TiO de Camp - Oilseed meal and cold pressed camelina oil

Summary

Camelina (*Camelina sativa* (L.) Crantz) is an oilseed crop in the cruciferous family. The species has a short growth cycle, and tolerates droughts and cold well. These characteristics mean that its management can be more flexible than winter cereals especially in terms of seeding dates, and make it an interesting alternative from a technical point of view for implementation in rotation in dry farming cereal fields, and one which contributes to sustainable crop production. However, it is not widespread, partly because it is a less productive crop than cereals. Oil and oilseed meal rich in healthy fatty acids (omega-3), antioxidants and vegetable protein, among other products, are also obtained from pressing camelina seeds. These compounds can enhance the value of the crop, making it attractive to farmers. Although oil from the first pressing, without any prior refinement, may not be used for human consumption in Spain (Royal Decree 308/1983 of 25 January), its use in cosmetics, pharmaceuticals, industry and in animal feed is permitted. Oilseed meal is also used on fish farms to feed salmon, and can also be used as an ingredient in feed for other domestic animals, and is included as such in Regulation (EU) 2017/1017 of the European Commission. The TiO de Camp: Cold Pressed Camelina Oil and Cake Project studies the growth and production of 10 camelina varieties from different geographical origins under Mediterranean climatic conditions, analyses industrial production from cold pressing this type of grain (very small grain) and categorises the products, oil and cake, obtained from cold pressing the 10 varieties, with the idea of using them for different high added-value applications.

Objectives

In this project, the main objective was to study the growth of a total of 10 varieties of camelina (*Camelina sativa*) under dry and semi-arid Mediterranean climatic conditions, to analyse the effect of growing conditions on the quality of the oil and cake produced, and finally to assess: 1) the use of this crop in rotation with winter cereals, and 2) the inclusion of camelina cake in animal feed. At the same time, the industrial processing of this type of grain (very small grain) by cold pressing was further developed.

Description of the actions carried out in the project

Nine spring varieties and one winter variety were used in this operational group.

Taula 1: varietats de camelina utilitzades a l'experiment

Varietats	Entitats	Cicle	Pes 1000 llavors (g)
Alba	Camelina Company Espanya SL. (Madrid, Spain)	Primavera	1.288
Calena	University Alma Mater Bologna (Italy)	Primavera	1.295
CO46	USDA-ARS (Morris, Minnesota)	Primavera	1.453
GP204	Universitat de Lleida (Catalunya)	Primavera	1.227
Joelle	USDA-ARS (Morris, Minnesota)	Hivern	1.085
Omega	University Adam Mickiewicz (Poznan, Poland)	Primavera	1.387
Selone Arivage	AgrosemenS(Rousset, France)	Primavera	1.116
Sonny	KWS SaatSE (Einbeck,Germany)	Primavera	1.164
Swiss Landrace	Sativa Biosaatguy GmbH (Jestetten, Germany)	Primavera	1.181
Vera	Camelina Company EspañaSL. (Madrid, Spain)	Primavera	0.881

Field trials (2020-21 and 2021-22 seasons)
2020-21 Campaign

During September 2020 farmers were contacted and two fields selected, one in Agramunt (41º46'33''N - 01º05'40''E) and one in Montargull (41º57'42''N - 01º05'53''E). The same trial as in Agramunt was also conducted in the experimental fields of the University of Lleida (UdL) School of Agrifood and Forestry Engineering and Veterinary Medicine (ETSEA). In October 2020, the Agramunt and Montargull fields were fertilised with slurry before sowing. The Lleida field was fertilised with inorganic fertiliser at a rate of 50 kg N ha-1. On 16, 18 and 19 November 2020, the 10 selected varieties were sown in Agramunt, Montargull and Lleida, respectively. The sowing rate was adjusted to the specific seed weight of each variety in order to sow 500 seeds m^2. The sowing in Agramunt and Montargull was carried out with a conventional seed drill, in basic plots measuring 3 m wide x 40 and 30 m long, respectively. In Lleida, sowing was carried out with the Wintersteiger micro-seeder owned by IRTA in elementary plots 1.5 m wide x 10 m long. The herbicide trial was also sown on 16 November in Agramunt, and the herbicides were applied on 18 November.

