

THE USE OF TARTARY BUCKWHEAT WHOLE FLOUR FOR BAKERY PRODUCTS: RECENT EXPERIENCE IN ITALY

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Nowadays consumers are paying increasing attention to the health subtle bearings of the food they consume. The term nutraceutical has been adopted to point to those food preparations which are acknowledged to possess health beneficial properties. Most of these properties rely on the presence of bioactive compounds in the various food ingredients. Among bioactive food components an important group is represented by the flavonoids, of which rutin is credited to exert a multiplicity of health beneficial effects.

Tartary buckwheat (*F. tataricum*), whose whole flour contains high amounts of rutin (up to 2000 mg/100 g dry weight), offers the opportunity to obtain a new range of functional foods capable of providing the consumers effective amounts of such bioactive compound through the daily average consumption of traditional wheat based staples like bread and biscuits.

A preliminary attempt was made to verify the possibility to secure, through the preventive nutrition approach, the multiplicity of health beneficial properties rutin is expected to exert, thanks to the introduction of a few percent of tartary buckwheat whole flour in the original recipe of some traditional backed foods typical of Tuscany, a Region of Central Italy.

Keywords: *Fagopyrum tataricum*, bioactive compounds, functional food

1. Introduction

Buckwheat represents one of the major staples in several Asian and Eastern European Countries. In China and Russia, this crop is widely cultivated and indeed these Countries are the major producers of buckwheat grain.

Buckwheat is consumed as pancakes, fresh noodles, fried dough, porridge, flakes, boiled and popped groats, rye and buckwheat and wheat and buckwheat crackers.

These foods have been developed with the purpose to feed people, not in any case focusing on the target to increase and preserve the rutin content.

The growing evidence of the health beneficial properties of buckwheat grain components, such as protein, starch, minerals and the flavonoid rutin (Christa and Soral-Šmietana, 2008), has raised the interest of ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) in this crop, presently cultivated in few alpine valleys, with the purpose to provide, throughout the Country, the farmers of high hill and mountain areas an alternative to the economically declining cereals currently grown.

Besides assessing the grain yield potential of as many as possible varieties of the two cultivated buckwheat species i.e. *Fagopyrum esculentum* Moench (common buckwheat) and *Fagopyrum*

tataricum Gaertn. (tartary buckwheat) so to identify the best adapted varieties (Brunori et al., 2006), aware of the multifaceted health beneficial properties attributed to buckwheat thanks to the bioactive component rutin, the grain content of this flavonoid was also determined in collaboration with the Corvinus University of Budapest (Brunori and Vegvari, 2007). Hence, the issue of taking advantage of the buckwheat produce was faced, upon the evidence that both buckwheat species may be satisfactorily cultivated in the highlands of Central and Southern Italy.

The possibility was considered to introduce some health beneficial properties of buckwheat grain components into traditional Italian staples like bread and biscuit. In particular, the high content of rutin present in the grain of tartary buckwheat (Kitabayashi et al., 1995b) was expected to provide preventive contents of this flavonoid by adding a few percent of whole flour to the recipe, a chance not within the capability of common buckwheat (Kitabayashi et al., 1995a).

However, not to neglect the beneficial effects of other components of common buckwheat (protein, starch and minerals), within a co-operative project with Corsini Biscotti, a mixture of the whole flour of the two buckwheat species was added to the original recipe of some traditional food products, taking care not to prejudice the consumers acceptance of these traditional Italian quality improved wheat based goods.

2. Materials and methods

Biscuits

Traditional Tuscany biscuits were prepared following the original recipe in which twenty percent of wheat flour was replaced with whole flour of two buckwheat species (common and tartary) as follows:

- 1) Wheat flour 80%, common buckwheat whole flour 16% and tartary buckwheat whole flour 4%;
- 2) Wheat flour 80%, common buckwheat whole flour 12% and tartary buckwheat whole flour 8%;
- 3) Wheat flour 80%, common buckwheat whole flour 8% and tartary buckwheat whole flour 12%.

