Underpinning the structural and physicochemical characteristics of durum wheat flour (*Triticum Durum*) to reduce semolina by-product production

Diogo Salvati [1,2], Maria Franco [1], Manuel Gomez [1], Maria Inês Dias [2,3], Laura Roman [1]*

[1] Food Technology Area, College of Agricultural Engineering, University of Valladolid, Av. Madrid 50, 34004, Palencia, Spain
[2] Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança (IPB), Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[3] Laboratório Associado para a Sustentabilidade e Tecnologia em Regiões de Montanha, IPB, Campus de Santa Apolónia, Bragança, Portugal
* lroman@uva.es.

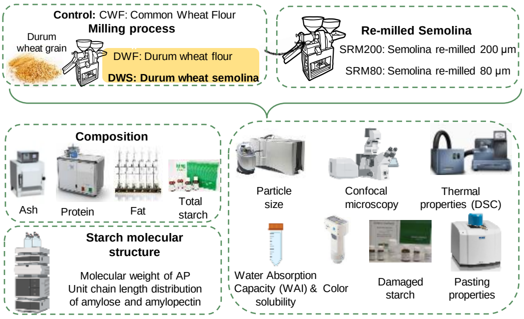
INTRODUCTION

Durum wheat (*Triticum durum*) is a valuable cereal crop characterized by its endosperm hardness, and high protein and carotenoid content compared to common wheat (*Triticum aestivum*). Durum wheat is frequently used to produce large-particle-size semolina (~250-450 μm) for quality pasta production. Nevertheless, this process yields approximately 5% of flour, with a smaller particle size than semolina (<180 μm), typically used for animal feed. This often results in the generation of residual materials during processing. A comprehensive study on the characterization of these by-products and their potential modification to enhance functionality could facilitate the implementation of a circular economy, enabling their reuse as a source of starch in high-quality food products

GOALS

1. Understanding the nutritional, molecular and physicochemical differences of durum wheat flour as compared to durum wheat semolina and common wheat flour.
2. Evaluation of the influence of the particle size on the molecular and physicochemical properties of durum wheat.

MATERIALS AND METHODS



MAIN RESULTS

Milling process and endosperm hardness resulted in flours with different particle size. DWS flour exhibited the largest particle size, with an average diameter of 349 μm. The flours obtained from remilled DWS, namely SRM200 and SRM80, displayed significantly smaller particle sizes, with an average diameter of 207 μm and 76 μm, respectively. The durum and common wheat flours exhibited average particle sizes of 111 μm and 139 μm, respectively

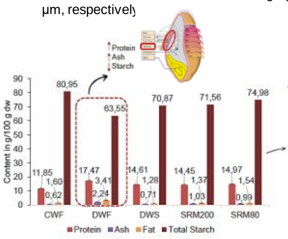


Fig 1. Proximate composition.

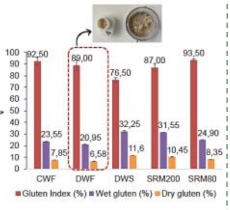


Fig 2. Gluten index.

Furthermore, DWF showed a lower gluten index than CWF, while the gluten index in re-milled semolina was similar to CWF, remaining constant regardless of its particle size.

Differences in protein and starch distribution were also visible in confocal microscopy, with DWF exhibiting more protein-rich domains than CWF.

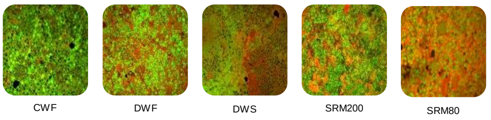


Fig 3. Confocal scanning laser microscopy with protein and starch labeled in red and green, respectively.

All wheat flours exhibited similar unit chain length distribution for amylose and long- and short-chains of amylopectin, although amylose content was slightly higher in durum wheat. Mw of amylopectin was higher for DWF and DWS than CWF.

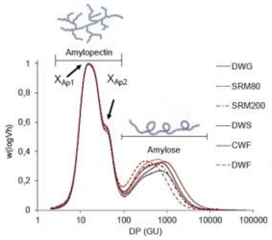


Fig 4. Unit chain length distribution of amylopectin and amylose.

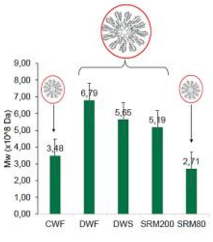


Fig 5. Molecular weight of amylopectin.

Damage to the starch granules increased with particle size reduction (Re-milled DWS>DWF>DWS>CWF), which was accompanied by a decrease in starch molecular weight and an increase in water absorption (WAI) and solubility.

Fig 6. Damage starch.

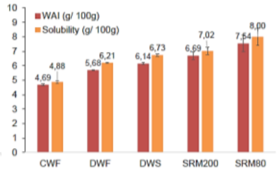


Fig 7. Flour hydration properties.

During hydrothermal processing, DWF exhibited a lower peak viscosity, which may be attributed to its higher protein, and, hence, lower starch content. In contrast, re-milled semolina flour increased its viscosity, although all values remained below CWF. After heating and cooling, DWF, with similar particle size to CWF, exhibited less ability to build-up viscosity based on its lower setback and final viscosity. Likewise, calorimetric results showed DWF and DWS had a lower retrogradation enthalpy than CWF, indicative of less extent of amylopectin retrogradation, which may be associated with their harder endosperm. A decrease in this enthalpic transition was also observed with size-reduction and fractionation of DWS.

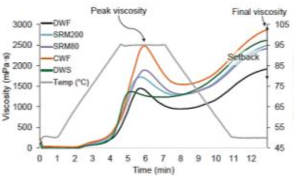


Fig 8. Pasting properties of the flour using a RVA.

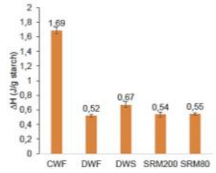


Fig 9. Thermal properties of the flour using DSC.

CONCLUSIONS

Differences in nutritional composition were identified mainly in durum wheat flour, which had a higher protein, lipid, and ash content, which may be related to the presence of the outer part of the grain. Semolina's gluten index after milling and fractionation resembles common wheat. Damage starch granules increased water absorption and decreased molecular weight. DWF exhibited a lower peak viscosity, which may be attributed to its higher protein, and, hence, lower starch content. In contrast, retrogradation was retarded in durum wheat flour and Re-milled semolina.

Alignment with Sustainable Development Goals (SDGs)

This work is aligned with several Sustainable Development Goals (SDGs): SDG 2 (Zero Hunger), increasing the availability of nutritious food options and improving food security; and SDG 12 (Responsible Consumption and Production), emphasizing resource optimization, waste minimization and support for sustainable consumption and production. This research contributes to promote sustainable agricultural and industrial practices, which in turn reduce environmental impact and improve the food sector.

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