Contribution to understand the fluctuation of linolenic acid profile in winter oilseed rape grown in France

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Abstract

According to the increase of rapeseed oil for human consumption in France, the linolenic acid content (C18:3 n-3) of 9% is required. The authors brink their contribution to understand the fluctuation of this criteria. Genetic effects were underlined and could be used for recommended list of varieties. Locations induced also high fluctuations. On this point, in relation with the accumulation of the fatty acids in the seed during an early sensitive window, the authors demonstrated that the most important criteria was the cumulated minimum temperature during a sensitive period of 60 days (flowering to flowering + 60 days). The model identified that to reach the higher value (i.e. > 9% of C18:3), the cumulated minimum temperature needs to be below 450 °c base 0). The model was established during two years (2004 and 2005), and tested in 2006. The application of such a result could be to predict before harvest the average value for the linolenic acid content and to advise for dedicated the seeds from one area to special use for labelled oil with a linolenic acid certificated over 9%.

Key words : oil, linolenic acid, accumulation, prediction

Introduction

Following the studies conducted on oilseed rape, there is now evidence that the rape oil get really an interest for human consumption and mainly in prevention of heart attacks and in reducing cholesterol levels in blood. This quality is mainly related to fatty acids profiles and especially in the linolenic content (C18:3, omega 3) of the oil.

According to a survey conduct in France, we identified a fluctuation of these criteria. The data published in the *codex alimentarius* indicate an average value of 9%. Our results bring a contribution to understand the mains factors involved and to help the crushers to select varieties and/or locations to collected seed according to the requirement of the market. For example, some oils crushers developed a market for rape oil certificated at 9% of C18:3. Previous results obtained by Izquierdo and al. (2002) on sunflower indicated that the most important criteria to explain the fluctuation of fatty acid in the oil was the night temperature during an early sensitive period taking place 10 days after anthesis (DAA) to 30 DAA. Using this threshold, Merrien and al., (2005) put evidence that it was possible to explain the variation of fatty acid composition in sunflower oil according to different location in France. A strong correlation was obtained between the minimum temperature during this period and the fatty acid content in the oil. The greatest were the values, the highest was the oleic content. The model was valid for conventional type as for oleic type.

Tremolières (1978), Deng and Scarth (1998) demonstrated also the strong effect of temperature on fatty acids equilibrium. Champolivier and Merrien, (1993) show that the most active period for fatty acid accumulation in the rape seed take place during 60 days after anthesis 60days.

Materials and methods

We collected during 3 years (i.e : 2004, 2005 and 2006) samples from fields plot experiment through 3 locations in France : the East (Nancy), the Centre (Bourges) and the Atlantic border (Surgères). Those samples included each year a panel of the most important varieties grown in France.

For each sample (varieties/years/locations, we check the growth stages (mainly anthesis). The climatic datas was collected from the nearest climatic stations. According that night values was not available, we set up the hypothesis that the minimum temperature was the night one. The cumulative values, day by day, was calculated during the sensitive period (during 60 days after anthesis - DAA).

The fatty acids profiles were check by gas chromatography following the ISO method (NF EN ISO 5508).

Results

Interrelation between fatty acid in the oil

From our data set, the fluctuation of oleic content range from 59 to 68% of the total fatty acid content in the oil. As far as linolenic fraction is concerned, the fluctuations range from 11 down to 6 %. The figure 1 indicated the inverse relation between the main fatty acid composition in 2004: as the oleic fraction increase, the linoleic (C18:2) and the linolenic (C18:3) fraction decrease. The same figure was obtained for 2005 and 2006.

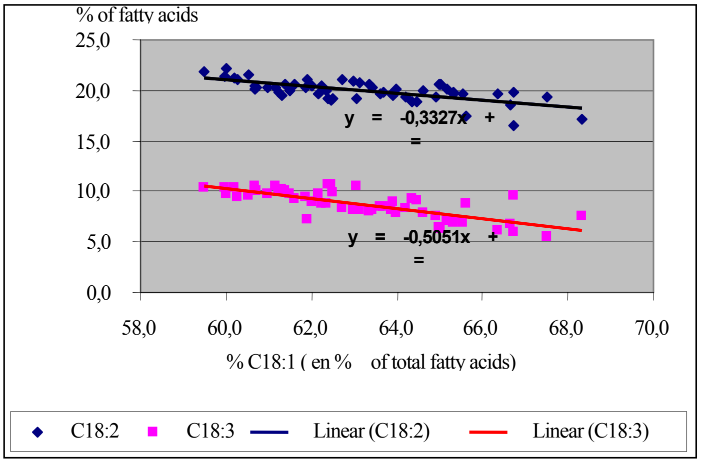

Figure 1: Relations between the3 main fatty acid content in the rapeseed oil collected from different location in 2004.

