Impact Of The Growing Conditions On The Oil Content And Fatty Acid Metabolism In Developing Camelina Seeds

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Introduction

In Europe, the interest in camelina (*Camelina sativa*) as new oilseed crop has rapidly grown in the last years, due to its peculiar fatty acid (FA) profile, good agronomic performances and wide environmental adaptability. The main characteristic of camelina oil is the very high content of polyunsaturated FAs (PUFAs, C18:2 and C18:3, >50%) and C20:1 (> 15%), that can be valorized in several oleochemical applications (e.g., production of surfactant, paint, aviation fuel). In particular, C20:1 could be used as source of medium chain FAs that nowadays are totally derived from imported coconut and palm kernel oils. The just started European Project COSMOS (Camelina and crambe Oil crops as Sources of Medium-chain Oils for Specialty) aims at limiting the European dependence from imported oils (i.e., palm and coconut) by promoting camelina and crambe (*Crambe abyssinica*) domestic cultivation. As for the other oilseeds, the main factors influencing camelina oil quality are environmental conditions and genotypes (Vollmann et al., 2007). In particular, high temperatures during seed filling period interfere with the activity of the enzymes responsible of PUFA metabolism (Cheesbrough, 1989). In the general aim of investigating the influence of temperature on FA metabolism in camelina oil, the objective of this preliminary study is to compare the seed oil content and the FA profile of camelina grown in open field and in controlled environment, under comparable growing conditions.

Methods

A camelina open field (OF) trial was set in spring 2015 at the experimental farm of the University of Bologna (Cadriano, BO). The variety Midas (Linnaeus Plant Science, Canada) was sowed on the 1st of April 2015 in plots and harvested 85 d later (25/06/2015). During the flowering period, aiming at investigating fat and fatty acid accumulation in developing seeds, seed samplings (n=8) were set every 4 d since the beginning of flowering (13/05/2015) until seed colour changed (16/06/2015). On the main stem of 20 different plants the first 6 basal pods were sampled during each survey, all the collected immature seeds were stored at -80 °C until further analyses. Following this preliminary study, Midas plants were grown also in pots and placed in a green house until the start of flowering. Thereafter the pots were moved into a growth chamber (GC) set with a temperature of 24-14 °C (day-night) and 14 h of light. The temperature range was chosen to mimic the mean temperatures occurred during the flowering period in the open field trial. All seeds, contained in the first 8 basal pods of the main stem of 10 plants, were sampled at 6 different development stages and stored at -80°C. Total lipids were extracted using the method described by Hara and Radin (1978), particularly indicated to work with very limited quantities of immature seeds (~1 g). Residual moisture content was determined as the weight difference of about 30 seeds before and after desiccation at 80 °C for 48 h (Rodríguez-Rodríguez et al., 2013). Triacylglycerols were transesterified into the corresponding FA methyl esters and characterized by capillary column gas-chromatography (HRGC-FID, ThermoQuest, Italy).

Results

The oil content in the camelina seeds grown in OF was significantly higher (+300%, $P \leq 0.01$) than that of the plants grown in the GC (Fig. 1). This great difference is probably due to some limiting conditions occurring inside the GC (e.g., elevate humidity, artificial illumination, absence of pollinators). The effect of controlled environment appeared much less evident on the FA profile of developing camelina seeds (Tab. 1). In particular, the plants grown in OF showed always significantly higher contents ($P \leq 0.01$) in C18:1 and C18:2, while those grown in the GC accumulated higher

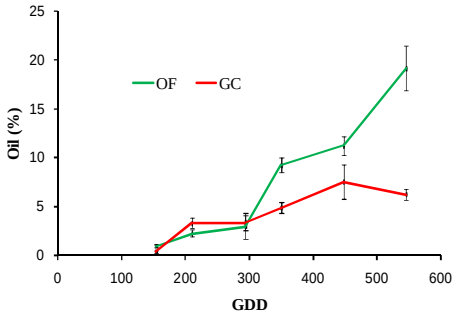

Fig.1. Oil accumulation in camelina seeds grown under different growing conditions (open field OF in green vs. growth chamber GC in red) surveyed at different growing degree day ([1]GDD) after flowering. [1]*GDD was calculated as the difference between mean day temperature and a base temperature of 5°C (Gesch, 2014).*

amounts of C18:3 only in the final sampling. The natural increase of temperatures during seed filling stage in OF has probably negatively affected the activity of desaturase enzyme, thus resulting in final lower amount of C18:3. Otherwise, the metabolism of C20:1 did not significantly change between OF and GC growing conditions.

	Principal fatty acids (%)							
GDD	***C18:1***		***C18:2***		***C18:3***		***C20:1***	
	OF	***GC***	***OF***	***GC***	***OF***	***GC***	***OF***	***GC***
154	26.0 ± 0.9	18.3 ± 7.1	39.6 ± 0.9	32.8± 8.3	12.6 ± 0.3	9.5 ± 2.4	1.2 ± 0.2	0.8 ± 0.3
210	25.4 ± 1.9	21.2 ± 4.8	33.9 ± 1.2	32.9 ± 6.9	16.4 ± 1.6	16.0 ± 6.0	5.2 ± 1.6	6.2 ± 5.0
294	18.74 ± 1.7	17.5 ± 1.5	27.0 ± 0.7	26.8 ± 3.4	22.9 ± 1.7	22.2 ± 4.4	11.5 ± 0.8	10.4 ± 0.9
350	16.5 ± 0.6	15.9 ± 2.6	25.0 ± 0.4	25.9 ± 2.2	26.9 ± 0.6	23.6 ± 3.9	13.9 ± 0.4	11.2 ± 0.6
448	17.0 ± 1.3	13.2 ± 0.8	24.1 ± 0.8	19.6 ± 0.9	28.7 ± 1.3	27.9 ± 2.3	12.8 ± 0.2	12.3 ± 0.2
546	17.70± 0.3	12.3 ± 0.3	23.9 ± 0.2	20.3 ± 0.1	28.2± 0.5	33. 5 ± 0.1	12.7 ± 0.3	12.4 ± 0.2

Table 1. Accumulation dynamic of the principal FAs in camelina oil, surveyed at different GDD after flowering.

Conclusions

Camelina oil content emerged much more influenced by controlled environmental growth conditions than its FA composition, possibly being regulated mostly by temperature. The results of this preliminary study will help to set further trials, aiming at deeply understanding the effects of temperature on camelina FA metabolism and thus enabling the development of models to predict oil composition as a function of the temperatures occurring during filling stage.

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