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Changes in the Composition of Winter Rape Oil during Seed Maturation

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Abstract. The course of biosynthesis of fatty acids in the seeds of winter rape (*Brassica napus* L. ssp. *oleifera*, f. *biennis* cv. Třebíčská) was investigated. After the termination of flowering seed samples were taken at five intervals, the seeds were divided into 4 fractions according to size, and their weight, water content, oil content and fatty acid composition were determined. The oil content was found to increase in all size categories with time, with the exception of a minute drop when complete maturity is reached. Larger seeds contained more oil. The fatty acid composition changes with time in the individual size fractions almost continuously. The same holds for differences between seed sizes of the same sample. The main change in oil composition consists in the decrease of C_{18} acids in favour of C_{22} acids. Greatest decrements during maturation were found with oleic acid, less with linoleic acid. In absolute amounts the quantity of all synthesized acids rises, the greatest rise being observed with C_{22} acids (i.e. predominantly erucic acid). It follows from the mean rates of synthesis of the individual groups (C_{16}, C_{18}, C_{20}, C_{22}) of fatty acids that the fraction of C_{22} rate of synthesis increases, while that of the C_{18} acids decreases with the same speed. The results indicate that the fatty acid synthesis is most intense during the second half of seed maturation, the main role being played by accelerating the synthesis of higher acids, especially of erucic acid.

In the main, the composition of fatty acids in plant oils can be taken as a typical characteristic. HILDITCH (1956) laid out the principle that fatty acids synthesized in the seed are specific for genera, if need be also for varieties, both qualitatively and by their quantitative composition. External conditions (climate, agricultural technology etc.), however, affect the course of biosynthesis and thus also the resulting oil composition. Otherwise, it is possible through selection and crossing to develop new varieties with oil composition very different from the norm. The fatty acid composition of oils used to be characterized by indirect methods only (iodine number, refraction index etc.) or by classical separation methods which are not accurate enough from the present viewpoint. An attempt to summarize the data obtained by modern methods has been published by UZZAN and ARONDEL (1965) who evaluated the

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effect of variety, climate and growth conditions on the composition of peanut, rape, sunflower and soybean oils. It was found that the fatty acid composition depends most on the variety.

Great differences in oil composition are found when fatty acid synthesis proceeds as a system of more or less independent partial processes, the regularities of which are most readily recognized by examining the fatty acid composition during maturation (KARTHA 1959). For this purpose, gas chromatography was found to be of great value (JAMES 1962, 1963, MIKOLAJCZAK et al. 1961, SALLANS 1964). This method was used by ROTINI and co-workers (1962, 1964) who found that during the ripening of olives unsaturated acids are formed at the expense of saturated ones. Other papers on the fatty acid changes during fruit ripening (e.g. of almond tree and grape vine, GALOPPINI, LOTTI 1962, 1963 or of pumpkin and walnut tree, LOTTI, GALOPPINI 1963 a, b) indicate that some acids are accumulated at the expense of others. A decrease is found mostly with palmitic, linolenic or linoleic acid.

It follows from papers on the composition of fatty acids of rape-seed oil (*Brassica napus* L.) and of related oils (*B. campestris* L., *B. nigra* L. KOCH, *B. juncea* COSS. etc.) that the content of typical fatty acids (eicosenoic and erucic) varies considerably (YOUNGS et al. 1951, CRAIG 1956, CRAIG, WETTER 1959, MIKOLAJCZAK et al. 1961, ZEMAN 1963, 1964, ZEMAN, FIBY 1964). Other authors stress mostly the effect of variety, climate, year of harvest, use of fertilizers etc. on the oil composition (CRAIG, WETTER 1959, CRAIG 1961, BACHMANN 1964, FIBY 1964, LÖÖF, APPLEQVIST 1964, SALLANS 1964). The most significant differences are found in different varieties, just as in other oil-bearing plants. Canadian investigators (STEFANSSON et al. 1961, DOWNEY, CRAIG 1963, 1964, DOWNEY 1964, HARVEY, DOWNEY 1964, DORRELL, DOWNEY 1964, DOWNEY, HARVEY 1963, TAKAGI 1965) who studied the heredity of fatty acid biosynthesis established that the biological synthesis of erucic acid in the rape is controlled by two genes of the embryo. Eicosenoic and erucic acids are synthesized by the stepwise addition from oleic acid. Careful selection yielded spring rape and turnip with negligible amounts of C_{20} and C_{22} acids, the oil content being unchanged.