In the attempt to deactivate the rutin degrading enzymes known to be present in tartary buckwheat grain (Yasuda et al. 1992), the whole flour was either or not pre-treated in an oven at 80°C for 30 minutes (Arita and al. 1998). Cookies prepared following the traditional recipe served as control.

Circular shaped biscuits around 3 cm in diameter were obtained from the dough as soon as it was ready. Biscuits were placed on a tray (one for each of the six different preparations) and baked in an oven at 175°C for 13 minutes.

The time elapsed for the action of rutin degrading enzymes, eventually occurring between the addition of the buckwheat wholemeal to the developing dough and the onset of baking, was approximately 15-20 minutes.

Single baked biscuits had a weight of approximately 9 g each.

Flours and cookies were analysed for rutin and quercetin by the HPLC method according to the procedure previously described (Brunori and Vegvari, 2007).

Bread

A typical bread of the Tuscany Region was prepared replacing twenty percent of wheat flour with common buckwheat whole flour (16%) and tartary buckwheat whole flour (4%).

Again, the whole flour of tartary buckwheat was either pre-treated or not in an oven at 80°C for 30 minutes, in the attempt to inactivate the rutin degrading enzymes. Traditional bread prepared utilising only wheat flour served as control.

Soft wheat sour dough, pre-fermented for 12 hours, was added to the other ingredients (wheat flour, common and tartary buckwheat whole flour, salt and water). The resulting mix was utilised to prepare loaves around 20 cm in length and 8 cm in diameter. The dough portions so obtained were proof-tested

for 4-5 hours and subsequently baked at 190-200°C for 45-50 minutes. Baked loaves had a weight of approximately 300 g.

Flours and bread were analysed for the content of rutin and quercetin by the high pressure liquid chromatography (HPLC) method following the procedure previously described (Brunori and Vegvari, 2007). Quercetin was taken into account to evaluate any degrading activity of rutin hydrolyzing enzymes.

3. Results and discussions

The contents of rutin and quercetin of wheat flour and buckwheat whole flour are reported in Table 1. Quercetin was not found in wheat flour nor in common buckwheat whole flour while an appreciable amount was instead present in tartary buckwheat whole flour no matter the heat treatment. As expected a much higher content of rutin was evident in tartary buckwheat compared to common buckwheat while its presence was not detected in wheat flour.

Table 1. Rutin and quercetin contents of wheat flour and common and tartary buckwheat whole flour.

	Rutin (mg/100 g DW)	Quercetin (mg/100 g DW)
Wheat flour	0.00 ± 0.00	0.00 ± 0.00
Common buckwheat whole flour	18.96 ± 0.44	0.00 ± 0.00
Tartary buckwheat whole flour	1091.43 ± 8.90	1.88 ± 0.12
Tartary buckwheat heat-treated whole flour	1148.51 ± 32.49	2.73 ± 0.01

DW=dry weight

Biscuits

The appearance of biscuits is provided in Figure 1.



Figure 1. Traditional Tuscany biscuits in which 20% of wheat flour was substituted with buckwheat whole flour (8% common buckwheat and 12% tartary buckwheat).

Both the appearance and the taste were not prejudiced by substituting a 20% proportion of wheat flour with buckwheat whole flour. The present finding seems to prove that an appreciable amount of buckwheat whole flour can be supplemented to this particular Tuscany biscuit and that significant beneficial buckwheat bioactive compounds can be secured in this food preparation.

As to the actual recovery of the rutin and quercetin, data on the content of these flavonoids in the biscuits, whose original recipe was supplemented with different proportions of common and tartary buckwheat whole flour, are reported in Table 2.

Table 2. Rutin and quercetin contents of biscuits containing different proportions of common and tartary buckwheat whole flour. Tartary buckwheat whole flour was either (sample 1, 3 and 5) or not (samples 2, 4 and 6) heat-treated in an oven at 80°C for 30 minutes. Control biscuits were made of plain wheat flour.

