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IMPACT OF TEMPERING PROCESS ON THE YIELD AND COMPOSITION OF QUINOA FLOUR

Introduction
Roller milling is a dry-milling technique that aims to separate the anatomical parts of the seed kernel. Prior to milling, seeds are tempered to facilitate the removal of bran as the plasticity of the bran layer is increased by the absorption of water. Milling and tempering of wheat have been well-studied but these techniques require another approach for quinoa due to its different seed morphology and size. Roller milling of quinoa is considered a technological challenge but the technique offers the opportunity to separate the different seed tissues. The separation leads to different fractions, rich in different target substances. These fractions can be used as separate food ingredients, which might stimulate the use of quinoa by creating more added value. Nevertheless, studies concerning roller milling and tempering of quinoa are rather limited. This study aims to investigate the impact of different tempering conditions on the roller milling of quinoa.

Material and methods
Three types of commercially available quinoa seeds (white quinoa Q1, Q2; red quinoa Q3) were roller milled on a small scale by a Brabender Drummill Junior. Two levels of tempering time (8 and 20 h) were combined with three levels of tempered moisture (15, 15 and 17%). Flour yield was recorded and the obtained flour was characterised by ash and protein content, and particle size distribution.

Chemical composition
Higher levels of tempered moisture (15 or 17%) were beneficial to reduce the ash content of quinoa flour (Fig. 1a). The ash content of all samples was lower when the quinoa kernels were tempered at 15% moisture. An additional reduction of flour ash content was observed for Q3 when tempering (8 and 20 h) occurred at 17% moisture. Tempering at 17% had no additional effect on the ash content of Q1 or Q2 flours when combined with a tempering time of 8 h. An increase in tempering time, at a fixed moisture level, generally resulted in a higher flour ash content. No effect of tempering time was observed for samples Q1 and Q3 if tempered at respectively 15 or 17%, and 17%.

Flour yield
Flour yields were maximal after tempering at 15% moisture (Fig. 2). Milling trials indicated that tempered moisture influenced flour yields of all quinoa samples, while an effect of tempering time was only observed for sample Q3. An increase in tempered moisture resulted in a reduction of flour yield. The lowest flour yields were generally obtained for sample Q3; changes in tempering conditions could not increase the flour yield to the same levels of sample Q1 and Q2. The lower milling potential of sample Q3 could be ascribed to the smaller average kernel size, as small-sized kernels are associated with a higher bran to perispem ratio and a lower potential flour yield.

Particle size distribution
For samples Q1 and Q2, an increase in tempered moisture resulted in a reduction of all particle size distribution parameters (Fig. 3a). It is possible that the size of the bran particles sufficiently increased due to the higher tempered moisture and the separation of bran and flour by the sieve (mesh 200 μm) of the laboratory mill therefore improved. The fraction of large particles was considerably higher for Q3 flours (Fig. 3b) as compared to the other samples. This could be related to the small kernel size but could also be ascribed to the higher kernel hardness.

Conclusion
The flour milling process of quinoa kernels is mostly influenced by the applied tempered moisture: the flour yield decreases, while the bran-perispem separation improves by increasing tempered moisture. Extension of tempering time has no effect on the flour yields of samples Q1 and Q2. The extension, however, tends to reduce the separation efficiency of the milling process as noticed by the increased ash and protein content of the resulting flour. Furthermore, this study suggests that the kernel properties have a distinct impact on the milling behaviour of quinoa quinoa with a smaller kernel size led to a lower flour yield and flour with a different composition (ash, protein) and particle size distribution. Further research should look into the relationship between kernel properties and roller milling. Despite the differences in kernel properties, the 15% - 8 h treatment resulted in an acceptable flour yield for all quinoa samples studied.