Comparison of stone-milled and recombined whole-grain flours for their rheological properties and bioactive compound content

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Introduction and Aim

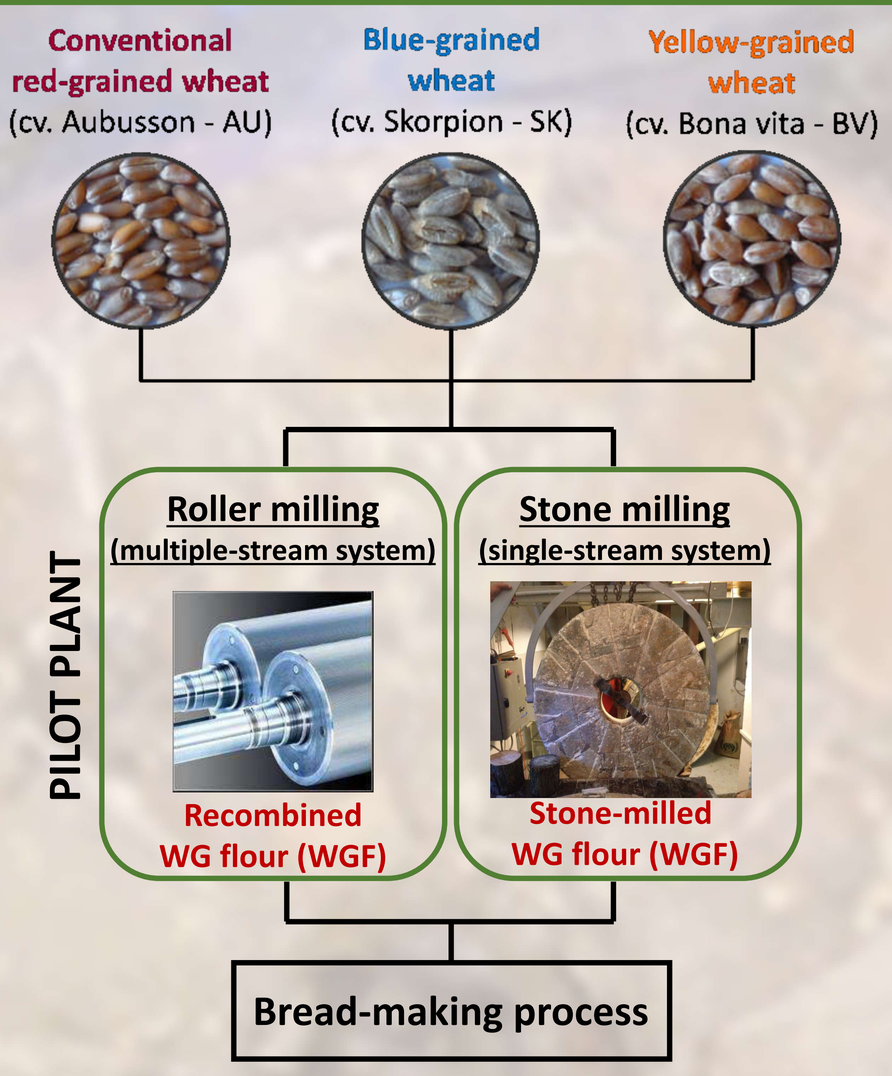
In recent years, the growing interest in wholegrains is due to the re-discovery of their nutritional values and health benefits. At the same time, attention is focusing on ancient milling techniques, in particular stone milling (i.e. single-stream system). On the contrary, at the industrial level the wholegrain flours are obtained by separation and subsequent recombination. Nowadays, there is no information on how the different processing technologies influence the rheological properties and characteristics of the bread.

The aim of this work was to study the effects of roller milling and stone grinding on:

- rheological properties;
- xanthophylls, phenolic acids and antioxidant capacity;
- bread-making performance

of the related whole-grain flours (WGF).

Materials and Methods



- Straight dough method (yeast 2%; salt 1%; leavening 90 min @ 30°C)

Figure 1: Diagram of processing conditions

PHYSICAL AND CHEMICAL ANALYSES (n=3)

- Particle size distribution (Vibratory Sieve AS 200 basic)
- Xanthophylls and phenolic acids (RP-HPLC/DAD; Giordano et al. 2017)
- Antioxidant capacity (AC-FRAP; Serpen et al. 2012)

EMPIRIC RHEOLOGY AND BREAD CHARACTERISTICS (n=2)

- Gluten aggregation properties (GlutoPeak®; Melnyk et al., 2012)
- Mixing properties (Farinograph®; ICC 115/1)
- Leavening properties (Rheofermentograph®)
- Bread specific volume (Sesame Replacement Method)

STATISTICAL ANALYSIS: Stone-milled vs Recombined WGF

- t-Test and ANOVA (**p<0.01; ***p<0.001). Statgraphics Plus v. 5.1 (Statpoint Inc., USA) or SPSS 25.0 (SPSS Inc., USA).

Conclusions

- The wholegrain flours obtained from stone milling showed only negligible differences in the rheological properties compared to the flours obtained with roller milling.
- Breads from the two types of WGFs did not differ significantly for the content of antioxidant compounds, except for lutein.
- The apparent higher volume of bread sample from stone-milled WGF was actually due to the formation of a crumb defect whose origin has yet to be investigated.

