

Biomass pellets production with industrial and agro-industrial wastes

J. C. A. R. Claro & D. Costa-Gonzalez

*Centro de Química – Vila Real / Departamento de Química,
Universidade de Trás-os-Montes e Alto Douro, Portugal*

Abstract

Based on a patented process for the treatment and reprocessing of waste and effluents from olive oil and cork industries (such as two-phase olive husks cork powder), new research has been carried out incorporating other industrial wastes.

In previous research, using only olive oil and cork wastes, we obtained biomass pellets with high calorific values (20.6 MJ/kg and 22.2 MJ/kg), low moisture (8.9%) and relatively low ashes percentage (3.9%). Several new formulations and its relevance in the calorific value were now tested using other wastes or by-products. We have analysed the potential inclusion of olive leaves from the olive oil industry, grape husks and grape seeds from the winery industry and chestnut shells (outer shell and inner skin) from the chestnut industry.

This process will contribute to solving environmental problems resulting from the discharge of those wastes and effluents and to create a viable and profitable alternative to their storage and/or a deposition in landfill. The increase of others biomass sources on these types of process is extremely important as an environmental and economic management point of view.

This research shows that the use of different types of raw materials as biomass sources (giving different pellets formulations) results in a different final product with different physical and chemical characteristics that may improve its quality.

Keywords: biomass pellets, olive wastes, cork wastes, food industry wastes.

1 Introduction

Company strategies are now becoming increasingly focused on factors for increasing productivity which also profess to be “environmentally-friendly.”



The reprocessing of wastes and by-products is therefore at the top of corporate concerns.

Given the strategic importance that the olive oil sector represents for Mediterranean countries, these production and transformation units must not disregard this new attitude.

In this context this process could be important to biomass industries and constitutes a very important technological platform internally for olive oil companies, launching them into a strategic framework characterised by an increase in productivity, a cleaner and more environmentally-friendly production that will become an important contribution to the sustainability of the sector.

Olive oil can be obtained by three processes each of which includes the phases of weighing, washing of the olives, warehousing and milling (or grinding).

The traditional process involves a pressing phase of the olives followed by a decantation/centrifugation which produces husks and olive mill wastewater in addition to the olive oil.

More modern methods include, a “beating” process replacing the pressing, followed by an “extraction” in horizontal centrifuges. Water is added during these last two phases to facilitate the separation of the olive oil.

These more modern methods consist of:

Phase 1: Here the effluents are the same as those in the traditional method (husks and olive mill wastewater which are separate);

Phase 2: This process results in a single effluent, known in the industry as “humid husks” or a “paste” (the result of the husks mixed together with the olive mill wastewater).

Most of the olive oil currently produced uses the two production processes above.

There are also production units known as “husk oil extraction units” which extract some of the remaining olive oil from the “husks” or “humid husks”.

In any case and irrespective of the method used, all the units generate waste and effluents which are harmful to the environment (Sassi *et al.* [1], Andreozzi *et al.* [2], Morillo *et al.* [3]) and full research has been done about this issue (Gómez *et al.* [4], Russo *et al.* [5], Roig *et al.* [6]).

Some existing treatment and/or reprocessing systems for effluents from olive oil production units are: irrigation of agricultural soils, lagooning, concentration through evaporation, physical/chemical processes, thermal processes, biological processes.

On the other hand, as far as the cork industry residues are concerned, (mainly cork powder, particles less than 0.25 mm in size), which are considered as industrial residues (Code 03 01 99 of European Waste List), problems associated with drainage and storage have been verified, as well as the harmful environmental effects caused by them. The study by the Industrial Association of the District of Aveiro (“Multi-Sector Study on the Area of Environment”) in 2000 must be highlighted here (AIDA [7]). This study explicitly refers to the fact that “The production of cork powder is, inclusively, responsible for some physiographical changes verified in the Council of Santa Maria da Feira (small

valleys that disappear due to the continual deposition of cork dust in them)". However, the cork powder has had its main use as a combustible fuel for producing energy (burns in kilns), with a small fraction being used for filling in corks of a lower quality, in the linoleum factory and in the control of soils (Gil [8]).

Therefore it can be seen that none of the processes already known represent a sole and universal solution for the effective treatment and reprocessing of waste and effluents from olive oil production units and which at the same time is a solution for the drainage and efficient reprocessing of cork industry wastes.

The process presented in this paper can be applied to the treatment of effluents and waste from olive oil production units in the following situations:

- Through the separate treatment of the waste and the effluent (husks and olive mill wastewater);
- Through the joint treatment of the waste and the effluent (humid husks).

