of quercetin.

Keywords: Tartary buckwheat (*Fagopyrum tataricum*), rutin, quercetin, bread baking, antioxidant activity, total polyphenols

INTRODUCTION

Rutin (quercetin-3-rutinosid) is a flavonol glycoside that is synthesized in higher plants and used as a mechanism for protection against ultraviolet radiation and diseases (**Gaberščik et al., 2002; Rosema et al., 2002**). Despite that it has antioxidant properties that may inhibit lipid peroxidation (**Jiang et al., 2007**), decrease capillary fragility associated with hemorrhagic changes (**Yildzogle-Ari et al., 1991**), and reduce high blood pressure and the risk for arteriosclerosis (**Hellerstein et al., 1951**). Flavonol glycosides, including rutin, quercetin, and kaemferol-3-rutinoside, as well as trace amounts of flavanol triglycoside have been identified in methanol extracts of buckwheat (**Tian et al., 2002**) and it is known that tartary buckwheat contains higher concentrations of rutin compared to common buckwheat, other grain crops, and most fruits and vegetables **(Jiang et al., 2007; Kreft et al., 1999; Ohsawa et al., 1995; Park et al., 2000**). Tartary buckwheat could be as such used as a rich source of rutin for preparation of functional food products. And since it does not contain gluten it could be a good source of dietary important components such as polyphenols, vitamins and minerals for celiac disease patients, which usually have monotone and qualitatively poor diet.

Processing methods can modify the polyphenol content of food in several ways (**Manach et al., 2004**). Thermal processing of common buckwheat was shown to have a detrimental effect on the flavonoid content (**Dietrych-Szostak et al., 1999**). In addition, **Sensoy et al. (2006)** reported that extrusion had no effect on the antioxidant activity of buckwheat, in contrast to roasting, which caused a slight decrease of antioxidant activity. An analysis of roasting, pressure steam-heating, and microwave heating methods showed a decrease in phenolic content and antioxidant activity of tartary buckwheat whole-meal flour (**Zhang et al., 2010**). In contrast, other data have shown that cooking, steaming, and microwaving have no deleterious effect on the total polyphenolic content and antioxidant activity of some vegetables (**Turkmen et al., 2005**). Moreover, moderate heat treatment may increase the phenolic content and antioxidant activity (**Turkmen et al., 2005**) due to the occurrence of Maillard reactions, which can lead to the synthesis of substances with antioxidant properties (**Lindenmeier et al., 2004**).

Although some research has been conducted on common buckwheat, data on the antioxidant properties and rutin content of tartary buckwheat flour products are limited. Kreft et al. (**Kreft et al., 2006**) recently reported on the degradation of rutin in common buckwheat products. Noodles made of dark common buckwheat flour contained approximately one third the concentration of rutin found in flour (0.08 mg of rutin/g vs. 0.218 mg of rutin/g, respectively). However, proper assessment of the antioxidant potential of tartary buckwheat is dependent on understanding how processing impacts these compounds, and to date these data have been scarce. In the present study we examined nutritional quality, i.e. rutin and quercetin content as well as the antioxidant activity of tartary buckwheat flour and bread that contained different ratios of tartary buckwheat and wheat flour. Specifically, we wanted to assess how these factors are affected during the bread making and baking processes.

MATERIALS AND METHODS

Rutin and quercetin concentrations were analyzed in buckwheat flour (Tf), wheat flour (Wf), dry yeast, dough, and bread made from tartary buckwheat and wheat flour in the following ratios: 100:0 (T_0), 70:30 (T_30), 50:50 (T_50), and 0:100 (T_100). The bread making procedure was as follows: 5 min of kneading, 30 min of rising, an additional 1 min of kneading, and 29 min of a second rising. Dough sampling was carried out at 35 and 60 min after the commencement of the first kneading. Breads were baked in triplicates and volumes were measured. Baking was performed in an oven with hot air circulation. The temperature was initially 200°C for 10 min and then subsequently lowered to 180°C for an additional 30 min. Samples of crust (0 to 10 mm under the bread surface) and bread inside were taken from the loaves of baked bread. After 5 h of cooling at room temperature, the samples were frozen at -20°C, freeze-dried, and milled for future analyses.