In spite of this, however, the actual dynamics of the formation of individual acids of these oils remains little known. Only KARTHA and SETHI (1963) supplied some data on the course of synthesis of fatty acids during the maturation of mustard and garden *Nasturtium*. It was shown that the synthesis of erucic acid proceeds at later stages of seed maturation some 3—4 times more rapidly than during the early stages of development. At first, mostly the common C_{18} acids are synthesized. Enzymes producing higher acids thus prevail only later. In view of the fact that this type of problem has not been tackled in the rape, it was decided to follow the composition of fatty acids in winter rape seeds from the beginning of their development to complete maturity and to attempt to establish laws governing the changes to be expected.

Material and Methods

The objective of the experiments was to establish the course of oil biosynthesis of winter rape (*Brassica napus* L. ssp. *oleifera*, f. *biennis*). The experiment was conducted at the Research Station for Oil-Bearing Plants at

Opava, using the variety Třebíčská during the vegetation season of 1961—1962. For treatment conventional technology (VOŠKERUŠA 1965) was used. Sowing took place on August 24, first flowers appeared on May 12, general flowering set in around May 20. After the termination of flowering, 50 plant samples were removed from the plot at five intervals, so as to avoid plants from the edges. The dates of sampling were June 15, June 21, July 2, July 7, July 19. The last sampling took place at the stage of full biological maturity. After sampling the plants were stored in the laboratory at room temperature for drying. After drying, the seeds were removed and cleaned. The weights of 1000 seeds from the individual samples were: 0·53 g, 0·85 g, 2·13 g, 2·84 g, 3·68 g respectively.

The seeds were sorted in sieves into size fractions of up to 0·9 mm, 0·9 to 1·3 mm, 1.3—1.7 mm, 1·7—2·1 mm. In samples from the latter dates there were a few seeds up to 2·5 mm in size, but on account of their paucity they were not analyzed any further. The weight of seeds, water and oil content were determined in the seeds by standard procedures (Jednotné analytické metody 1956). The oil thus obtained was converted to fatty acids methyl esters and the fatty acid composition determined by gas chromatography on non-polar and polar stationary phases, using previously described procedures (ZEMAN 1964, ZEMAN, FIBY 1964)

Results

The relative participation of fractions in the individual samples calculated from absolute weights of fractions is shown in Table 1. The values of oil and water contents per dry weight are in Table 2. These values were then used to obtain the absolute amount of dry matter in fractions and samples, the percentual content of oil in dry matter and the absolute and relative amounts of oil in fractions and samples. Taking into account the average molecular weights of fatty acids for individual fractions and samples as obtained by gas chromatography, it is possible to express the relative amount, of fatty acids in the dry matter and absolute amounts of fatty acids in fractions and samples. These last-named values were used for constructing Fig. 1. Other values are not given, as they served merely for auxiliary calculations.

Results of gas chromatography are shown in Table 3. These data obtained made it possible to calculate the content of fatty acids groups of equal length of the carbon chain. This content is expressed as per cent of dry weight of size fractions in the individual samples (Table 4). The values of averages from this Table are represented graphically in Fig. 2, which makes the relationships more apparent. Absolute values of the amounts of individual fatty acids groups in fractions and samples are shown in Table 5. To assess the relative increments of fatty acids within the sum of all size fractions one may use Fig. 3 showing the values referred to the 1st sample as 100%. Other calculations make it possible to determine the average rates of synthesis in the individual time intervals between samples (Table 6), the relative values of these rates being shown in Fig. 4.

Discussion

The results presented here represent interesting material for evaluating the dynamics of fatty acid synthesis during the ripening of winter rape seeds. Both quantitative (increments, size changes) as well as qualitative parameters

Table 1.
Percentage of size fractions in individual samples

Sample	Weight percentage of size fractions (mm)				Absolute weight of sample (g)
	0·9	1·3	1·7	2·1	
1	19·7	68·2	12·1	—	81·6
2	9·5	78·1	12·4	—	214·7
3	0·9	64·4	32·1	2·6	1111·6
4	—	30·3	60·4	9·3	1391·4
5	—	6·9	58·6	34·5	1662·9

(changes in oil composition) can be assessed. The increment of total seed weight (Table 1) is relatively low for the early stages, the highest increments being found only during the second half of ripening. It is of greater interest to study the absolute and relative distribution of size fractions (Table 1). The decisive break comes in the middle of the period examined (3rd sample) when both the weights and the larger-size fractions increase, whereas the small-size fractions decrease. This is even more apparent during the interval from the 3rd to the 4th sample when within a few days the main fraction of 0·9—1·3 mm