	Wheat flour	Common buckwheat whole flour	Tartary buckwheat whole flour	Rutin (mg/100g DW)		Quercetin (mg/100g DW)	
				expected	observed	expected	observed
Control	100%	0%	0%	0.00	0.00 ± 0.00	0.00	0.00 ± 0.00
Sample 1	80%	16%	4%	27.68	27.97 ± 0.95	0.06	3.58 ± 0.16
Sample 2	80%	16%	4%	26.43	26.54 ± 1.16	0.04	2.18 ± 0.01
Sample 3	80%	12%	8%	53.14	52.04 ± 2.81	0.12	6.72 ± 0.13
Sample 4	80%	12%	8%	50.70	48.46 ± 3.11	0.09	10.23 ± 0.62
Sample 5	80%	8%	12%	78.59	72.14 ± 7.16	0.19	14.79 ± 0.44
Sample 6	80%	8%	12%	74.98	70.95 ± 3.38	0.13	13.10 ± 0.30

DW = dry weight

The content of rutin recovered in the biscuits quite matched the amount predicted, so that nearly all the rutin could be preserved without undergoing major processes of enzymatic degradation, whereas quercetin was low but appreciably higher than expected. Furthermore, no apparent differences were observed between the preparations containing similar amounts of common and tartary buckwheat whole flour differing only for the heat pre-treatment. Somewhat surprisingly, taking into account that the molecular weight of quercetin is practically half that of rutin (quercetin + rutinose), the rutin equivalents recovered in the baked biscuits did exceed those expected on the basis of the values observed in the raw whole flour. Apparently, the specific process of biscuit preparation seems to enhance the content of these bioactive compounds, as the analytical procedure adopted would suggest. This might be the result of an increased rutin solubility, likely due to the high temperature of the baking process in a fat rich environment, as well as to a reduced degradation of rutin to quercetin

The biscuits prepared with the highest content of tartary buckwheat whole flour (12%) presented a final content of rutin of 72 mg per 100g dry weight. The daily consumption of 50-60 g of these biscuits (6-7 pieces) could guarantee the availability of a preventive dose (40 mg) of rutin.

Bread

The appearance of bread loaves is provided in Figure 2.



Figure 2. Typical bread of the Region Tuscany in which 20% of the wheat flour was substituted with buckwheat whole flour (16% common buckwheat and 4% tartary buckwheat).

Adding buckwheat whole flour in a proportion of 20%, as in the present case, results in a somewhat reduced loaf volume and crumb appealing texture. If the objective of a supplement of 20% buckwheat whole flour is to be attained to keep effective contents of rutin and the benefit of buckwheat protein and starch, efforts are to be devoted to identify high quality strong gluten wheat flour able to warrant a satisfactory loaf volume and a pleasant crumb structure.

The rutin and quercetin content of control and bread containing either heat-treated (sample 1) or not (sample 2) whole flour of common and tartary buckwheat are presented in Table 3.

Table 3. Rutin and quercetin contents of breads containing common and tartary buckwheat whole flour. Tartary buckwheat whole flour was either (sample 1) or not heat-treated in an oven at 80°C for 30 minutes (sample 2). Control bread was made of plain wheat flour.

	Wheat flour	Common buckwheat whole flour	Tartary buckwheat whole flour	Rutin (mg/100g DW)		Quercetin (mg/100g DW)	
				expected	observed	expected	observed
Control	100%	0%	0%	0.00	0.00 ± 0.00	0.00	0.00 ± 0.00
Sample 1	80%	16%	4%	47.37	6.45 ± 0.25	0.11	15.81 ± 0.21
Sample 2	80%	16%	4%	45.33	4.44 ± 0.18	0.07	17.37 ± 0.11

DW = dry weight

As expected, no rutin nor quercetin was observed in the control bread. In buckwheat supplemented bread most of the rutin was degraded to quercetin no matter the heat treatment. At variance with the biscuits of above, the sum of rutin and quercetin was appreciably lower than the expected amount of the rutin equivalents supplied to the wheat flour through the buckwheat whole flour as if the long dough proofing adopted, besides favouring an almost complete hydrolysis of rutin to quercetin, may promote a further degradation of the quercetin rings backbone.