On 27 January 2021, the 10 camelina varieties were sown in Montargull. In February 2021 Cletodim (Centurion plus) was applied at 1 L ha-1 for dicot weed control in all three fields. The Agramunt field was invalidated due to human error.
Data on crop density and phenological state were collected during the rest of the season.
The Lleida trial was harvested on 17 May, except for the Joelle variety, which was harvested a week later (24 May).

The camelina sown in November in Montargull was harvested on 3 June, except for the Joelle variety, which was harvested on 17 June. In each 3-metre-wide elementary plot, only the centre line (1.5 m wide) was harvested to avoid contamination between varieties. The January sowing in Montargull was harvested on 1 July.

The grain was cleaned by sieving immediately after harvesting and left to dry for two weeks. The bags were then weighed in the UdL Weed Science and Plant Ecology research group laboratory and productivity was estimated in kg ha-1.

In all three cases, between one and two days before harvesting, the biomass (aerial part) of 1 m^2 was collected from three areas of each plot, a total of nine subsamples for each variety in each situation (1st and 2nd sowing date in Montargull and in Lleida) for a total of 27 samples per variety. This biomass was left to dry and then weighed (total biomass). The grain was then separated from the plant biomass with a minibatt+ thresher. Thus, the harvest index for each variety could be estimated using the formula:

HI = Bgra / Btot

Where HI is the harvest index, Bgra is the grain biomass resulting from threshing, and Btot is the total biomass, i.e. the weight of the grain and the vegetative part together.
The grain samples from all trials were sent to Germany on 31 July 2021 for industrial pressing and analysis of the oils and cakes.
Part of the harvest was saved to calculate the percentage of oil present in the grain using an NMS 110 minispec spectroscope (Bruker®).

2020-21 Campaign

The varieties sown in this second season were Calena, CO46 and GP204.
These three varieties were sown in Vall-llebrera (41º56'17''N - 01º05'19''E), Agramunt (same field as the previous year) and Lleida (same field as the previous year). The sowing method was the same as in the 2020-21 season, but the sowing dates varied. In Vall-llebrera sowing was on 9 November, in Agramunt sowing was delayed until 2 December, due to the weather and technical reasons, and in Lleida, to 20 December, for the same reasons. The second sowing date for Montargull was 28 January 2022. The herbicides were applied in the Agramunt trial on the afternoon of 2 December, after sowing.
Due to the drought between December and April 2022, all the plants grown in the Agramunt trial died and, once again, this location had to be discarded.
During the rest of the season, data on crop density and phenological state were collected, as in the previous season.

Harvesting in Lleida took place on 13 May and in Vall-llebrera on 9 June. During the previous days, biomass was taken at three points of 1 m^2 in each of the plots in order to calculate the harvest index.
Both the harvest with the micro-harvester and the biomass collected were treated in the same way as in the previous season.

Laboratory tests
Oil analysis

The following oil analyses were carried out on the different samples of each repetition of the different trials previously obtained by industrial grain processing:

- Fatty acid profile
- Tocopherols (vitamin E)
- Absorbance at 270 and 232 nm.
- Peroxide value
- Stability against oxidation
- Acidity
- Pigments
- Phenolic compounds

Cake analysis

The analyses followed the protocols proposed by the AOAC (2006), following the Weende schedule for dry matter (DM), organic matter (OM), ash and crude protein (CP), as well as the Van Soest method for neutral detergent fibres (NDF) and acid detergent fibres (ADF). The list of analyses was as follows:

- Titration of the DM content (method number 934.01). This indicates the moisture content of the sample.
- Titration of ash content (method number 942.05). This indicates the mineral content of the sample. The difference is used to calculate the OM content, which relates to the amount of matter potentially usable by the animal to obtain its energy and protein requirements.
- Titration of the CP content (method number 990.03). This indicates the N content of the sample.
- Titration of the NDF and ADF content (Van Soest (1991) sequential procedure). ADF contains non-digestible cell wall substances (mainly cellulose and lignin). NDF consists of ADF plus the hemicellulose content, which is more degradable than the two former substances.
- For both the oil and cake analyses, in order to obtain a characterisation of the products obtained from the different camelina varieties tested, the values obtained were treated statistically with the JMP 16 programme to obtain the mean values and the corresponding standard errors, as well as to carry out the analysis of variance where the specific effect of the type of variety, location and sowing time were analysed as the main factors.