Table 2
Content of oil and dry matter in original seeds (O = oil content in weight %, S = dry weight in weight %)

Sample	Fraction size (mm)								Mean S
	0·9		1·3		1·7		2·1		
	O	S	O	S	O	S	O	S	
1	11·4	91·9	15·1	91·9	16·0	91·9	—	—	91·9
2	12·6	93·9	19·2	93·7	21·6	94·1	—	—	93·9
3	16·2	94·8	30·7	94·6	34·2	94·8	38·0	95·1	94·8
4	—	—	36·1	94·8	38·8	94·9	41·2	94·6	94·8
5	—	—	45·0	95·0	46·5	95·0	43·6	95·0	95·0

changes to 1·3—1·7 mm as the main fraction. A certain analogy may be found during the last interval. This would be in agreement with the assumption that during later stages the weight increment is mostly due to the growth (increase in size and weight) of the already existing seeds, whereas at the beginning of the development when new seeds are being formed the relative values of the size fractions change only little.

The observed differences in water content (dry matter) according to Table 2 are generally small, because the samples were prepared and stored under identical conditions. A higher water content in seeds from the earlier stages could be expected. The oil content in the original seeds (Table 2) shows that larger seeds contain more oil. A mutual comparison of values shows that the amount of oil rises smoothly in each size fraction. If one can assume, as above, that seeds of greater sizes are older in development than small seeds, the rise in oil content is apparently a direct consequence of seed development.

The greatest differences along this line were observed in the 3rd sample where unlike in the other samples all the size fractions are represented. This suggests the beginning of the period of most intense synthesis, as will be shown later. Toward the end of the ripening period when all the seeds gradually reach the mature stage, differences between fractions are smoothed out. This

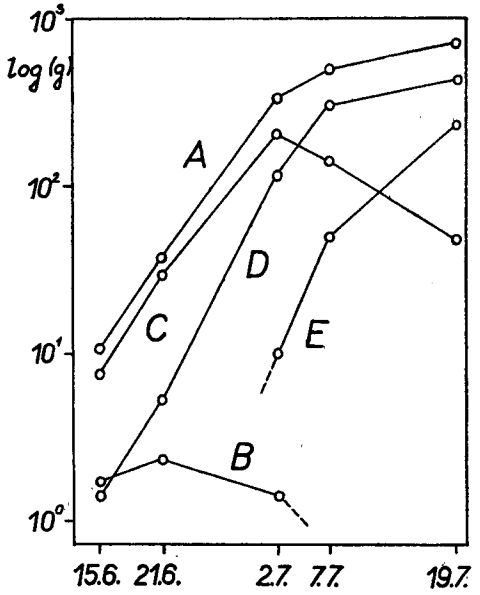

Fig. 1. Absolute amount of fatty acids in size fractions.
Abscissa: dates of sampling, plotted on an appropriate time scale, ordinate: amounts of fatty acids in g.
A — sum of all fractions, B — fraction smaller than 0·9 mm, C — 0·9—1.3 mm, D — 1·3—1·7 mm, E — 1·7—to 2·1 mm.

was indicated by the values of oil content in the last sample when smaller seeds actually showed a higher oil content than did the largest fractions (Table 2), the difference between maximal and minimal values being small. This stresses the importance of the oil content as a criterion of maturity of rape seeds.

The dynamics of fatty acid formation is well shown in Fig. 1, where the gradual changes in the amounts of fatty acids in the individual size fractions can be seen. The semilogarithmic plot makes the graph more readable. Both higher fractions reveal a rapid rise of synthesis, lower fractions showing a decreasing trend and disappearing completely. Both higher fractions show an analogous type of relationship, this becoming decisive even for the summary curve for all fractions. Graphic expression is preferable to a tabellar one, because it can respect the inequal intervals elapsing between the removal of the different samples. The relationships discussed here are in agreement with the conclusions on the connection between seed weight increment and shifts between size fractions.