In this sense the process can be applied in any type of olive oil production installation whether it is using the traditional production system or the modern two-phase or three-phase production system. Therefore this approach could be an important contribution to a complete and universal solution for the efficient treatment of such residues and effluents. In fact, the known technologies only present part of the solution to the problem and some infer high implementation costs.

2 Methods and materials

2.1 Sample preparation

In sample preparation we use two-phase olive husks and industrial wastes or by-products, such as olive leaves, grape husks, grape seeds and chestnut shells that were previously turned into powder, in a grinding process using a sieve with a 1mm mesh.

The powder that results from the solid materials are mixed mechanically with the two-phase olive husks generating a pulp material or paste that later is extruded and passes through a drying system to obtain a dried solid product.

2.2 Tested formulations

The olive mill wastes (two-phase olive husks) were mixed with the different industrial wastes, testing two formulations with 8 and 15% (wt/wt) of each industrial waste powder.

2.3 Gross calorific value (GCV) determination

Gross Calorific Value was determined for each formulation by calorimetric analysis performed with an AC600SHC Semi-Automatic Calorimeter (Leco) in the Chemistry Department of Trás-os-Montes e Alto Douro University (UTAD) in Vila Real, Portugal.



3 Results and discussion

The process utilises grinded industrial wastes, namely olive leaves from the olive oil industry, grape husks and grape seeds from the winery industry and chestnut shells (outer shell and inner skin) from the chestnut industry, mixed mechanically with the effluents and/or wastes from olive oil production units creating a pulp material or paste that can be used, after drying, as a source of energy fuel. After the mixing, the paste can be extruded in the required form (e.g. pellets or briquettes) and reaches a convenient moisture in a dryer. The obtained dried solid product (Fig.1) has a calorific value about 20% higher than wood pellets or chips and a low percentage of moisture and ashes. With this very high calorific value, the recovery of the dry product as pellets, chips, briquettes or logs for burning in a biomass boiler will be extremely feasible.



Figure 1: Biomass samples obtained by the described process.

In table 1 we can see the results of the gross calorific value for the different formulations of the biomass pellets obtained by this process.

This result shows that the use of different types of raw materials as biomass sources for pellet production could be done based on this process and a similar range of calorific values are obtained (21.3 – 23.0 MJ/kg) comparatively to those with the cork powder. Different formulations lead to different final products with different physical and chemical characteristics that may define and improve its quality. Additionally the pellets biomass does not release unpleasant odours and has good mechanical resistance. Nevertheless, more research is needed to design pellets with suitable properties for specific applications and achieve all standards and norms required in the market.

Table 1: Gross calorific value (*GCV*) from biomass samples of olive mill wastes (two-phase olive husks) with 8 and 15% (wt/wt) of different kinds of industry wastes.

Industry biomass wastes	Gross Calorific Value (<i>GCV</i>) MJ kg ⁻¹		
	Sample n°	8% (wt/wt)	15% (wt/wt)
Olive leaves	1	22,5390	22,0738
	2	22,4635	22,2682
	3	22,6383	22,1495
	Average	22,5469	22,1638
	S.D.*	0,0609	0,0696
Grape husks	1	22,8858	23,0456
	2	22,8237	22,9319
	3	22,7819	22,7606
	Average	22,8305	22,9127
	S.D.*	0,0369	0,1014
Grape seeds	1	22,8982	23,0718
	2	23,0390	23,1672
	3	22,8415	22,8296
	Average	22,9262	23,0229
	S.D.*	0,0752	0,1288
Chestnut shell	1	21,9291	21,2779
	2	22,1941	21,3670
	3	22,0296	21,3221
	Average	22,0509	21,3223
	S.D.*	0,0954	0,0298

* S.D. = Standard Deviation.

4 Conclusions

This approach offers an important contribution to a complete solution for the residues and/or effluents of the olive oil production units and the end-product obtained does not create a new environmental problem. The final product of this process has a high calorific value, about 20% higher relatively to wood pellets or chips and constitutes a material with great potential as biomass fuel. This process also presents a solution to an environmental problem which is duly identified and regulated by European standards and national laws.

This enables the difficulties and disadvantages of the existing technologies to be overcome, especially those related to high implementation/execution costs and to the fact that they do not translate into a global solution, contributing only partial and/or one-off solutions to the problem.



In addition to all the environmental benefits, the process enables a product to be obtained that has a commercial value and which may constitute an attractive financial compensation for the olive oil production units and for the cork transformation units. Additionally this process allows water recuperation by condensation of the steam produced in the drying process.

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