Methanolic extracts were prepared in duplicate out of previously described samples. For this reason 25 mL of 80 % methanol (HPLC grade; Sigma-Aldrich

Corporation, St. Louis, USA) was added to 1 g of each milled sample. The mixture was shaken at room temperature for 8 h at 250 rpm. Samples were then filtered through filter paper (130 g/m^2, Filtrak, Thermalbad Wiesenbad, Germany) and kept at 8°C for further analysis. Before analyzing rutin and quercetin concentrations by HPLC, sample extracts were additionally filtered through a syringe filter unit (0.22 µm). Detailed description on the rutin and quercetin content analyzes procedure is described elsewhere (**Vogrinčič et al., 2010**).

RESULTS AND DISCUSION

Tartary buckwheat flour was the only ingredient containing rutin and quercetin (11.67 and 0.63 mg/g, respectively) (Table 1). Rutin and quercetin concentrations increased with the growing percentage of tartary buckwheat flour used (Fig 1 and 2). Dough and bread made without tartary buckwheat did not contain any of these two compounds. Tartary buckwheat dough made of 100 % tartary buckwheat flour had a lower concentration of rutin and higher concentration of quercetin compared to the respective flour alone (Fig 1 and 2). 0.0175 mmol of rutin was degraded with the addition of water and yeast to tartary buckwheat flour and 0.0149 mmol of quercetin was gained at the same time. This indicates that 85 % of rutin was transformed to quercetin with the addition of water and yeast to the flour. Degradation could be caused by rutin degrading enzymes found in buckwheat (**Yasuda et al., 1994; Suzuki et al., 2002; Suzuki et al., 2005; Suzuki et al., 2007**). Rutin degrading enzymes are stable and active at pH 5 to 7 and below 40°C (**Yasuda et al., 1998**). We have measured the pH of the dough and it was between 5.5 and 6.1. The concentration of rutin continued to decrease during the bread rising process. In addition, the rutin concentration in dough after 60 min of rising was lower as it was after 35 min of rising (Fig 1). After the baking process some rutin remained present only in bread made of 100 % tartary buckwheat flour, while it was undetectable in all other samples. Based on a comparison of concentration levels (Fig 1 and 2) quercetin seemed to be more stable than rutin during the bread rising and baking process.

Table 1 Rutin and quercetin concentration in ingredients for bread: yeast, tartary buckwheat and wheat flour[a]

Ingredient	Rutin (mg/g)	Quercetin (mg/g)
Wheat flour	ND	ND
Tartary buckwheat flour	11.67 ± 0.09	0.63 ± 0.03
Yeast	ND	ND

[a] Results are given as an average of 4 measurements ± standard deviation.
ND: not detected