A completely novel contribution is represented by data on the composition of fatty acids (Table 3). Here, too, one may see similar trends as with previously

Table 3

Content of individual fatty acids in oils in the various size fractions of the rape from different samples

Sample	Fractions	C_{16}			C_{18}					C_{20}				C_{22}				Total
		16 : 0	16 : 1	Sum	18 : 0	18 : 1	18 : 2	18 : 3	Sum	20 : 0	20 : 1	20 : 2	Sum	22 : 0	22 : 1	22 : 2	Sum	
1	0·9	7·0	1·1	8·1	3·0	37·9	17·3	8·8	67·0	0·2	9·9	0·2	10·3	0·4	13·6	0·6	14·6	100·0
	1·3	6·7	1·1	7·8	2·4	40·4	16·1	7·3	66·2	0·4	9·7	0·3	10·4	0·4	14·7	0·5	15·6	100·0
	1·7	5·8	0·5	6·3	1·8	36·1	14·0	5·6	57·5	0·4	11·4	0·5	12.3	0·4	22·7	0·8	23·9	100·0
	2·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2	0·9	6·3	1·0	7·3	2·0	35·0	18·6	8·5	64·1	0·3	10·9	0·3	11.5	0·3	16·2	0·5	17·1	100·0
	1·3	6·2	1·0	7·2	2·1	33.9	16.5	6·2	58·7	0·4	10·5	0·2	11·1	0·5	21·8	0·7	23·0	100·0
	1·7	5·9	0·4	6·3	1·7	31·0	13.0	5·8	51·5	0·5	11·8	0·5	12·8	0·4	28·3	0·7	29·4	100·0
	2·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	0·9	8·2	1·2	9·4	2·2	28·5	19·0	8·1	57·8	0·5	9·7	0·4	10·6	0·4	21·1	0·7	22·2	100·0
	1·3	6·9	0·5	7·4	1·7	21·7	15·2	6·8	45·4	0·4	11·5	0·5	12·4	0·5	33·5	0·8	34·8	100·0
	1·7	6·3	0·3	6·6	1·2	23·1	13·1	6·4	43·8	0·5	11·1	0·6	12·2	0·6	35.8	1·0	37·4	100·0
	2·1	4·9	0·3	5·2	1·1	20·4	11·1	5·7	38·3	0·5	9·1	0·6	10·2	0·6	44.7	1·0	46.3	100·0
4	0·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1·3	5·8	0·3	6·1	1·2	22·4	14·3	6·6	44·5	0·6	9·2	0·6	10·4	0·4	37·8	0·8	39·0	100·0
	1·7	4·9	0·3	5·2	1·0	19·0	13·6	8·0	41·6	0·6	8·7	0·7	10·0	0·5	41·7	1·0	43·2	100·0
	2·1	3·9	0·3	4·2	1·0	20·1	11·0	6·2	38·3	0·5	7·3	0·6	8·4	0·7	47·4	1·0	49·1	100·0
5	0·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1·3	4·6	0·2	4·8	0·9	19·0	13·5	5·8	39·2	0·7	8·7	0·6	10·0	0·7	44·5	0·8	46·0	100·0
	1·7	4·2	0·2	4·4	0·9	17·9	12·2	6·3	37·3	0·7	7·8	0·6	9·1	0·8	47·5	0·9	49·2	100·0
	2·1	3·7	0·2	3·9	0·9	18·7	11.3	6·2	37·1	0·6	6·9	0·5	8·0	0·8	49·1	1·1	51·0	100·0

Note: Fatty acids were designated in an abbreviated form:
The first numeral stands for the number of carbon atoms in the molecule, the second numeral (after colon) for the number of double bonds. Thus 16 : 0 is palmitic acid, 18 : 2 linoleic acid etc.

discussed parameters (weight ratios, oil content etc.). The fatty acid composition changes continually between the individual samples quite clearly, but this holds also within the individual samples according to the size of seeds. The main change is the decrease of C_{18} acids in favour of C_{22} acids. A clear, even if less pronounced decrease may be seen in C_{16} acids, the amount of C_{20} acids remaining practically constant throughout maturation. On the basis of the oil