Final results and practical recommendations

The results of harvest yields during the two seasons varied greatly. While the 2020-21 season yields were unusually high (many yields > 2000 kg ha-1), those of the second season were unusually low (yields of 500-600 kg ha-1). Despite these yields, the cost of camelina production should also be assessed, as fewer herbicides were applied in the second season (only glyphosate in Montargull and no herbicides in Lleida) than in the first season (glyphosate + clethodim in Montargull and clethodim only in Lleida). For camelina production, values from other years must be taken into account in order to consider the seasons as a whole and not just the two years. In other words, the average values over a sufficiently long series of years show that camelina can be a useful and profitable crop in rotation with cereals.

One of the most important objectives of this project was to assess the quality of the oils and cake produced by these camelina varieties. With regard to the oils, the project confirmed their high quality under all conditions in which they were produced. However, it should be noted that the percentage of linolenic acid (omega 3) was higher when the camelina varieties were grown in Lleida (36.7%) than in Montargull, both in SD1 (34.8%) and SD2 (33.8%). Overall, polyunsaturated fatty acids were also more abundant in Lleida than in Montargull, as were the amounts of peroxides and pigments (antioxidants). It may be concluded that although all the oils are high quality, the oil produced in Lleida was better than that produced in Montargull. It is also important to note that the oils produced in SD1 at Montargull were of a higher quality than those produced in SD2. In terms of varieties, CO46 and Vera seemed to produce the highest quality oil.

Conclusions

The cake produced by the different camelina varieties was also high quality, with a very high crude protein percentage (41.7% on average, with values ranging from 40.9 to 43.2%), and a lower percentage of residue (ash) (6.0%) than that established by Feedepedia (6.9%). Whatever the case, all the varieties produced more protein in Lleida (44.2% on average) than in Montargull (40.5%). The sowing date also affected the quality of the cake. Thus, the varieties sown in SD1 showed a higher quality cake than in SD2. Among the varieties, Vera, CO46 and Calena appeared to be the highest quality.

Leader of the Operational Group

ORGANISATION: Roviroli, SL

Coordinator of the Operational Group

ORGANISATION:

Other members of the Operational Group (grant recipients)

ORGANISATION:

Other members of the Operational Group (not recipients of the grant)

ORGANISATION: Comercial Agrícola J. Perera

ORGANISATION: Premier Pigs, SL

ORGANISATION: University of Lleida

ORGANISATION:

Geographical area(s) of application

PROVINCE(S)	REGION(S)
LLEIDA	Segrià, Urgell, Noguera

Dissemination of the project (publications, conferences, multimedia...)

Over these two years, the trials and results have been shown to the farmers who own the fields where the experiments were carried out and to other farmers in the area who showed interest in the crop. Participants in the operational group (GO) were also shown the trials. The farmers have shown considerable interest in the harvests obtained, although the results of the last year, 2021-22, created doubts. One of the pending tasks will therefore be to show the results of the project as a whole, both in terms of harvest and oil and cake quality, which can increase the value of the harvests due to their high quality, and to explain the suitability of sowing part of the fields with camelina.

At the same time, work is being done to create a network of farmers who are interested in crop diversification and who can produce camelina with a view to marketing it for various purposes. Comercial Agrícola Perera, a company participating in the OG, has close contacts with farmers in the area and is carrying out much of this work. The purpose of the products will be conditioned, in part, by the qualitative characteristics of each variety, both the oil and cake, and the specific uses for which they may be marketed.

In September 2021, results from the Lleida trials were presented at the 32nd AAIC Meeting (32nd AAIC Meeting) in Bologna (Italy), and this year (October 2022) data from the Montargull SD1 and SD2 trials will be presented at the 33rd AAIC Meeting in Bozeman (USA). In the coming months there are also plans to publish at least two articles on the results from this project, one of a more agronomic nature and the other focusing on the quality of the products obtained (oil and cake). At least two scientific articles will also be written in journals such as *Industrial Crops and Products*, *Field Crops Research* and *Agronomy for Sustainable Development*, among others.

Finally, it should be noted that there is currently a final degree project about to be presented (October 2022) focusing on the Montargull 2020-21 data, and that the agronomic results of the project will be part of an ongoing doctoral thesis on camelina farming.

Project website

www.roviroli.cat

More information on the project

PROJECT DATES	TOTAL BUDGET

Start date (month-year): July 2020	Total budget: €193,369.50
Completion date (month-year): September 2022	DACC funding: €77,154.43
Current status: Completed	EU funding: €58,204.22
	Own funding: €58,010.85

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Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural

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