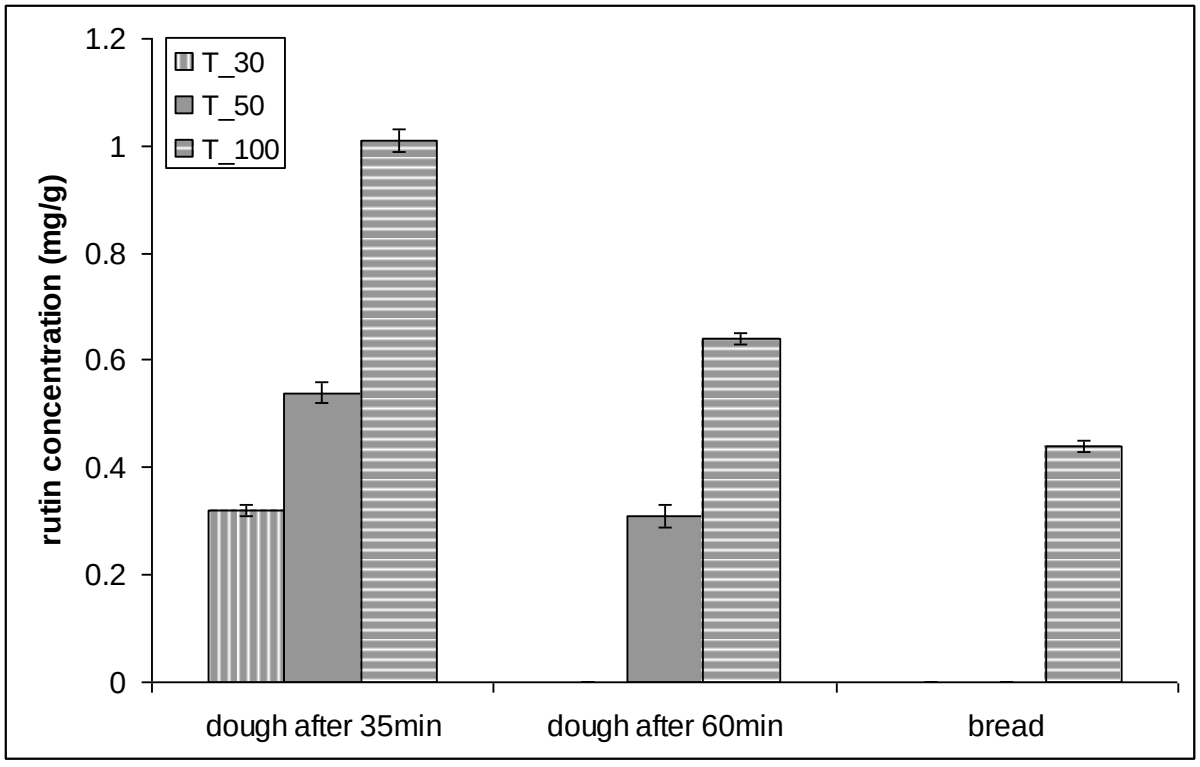

Figure 1 Concentration of rutin (mg/g) in bread and dough (sampled 35 and 60 minutes after the first kneading) made with 30% (T_30), 50% (T_50) and 100% (T_100) tartary buckwheat flour.

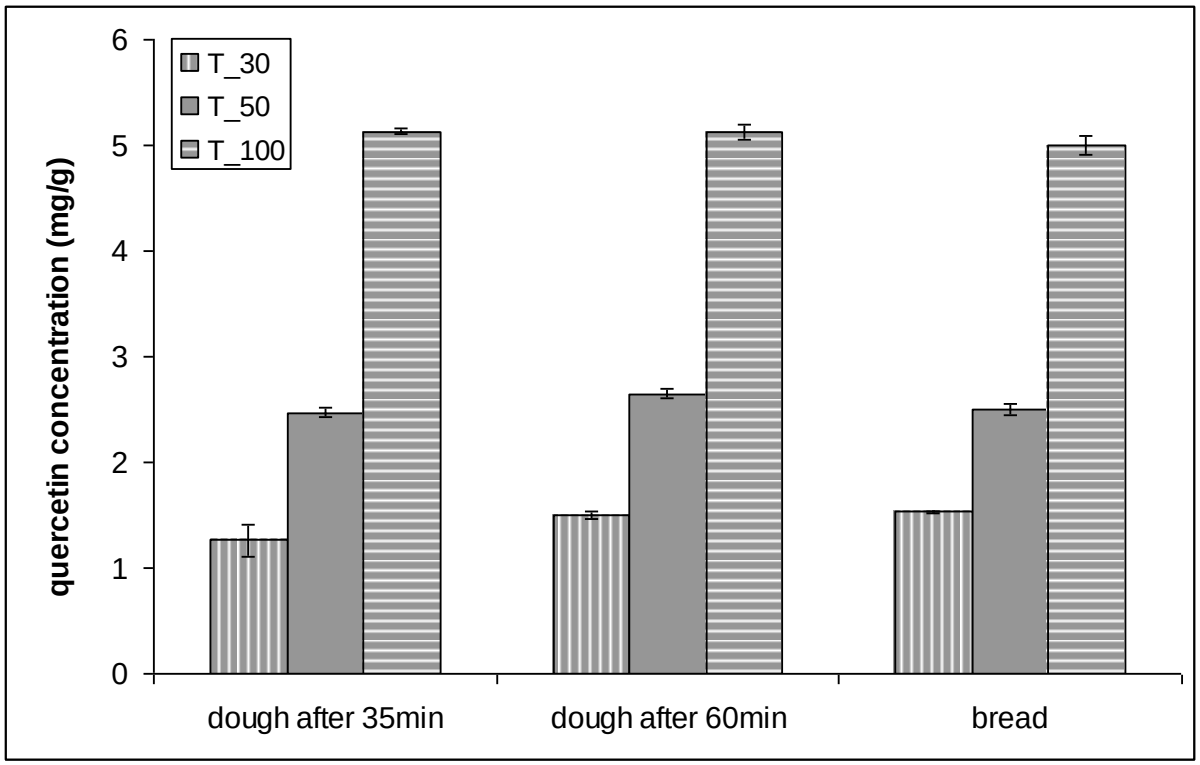

Figure 2 Concentration of quercetin (mg/g) in bread and dough (sampled 35 and 60 minutes after the first kneading) made with 30% (T_30), 50% (T_50) and 100% (T_100) tartary buckwheat flour.

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