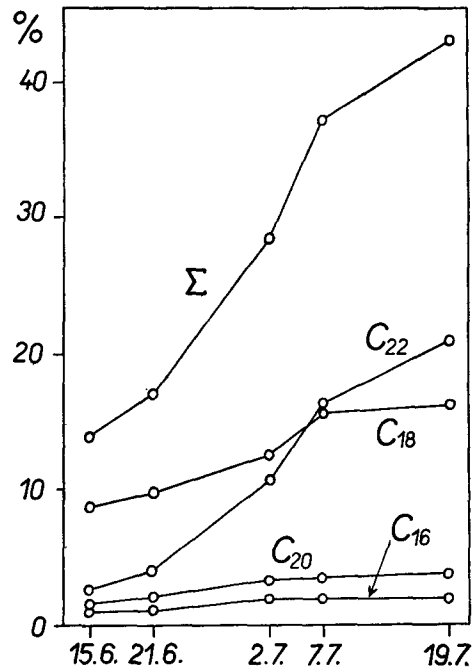

Fig. 2. Content of individual groups of fatty acids in % dry matter
Abscissa: dates of sampling, ordinate: % in dry matter. Σ — sum of all fatty acids in the oil. C_{16}, C_{18}, C_{20}, C_{22} — values of fatty acids of the carbon chain length shown.

composition of the variety Třebíčská as is known from field experiments and breeding practice one may consider the two highest size fractions of the last samplings as fully mature. It follows from the results of the oil composition during maturation that the characteristic acid of the *Cruciferae*, erucic acid, represents at the beginning of the synthesis only a minor component of the lipids extractable by the procedure used. Its level rises in parallel with the increase of synthesis and seed size up to the maximum during ripeness. The gradual decrease of the content of C_{18} acids is not equally pronounced for all the acids; it is highest for oleic acid, lower for linoleic acid and quite minute for linolenic acid. The decrease is quite pronounced with palmitic acid but the changes are not as clear as with other acids.

It is of some interest that the oil composition from the first stages of maturation is rather similar to that of free lipids remaining in rape meals after the industrial oil extraction (ZEMAN, POKORNÝ 1964, ZEMAN et al. 1964), viz. a high level of C_{18} acids and a low content of erucic acid. This agreement offers

an explanation for the composition of oils from the initial phases of maturation: petroleum-ether extracted lipids contain not only triglycerides but also more polar lipids with a fully different fatty acid composition, erucic acid being low and C_{18} acids being high. The triglyceride content assumes predominance only during synthesis in the course of ripening. At complete maturity when the extractable lipids contain practically only oil triglycerides as storage sub-

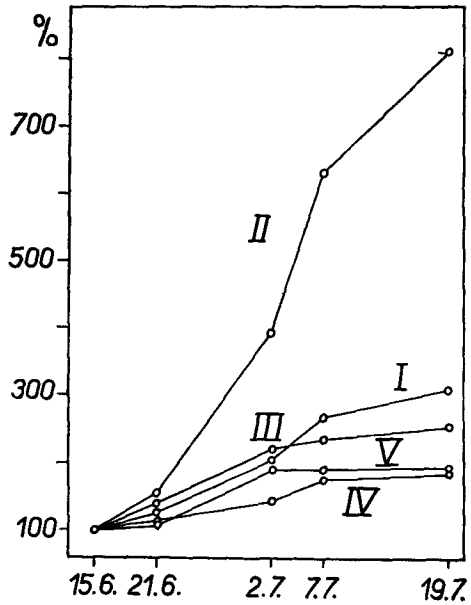

Fig. 3. Relative increments of content of the individual groups of fatty acids
Abscissa: dates of sampling, ordinate: per cent increments referred to the sampling of June 15 (1st sample). I — total fatty acids, II — C_{22} acids, III C_{20} acids, IV — C_{18} acids, V — C_{16} acids.

stances of the seed, the content of more polar lipids cannot affect the fatty acid composition. Our results indicate a mutual relationship between the content of C_{18} and C_{22} acids, as was previously demonstrated (CRAIG 1961, ZEMAN 1963, LÖÖF, APPLEQVIST 1964, ZEMAN 1964). This is caused by the fact that erucic acid is synthesized from oleic acid, eicosenoic acid serving as an intermediate in the synthesis (DOWNEY, CRAIG 1964).

After converting to a common basis percentage content of dry weight (Table 4), the data on fatty acid composition appear in somewhat different proportions (Fig. 2). It may be noted that the percentage content of all acids increases, as one may expect during continual synthesis. Increase is highest for C_{22} acids and quite low for other acids, even for those whose relative content in oils decreases. Erucic acid has thus a decisive role in the increment of oil content during rape maturation. This follows from Table 5 where the absolute values indicate that most of the synthesized fatty acids during later stages are higher acids, in particular C_{22}. This is even more clearly expressed in Fig. 3 where the relative increments of groups of fatty acids during maturation are shown on the basis of the oil composition in the first sample: the lower acids