Variations according to genotypes

The table 1 summarized the results obtained during the 3 years for the most important varieties in the data set. We identified for example that the profile for variety *Pollen* was lower for C18:3 compared to the others genotypes (around 2% less). Those results indicated also a strong variation for the same genotype from one year to another.

Table 1: **C18:3 values (in % of total fatty acids) for the most important varieties during three years.**

Varieties	2004	2005	2006
Aviso	10.3	10.1	8.6
Banjo	9.9	9.8	-
Campala	9.1	8.6	7.6
Grizzly	9.2	9.8	8.6
Pollen	6.8	7.2	-
Expert	8.3	8.5	-
Exocet	-	-	8.5
Quattro	-	-	7.1
Exagone	9	9.7	7.6

Location effect

In 2004, (Table2) the seeds collected in the East area get oil with a higher content in C18:3.

In 2005, the best composition was obtained with the seeds from the Centre of France and in 2006 it was with the seeds from Atlantic border.

Table 2: C18:3 average values (in % of total fatty acids) in 3 locations for the most important varieties during three years.

Location	2004	2005	2006
Atlantique border	7.4	9,1	8.6
East	9.5	8,9	7.7
Centre	8.9	9,6	7.8

Those results clearly indicated that the genotype effect, allied to the location were not the good criteria for explaining the fluctuation of the oil content in linolenic acid.

Effect of low temperatures

For each samples, we calculated the cumulated minimum temperatures during the sensitive period.

The figure 2 illustrated all the results obtained during 3 years for the 3 locations. In order to prevent from too strong genotype effect, we don't take into account the values for *Pollen*. There is a clear evidence of the relation between the low temperature during the sensitive period and the final content in linolenic acid of the rapeseed collected. If 9% value is expected in the oil for C18:3 content, this will be obtained through locations or years where the cumul of the low temperatures during 60 days after anthesis will be below 450°C. Over this threshold, the linoleic content will decrease, mainly by increasing the oleic and linoleic fraction, as indicated in figure1.

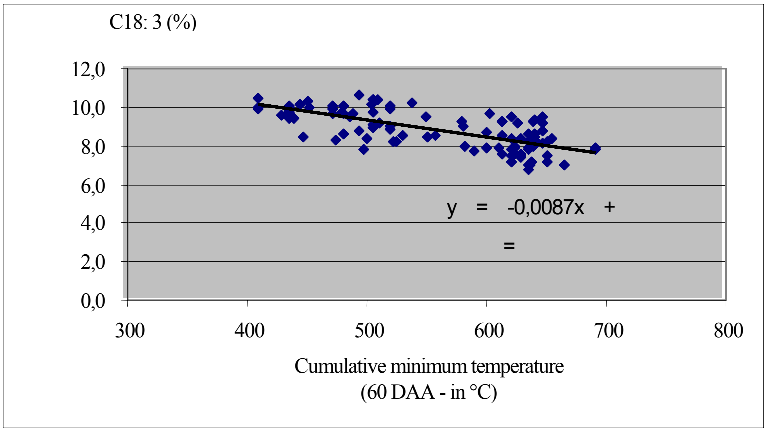

Figure 2: Relations between the cumulative minimum temperature 60 DAA (days after anthesis) and the C18:3 content in the rapeseed oil collected from different location over 3 years.

Discussion

Among the factors involved in fluctuation of fatty acid quality in oilseed rape the climatic conditions explain the difference between year and location. To secure a 9% threshold, crops needs to be grown in area with low temperature : no more than 450°c minimum temperature cumulated during 60 days after flowering.

The linear model fits quite well with the data. The fluctuation around the curve could came from climatic datas : variation could be obtained between the location of the climatic station and the field plots.

Nevertheless, with such a model, crushers could selected one month before harvest the best area where the threshold will be below 450°c. In this case, they could get a high probability to collected seeds with oil content in C18:3 over 9 %.

References

Champolivier, L., et Merrien, A., **1993** : Cinétique d'accumulation des teneurs en acides gras chez une variété de colza érucique. CR expérimental CETIOM-CBA ST Pathus, 08/1993, 9 pages.

Deng, X., Scarth, R., **1998** : Temperature effects on fatty acid composition development of low-linolenic oilseed rape (Brassica napus L.). *J.A.O.C.S.*, Vol. 75, n° 7, p. 759-766

Izquierdo, N. et al. **2002**: Night temperature affects fatty acid composition in sunflower oil depending on the hybrid and the phenological stage. *Field Crops research,* 4078, 1-12

Merrien, A., Pouzet, A., Krouti, M., Dechambre, J. et Garno, V. **2005** : Contribution à l'étude de l'effet des températures basses sur la composition en acide gras de l'huile des akènes de tournesol (oléique et classique). *OCL***,** vol.12, p.455-458.

Tremolières, H.A., Tremolières, A and Mazliac, P., **1978** : Effects of light and temperatures on the FA desaturation during the maturation of rapeseed. *Phytochemistry,* 17 : 685-687.