

## **CIRCULAR ECONOMY IN THE WINE SECTOR: ASSESSMENT OF THE POTENTIAL OF SEEDS OF PORTUGUESE GRAPE VARIETIES FOR OIL PRODUCTION AND BY-PRODUCTS DEVELOPMENT**

**Afonso, I.M.; Ferraz, A.; Rodrigues, A.S.; Vale, A.P.; Mendes, S.; Alonso, J.; Domingues, J.; Alves, M.; Rodrigues, A.C.**

Escola Superior Agrária, Instituto Politécnico de Viana do Castelo, Refoios do Lima, Ponte de Lima, Portugal

e-mail: [acrodriques@esa.ipvc.pt](mailto:acrodriques@esa.ipvc.pt)

### **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.

### **Materials and methods**

The study comprised the characterization of seven samples of grape seeds, representing mixtures of different grape varieties, provided by Portuguese companies located in Vinhos verdes and Douro wine regions, according to Table 1.

Table 1 - Mixtures of grape varieties, provided by Portuguese companies located in Vinhos verdes and Douro wine regions

Sample	Company	Wine Region	Grape varieties
1	Adega Cooperativa de Monção	Vinhos verdes	50% Loureiro; 50% Trajadura
2	Quinta das Pereirinhas	Vinhos verdes	80% Vinhão; 15% Borraçal; 5% Espadeiro (red grapes)
3	Quinta das Pereirinhas	Vinhos verdes	65% Loureiro; 15% Trajadura; 10% Arinto; 10% Alvarinho (white grapes)
4	Adega Cooperativa de Ponte da Barca	Vinhos verdes	80% Vinhão; 15% Borraçal; 5% Espadeiro (red grapes)
5	Adega Cooperativa de Ponte da Barca	Vinhos verdes	75% Loureiro; 15% Trajadura; 10% Arinto (white grapes)
6	Adega Cooperativa de Monção	Vinhos verdes	Alvarinho
7	Douro Aneto Wines	Douro	Touriga Franca

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 until constant weight and milled in a micro grinder for moisture content, ash, protein, oil, crude fiber, total phenolic compounds (TPC) and starch content analysis, according to Portuguese Standard methods. The lipid fraction was obtained by Soxhlet extraction using petroleum ether for 4 hours. Phenolic compounds were extracted using an aqueous suspension. Statistical analyses were performed using the SPSS statistical package (SPSS Inc., Chicago, IL), version 18.0. All the results were expressed in percentage, in dry basis.

## Results and discussion

Table 2 – Sample characterization in terms of moisture content, ash, protein, oil, crude fiber, total phenolic compounds and starch content

Sample	Moisture (%)	Ashes (%)	Protein (%)	Oil content (%)	Crude fiber (%)	Total phenolic compounds (%)	Starch content (%)
1	51,73±1,15c	2,69±0,04a	8,99±0,08a	9,89±0,26a/b	10,97±0,21c/d	0,70±0,11b/c	11,67±0,44a/b
2	47,39±3,17b/c	2,56±0,04a	9,68±0,10c	12,09±0,30b	11,01±0,07d	0,16±0,06a	11,80±1,91a/b
3	46,34±0,96b/c	2,88±0,03b	9,76±0,05c	11,69±0,34b	0,67±0,00a	0,66±0,12b/c	15,25±0,97b
4	45,23±0,37b	2,45±0,01a	10,09±0,06d	9,79±0,23a	11,12±0,25d	0,13±0,03a	10,02±0,18a
5	48,86±1,72b/c	3,17±0,03b	9,16±0,06b	15,57±0,19c	10,92±0,04d	1,04±0,06c	11,31±0,55a/b
6	44,63±3,43a/b	3,35±0,02c	9,66±0,10c	15,96±0,26c	7,23±1,04c	0,66±0,06b/c	13,25±0,60a/b
7	39,41±1,40a	2,91±0,05c	11,01±0,17d	31,34±0,12d	3,51±0,35d	0,26±0,07b	8,57±0,75a/b

In all the samples, the moisture content (39,41% - 51,73%) was higher than the value reported by Santi et al. (2015), of 14,71%. The crude fiber content ranged between 0,67% and 11,12%, the values being significantly lower than the one reported by Santi et al (2015), of 45,95 % for fibers and minerals. The total phenolic compounds (0,16% – 1,04%) were also lower than the values reported by Agostini (2014), ranging between 5,03% and 8,71%. Table 3 presents a brief characterization of grape seeds concerning the most relevant grape varieties present in each sample.

*Table 3 – Grape seeds characterization in terms of moisture content, ash, protein, oil, crude fiber, total phenolic compounds and starch content*

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

The results presented in Table 3 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 TPC 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 possible explanation for the lower content of phenolic compounds in the grape varieties tested in the present study may be related to sample preservation conditions during transport. 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 4).

Table 4 – 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

The results obtained in the present study also highlighted the lower moisture content and higher protein and oil content of grape seeds from Douro wine region grapes (Table 5), suggesting a higher potential for oil production. Such result may be related to the climate conditions. In fact, viticulture in Douro region may be affected by higher temperatures and hydric stress conditions, as a consequence of reduced water availability than in Vinhos verdes region. Nevertheless, grape seeds from Vinhos verdes region demonstrated a significantly higher crude fiber content.

Table 5 - 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

## Conclusions

The results obtained in the present study concerning the Portuguese grape varieties, Loureiro, Vinhão, Touriga and Alvarinho, 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

Agostini, F., 2014. Obtenção e análise de óleo e compostos fenólicos de sementes de diferentes variedades de uva (*Vitis vinifera* e *Vitis labrusca*) cultivadas no Rio Grande do Sul. MasterThesis, <https://repositorio.ucs.br/handle/11338/695>.

Fernandes, L., Casal, S., Cruz, R., Pereira, J.A., Ramalhosa, E., 2013. Seed oils of ten traditional Portuguese grape varieties with interesting chemical and antioxidant properties. *Food Research International*, 50, 161–166.

Klapa, O., 2015. Bioenergy and industrial applications of grape pomace from "Vinhos verdes", MasterThesis, <http://hdl.handle.net/20.500.11960/1426>.

Santi, A.C., Simon, K.M., Silva, A.J.M., Balbi, M.E., Monteiro, C.S., 2015. Characteristics of chemical composition and nutritional seed grape (*Vitis vinifera*, Vitaceae) cv. Cabernet sauvignon. *Visão Académica*, 16, ISSN 1518-8361.

Tournour, H.H., Segundo, M.A., Magalhães, L.M., Barreiros, L., Queirós, J., Cunha, L.M., 2015. Valorization of grape pomace: Extraction of bioactive phenolics with antioxidant properties. *Industrial Crops and Products*, 74, 397-406.