Circular Economy in the Wine Sector: assessment of the potential of seeds of Portuguese grape varieties for oil production and by-products development

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Introduction

The Horizon 2020 Strategic Plan considers 12 key areas to boost employment and growth, highlighting the use of waste as a resource through recycling, reuse and recovery of raw materials in the primary production process. In view of this strategic objective, Project WAW – Waste Around the Wine promoted by AMOG in partnership with ESA-IPVC and twelve Portuguese companies of the wine sector, aims to contribute to the development of innovative and sustainable processes, techniques, technologies and products, based on the valorization of agroindustrial waste. The valorization of agroindustrial waste represents one of the most important challenges of biotechnology research, contributing to the sustainability of the sector. Large amounts of wine residues are produced annually, which, due to their composition and organic load, may represent a serious environmental problem. The present study aims to characterize grape seeds from different Portuguese grape varieties and wine regions, and to assess the potential of grape-seed oils to be used in pharmaceutical, cosmetic and food applications.

Material and methods

Grapes were harvested at their ripening time, in Douro and Vinhos verdes region. On their arrival to the laboratory, the fruits were washed with water and grape seeds were separated from grape pomace. Grape seeds were weighed, dried at 60°C and milled in a micro grinder for moisture content, ash, protein, oil, crude fiber, total phenolic compounds (TPC) and starch content analysis, according to Standard Methods. The lipid fraction was obtained by Soxhlet extraction using petroleum ether for 4 hours. Phenolic compounds were extracted using an aqueous suspension. All the results were expressed in percentage, in dry basis.

Results and discussion

The study comprised the characterization grape seeds concerning the most relevant grape varieties present in each sample.

Table 1 – Characterization of grape seeds concerning the most relevant grape varieties present in each sample. Values with different superscript within the same column are significantly different (p<0.05).

Grape variety	Moisture (%)	Ash (%)	Protein (%)	Total fat content (%)	Crude fiber (%)	Total phenolic compounds (%)	Starch content (%)
Loureiro	48,98±2,60b	2,91±0,15a	9,30±0,40a	12,38±1,20a/b	7,52±2,36a/b	0,80±0,12b	12,74±1,37a
Vinhão	46,31±2,3b	2,51±0,0a	9,89±0,25a	10,94±0,7a	11,07±0,23b	0,15±0,05a	10,91±1,28a
Alvarinho	44,63±3,43b	3,35±0,02b	9,66±0,10a	15,96±0,23b	7,23±1,04a/b	0,66±0,06b	13,25±0,75a
Touriga Franca	39,41±1,40a	2,91±0,05b	11,01±0,18b	31,34±0,12c	3,51±0,35a	0,26±0,07a	8,57±0,60a

Table 2 – Average composition of grape seeds from white and red grape varieties

Grape variety	Moisture (%)	Ashes (%)	Protein (%)	Oil content (%)	Crude fiber (%)	Total phenolic compounds (%)	Starch content (%)
White	47,89±3,31a	3,02±0,21a	9,39±0,44a	13,28±1,14a	7,45±2,03a	0,77±0,11a	12,87±1,25a
Red	44,01±3,98a	2,64±0,21a	10,26±0,71a	17,74±3,69b	8,55±1,78a	0,19±0,06b	10,13±1,13b

Table 3 – Average composition of grape seeds from Vinhos Verdes and Douro region

Wine region	Moisture (%)	Ashes (%)	Protein (%)	Oil content (%)	Crude fiber (%)	Total phenolic compounds (%)	Starch content (%)
Vinhos Verdes	47,37±3,04a	2,85±0,20a	9,56±0,42a	12,50±1,17a	8,65±1,84a	0,56±0,18a	12,22±1,30a
Douro	39,41±1,40b	2,91±0,06b	11,01±0,18b	31,34±0,12b	3,51±0,35b	0,26±0,07a	8,57±0,75a

Table 4 – Average composition of grape seeds of different grape varieties in terms of organic acids

Grapes varieties	Ascorbic acid (%)	Cis-actinic (%)	Citric (%)	Fumaric (%)	Maleic (%)	Malic (%)	Oxalic (%)	Shikimic (%)	Trans-actinic (%)	Tartaric (%)
Alvarinho	0,21	0,09	5,46	0,01	0,02	16,26	0,21	0,20	0,02	ND
Loureiro	0,24	0,03	0,97	ND	0,04	16,88	0,30	0,24	0,01	0,72
Vinhão	0,26	0,01	0,71	0,01	0,03	15,74	1,02	0,26	0,01	2,29
Touriga	0,21	ND	1,56	0,01	0,03	15,05	0,46	0,25	0,01	1,16

The results presented in Table 1 showed that the highest oil content (31,34%) was obtained for Touriga Franca. Concomitantly, the moisture content for such grape variety (39,41%) was significantly lower, the values obtained for Loureiro (48,98%) and Vinhão (46,31%) being similar to the ones reported by Klapa (2015) of 42,2% and 44,5%, respectively. The oil content was also high in Alvarinho grape seeds (15,96%), followed by Loureiro (12,38%) and Vinhão (10,94%). Touriga grape seeds also presented a higher protein content (11,01%), when compared to Alvarinho, Vinhão and Loureiro, with 9,66%, 9,89% and 9,30%, respectively. The higher content of oil in Touriga Franca (Douro wine region) and Alvarinho (Vinhos verdes wine region) grape seeds may be related to the size of the seeds. In fact, the size of such grape seeds was significantly higher, when compared to other grape varieties. Fernandes et al. (2013) also reported a maximum oil content, extracted with petroleum ether, of 12.40% for Touriga Francesa grape seeds, and a minimum of 3,95% for Marufo, among ten red grape varieties from the northeast region of Portugal (Valpaços). Different agronomic and environmental conditions may explain the higher oil content obtained for Touriga Franca grape seeds, in the present study. On the other hand, the crude fiber content was higher in Vinhão grape seeds (11,07%), followed by Loureiro, Alvarinho and, finally, Touriga, with a significantly lower crude fiber content (3,51%). Regarding the phenolic compounds, Loureiro and Alvarinho grape seeds presented the higher values (0,80% and 0,66%, respectively), the content in Touriga and Vinhão being significantly lower (0,26% and 0,15%, respectively). The starch content was similar in all the grape seeds, ranging between 8,57% and 13,25%. The Total Phenolic Compounds content (0,15% - 0,80%) was lower than the ones reported by Tounour et al. (2015), after extraction with aqueous suspension (10,61% for Touriga Franca) and Klapa, after extraction with methanol (8,6% for Loureiro and 3,5% for Vinhão). A comparison between grape seeds from white and red grape varieties revealed that, in general, grape seeds from red grape varieties have higher oil content, but lower total phenolic compounds and starch content (Table 2).

The results obtained in the present study also highlited the lower moisture content and higher protein and oil content of grape seeds from Douro wine region (Table 3), suggesting a higher potential for oil production. Such result may be related to the climate conditions, viticulture in Douro region being affected by higher temperatures and hydric stress conditions than Vinhos Verdes region.

Conclusion

The results obtained in the present study concerning Portuguese grape varieties demonstrated that Touriga (Douro region) and Alvarinho (Vinhos Verdes region) may have a high potential for oil production, with significantly higher fat contents than other grape varieties. The results also suggest that seeds from grape varieties from Vinhos Verdes wine region, and white grapes in particular, may be a promising raw material for the development of other added value products such as grapefruit flour, with high nutritional properties, or natural pharmaceutical/cosmetic products with high phenolic compounds content.

References

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