The degradation of rutin to quercetin, that substantially occurred regardless of the heat-treatment, points to the need of working out processing conditions which may effectively attenuate the functionality of the rutin degrading enzymes whose activity is likely enhanced by the dough preparation and the extended leavening period in the presence of water and suitable temperature.

4. Conclusions

As for the biscuits, in spite of the rutin degrading enzymes known to be present in tartary buckwheat grain, it would appear that just a negligible degradation of rutin to quercetin occurs during the phase of dough preparation and subsequent baking process so that most of the rutin present in the whole flour can be recovered.

The present findings would indicate that an intake of 40 mg of rutin with a single meal (breakfast in this case) can be feasible by adding tartary buckwheat whole flour to some traditional Tuscany biscuits without impairing texture, taste and acceptability.

Whenever the bread texture could not be improved by utilizing wheat flours of superior baking quality, it will be still possible to reduce the proportion of buckwheat flour in the recipe and to utilize tartary buckwheat whole flour to provide bread with effective content of rutin. However, in this case still the problem remains of rutin degradation to quercetin to be worked out.

Having observed that the use of tartary buckwheat whole flour has the potential to provide the bread and biscuits dealt with in the present trial meaningful amounts of rutin, the problem arises as to where to find the necessary supply of tartary buckwheat. Likely, preliminary agronomic trials have indicated

that adequate supply of tartary grain may be secured through the cultivation of large surfaces of this crop in the high Plain of Sila in the Region of Calabria (Southern Italy).

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References

- Arita, T., K. Numata and K. Saio, 1998. Characteristics of Tartary buckwheat flour samples classified by milling and inactivation of rutin degrading enzyme (Rutinase) by microwave treatment. *Bulletin of the Tokyo Metropolitan Food Technology Research Center*, **7**, 1-6. (In Japanese with English summary)
- Brunori, A., A. Brunori, G. Baviello, E. Marconi, M. Colonna, M. Ricci and P. Mandarino, 2006. Yield assessment of twenty buckwheat (*Fagopyrum esculentum* Moench and *Fagopyrum tataricum* Gaertn.) varieties grown in Central (Molise) and Southern Italy (Basilicata and Calabria). *Fagopyrum* **23**, 83-90.
- Brunori, A. and G. Vegvari, 2007. Rutin content of the grain of buckwheat (*Fagopyrum esculentum* Moench and *Fagopyrum tataricum* Gaertn.) varieties grown in Southern Italy. *Acta Agronomica Hungarica*, **53**(3), 265-272.
- Christa, K. and M. Soral-Šmietana, 2008. Buckwheat grains and buckwheat products – nutritional and prophylactic value of their components – a review. *Czech Journal of Food Science*, **26**, 153–162.
- Kitabayashi, H., A. Ujihara, T. Hirose and M. Minami, 1995a. Varietal differences and heritability for rutin content in common buckwheat, *Fagopyrum esculentum* Moench. *Breeding Science*, **45**(1), 75-79.
- Kitabayashi, H., A. Ujihara, T. Hirose and M. Minami, 1995b. On the genotypic differences for rutin content in tatar buckwheat, *Fagopyrum tataricum* Gaertn. *Breeding Science* **45**(2), 189-194.
- Yasuda, T., K. Masaki and T. Kashiwagi, 1992. An enzyme degrading rutin in Tartary buckwheat seeds. Nippon Shokuhin Kogyo Gakkaishi (J. Jpn. Soc. Food Sci. & Technol.) **39**, 994-1000. (In Japanese with English summary)