Acknowledgments

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Results

Physical and chemical characteristics

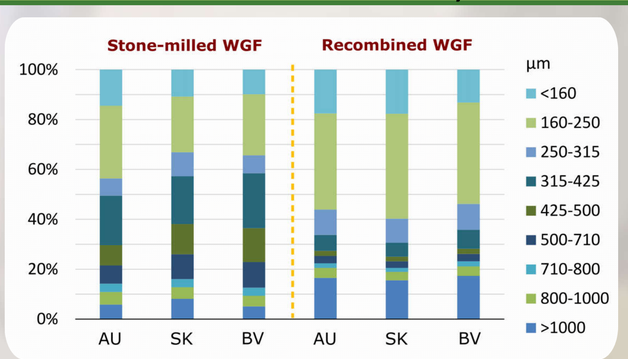

Figure 2: Distribution of flours particle size

- Stone-milled WGF: mainly particle size < 500 µm
- Recombined WGF: prevalence of large particle size (>800 mm 20%) and fine particle size (< 250 mm 56%)

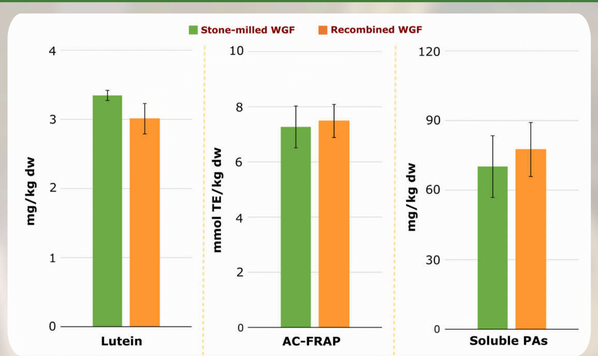

Figure 3: Lutein, AC and soluble PAs of WG flours (n=9, 3 cv*3rp)

No difference was observed between WGF flours for both lutein, antioxidant capacity and soluble phenolic acids.

Protein aggregation properties (GlutoPeak test)

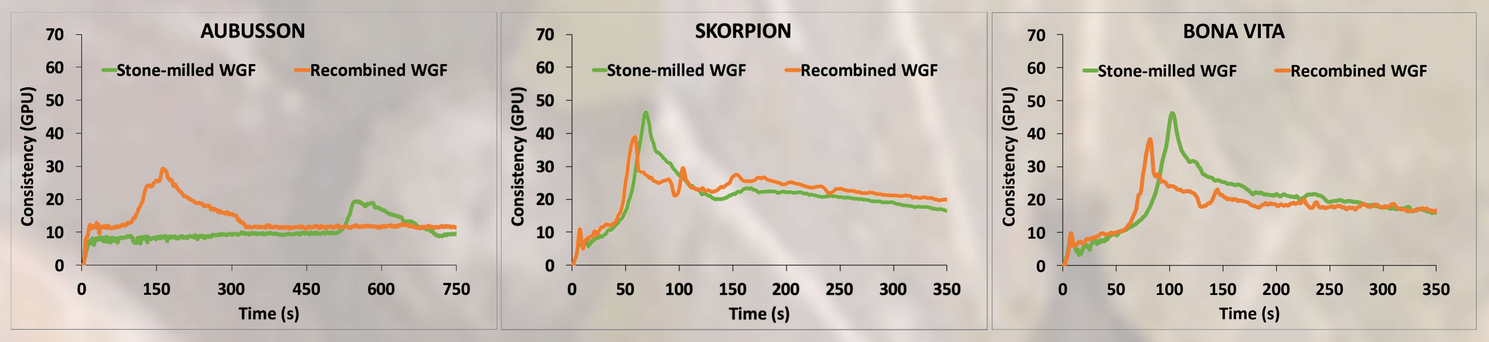

Figure 4: Effects of milling process on gluten aggregation properties

- Regardless the cultivars, all stone-milled WGF showed a higher peak maximum time and total energy compared to the recombined ones

Mixing and Leavening properties

		Aubusson - AU	Skorpion - SK	Bona vita - BV
Mixing Properties (Farinograph)	***Water absorption***	No effect	No effect	Increased (5%)
	Development time	Decreased (26%)	Decreased (14%)	Decreased (12%)
	Stability	No effect	Decreased (12%)	Increased (13%)
Leavening Properties (Rheofermentograph)	***Dough maximum height***	Decreased (9%)	Increased (12%)	No effect
	Dough collapse	No effect	Increased (27%)	Increased (28%)
	Maximum dough development time	Decreased (20%)	No effect	Decreased (9%)
	Dough stability	Increased (10%)	No effect	Decreased (8%)
	Maximum gas development time	Decreased (29%)	Increased (6%)	Increased (26%)
	Porosity time	No effect	No effect	Decreased (12%)
	Total gas volume	Increased (8%)	Increased (8%)	No effect
	Retention coefficient	No effect	No effect	No effect

Table 1: Effects of stone-milling on mixing and leavening properties of WGF in comparison with roller-milling (in brackets the increase or decrease expressed as percentage)

Bread properties

Figure 5: Effects of milling technique on bread properties (t-Test between stone-milled and recombined samples (**p<0.01; ***p<0.001)).

- The stone-milled WGF from SK and BV apparently gave a better result in terms of specific volume of bread, than recombined WGF. However, the presence of a relevant structural defect (crumb collapse) in the upper part of the sample was observed in those bread samples.
- Bread samples made from the two types of WGF did not differ significantly in the antioxidant capacity and Soluble phenolic acid content (n=9, 3cv*3rp). On the contrary, the crumb of breads from recombined WGF showed a lutein content significantly lower than the crumb of breads from stone-milled WGF.

References

- Giordano et al. (2017). *Food Chemistry*, *233*, 483-491.
- Melnyk et al. (2012). *Journal of Cereal Science, 56,* 561-567;
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