Table 4

Content of individual groups of fatty acids according to the length of the hydro-carbon chain (in % dry weight)

Sample	Fatty acids	Size fraction (mm)				Mean
		0·9	1·3	1·7	2·1	
1	C_{16}	0·9	1·2	1·0	—	1·0
	C_{18}	7·5	9·8	9·0	—	8·8
	C_{20}	1·2	1·5	1·9	—	1·5
	C_{22}	1·6	2·3	3·8	—	2·6
	Total	1·2	14·8	15·7	—	13·9
2	C_{16}	0·9	1·3	1·3	—	1·1
	C_{18}	7·7	10·9	10·7	—	9·8
	C_{20}	1·4	2·1	2·7	—	2·1
	C_{22}	2·1	4·2	6·1	—	4·1
	Total	12·1	18·5	20·8	—	17·1
3	C_{16}	1·4	2·2	2·2	1·9	1·9
	C_{18}	9·0	13·3	14·3	13·9	12·6
	C_{20}	1·6	3·7	4·0	3·7	3.5
	C_{22}	3·5	10·2	12·2	16·8	10·7
	Total	15·5	29·4	32.7	36·3	28·5
4	C_{16}	—	2·1	1·9	1·7	1·9
	C_{18}	—	15·4	15·5	15·2	15·4
	C_{20}	—	3·6	3·7	3·3	3·5
	C_{22}	—	13·5	16·0	19.4	16·3
	Total	—	34·6	37·1	19·4	37·1
5	C_{16}	—	2·1	2·0	1·6	1·9
	C_{18}	—	16·8	16·6	15·5	16·3
	C_{20}	—	4·3	4·0	3·3	3·8
	C_{22}	—	19·8	21·8	21·3	21·0
	Total	—	43·0	44·4	41·7	43·0

increase at first but stagnate later, higher acids rise more steeply, especially the C_{22} ones.

The rates synthesis (Table 6), calculated from the values of Table 5, indicate that the synthesis is most intense during the interval between the 3rd and 4th sample. During the last interval the rate of synthesis drops again to about one half of the original value. In spite of this, the increasing proportion of erucic acid is apparent in the total rate of synthesis. The relations between rates for the individual fatty acid groups are shown in Fig. 4 demonstrating the pro-

Table 5.
Absolute amounts of individual groups of fatty acids in fractions and samples

Sample	Fatty acids	Size fraction (mm)				Sum
		0·9	1·3	1·7	2·1	
1	C_{16}	0·1	0·6	0·1	—	0·8
	C_{18}	1·1	5·0	0·8	—	6·9
	C_{20}	0·2	0·8	0·2	—	1·2
	C_{22}	0·3	1·2	0·3	—	1·8
	Total	1·7	7·6	1·4	—	10·7
2	C_{16}	0·2	2·0	0·3	—	2·5
	C_{18}	1·5	17·1	2·7	—	21·3
	C_{20}	0·2	3·3	0·7	—	4·2
	C_{22}	0·4	6·6	1·5	—	8·5
	Total	2·3	29·0	5·2	—	36·5
3	C_{16}	0·1	14·9	7·4	0·5	22·9
	C_{18}	0·8	90·1	48·4	3·8	143·1
	C_{20}	0·2	25·1	13·5	1·0	39·8
	C_{22}	0·3	69·1	41·3	4·6	115·3
	Total	1·4	199·2	110·6	9·9	321·1
4	C_{16}	—	8·4	15·2	2·1	25·7
	C_{18}	—	61·5	123·7	18·6	203·8
	C_{20}	—	14·4	29·5	4·0	47·9
	C_{22}	—	53·9	127·7	23·7	205·3
	Total	—	138.2	296·1	48·4	482·7
5	C_{16}	—	2·3	18·5	8·7	29·5
	C_{18}	—	18·4	153·8	84·4	256·6
	C_{20}	—	4·7	37·0	18·0	59·7
	C_{22}	—	21·6	201·9	115·9	339·4
	Total	—	47·0	411·2	227·0	685·2

portions of the total rate of synthesis due to these groups during individual periods. The proportion of rate for erucic acid (C_{22}) rises steadily at the expense of other acids, especially of C_{18}. The proportion of rates for higher fatty acids (C_{20} and C_{22}) reaches 72% during maturity after the initial 30%. In analogy, just as with other relations, even here the middle of the period investigated represents a break. Then the average rate of synthesis of C_{22} acids reaches about 260-fold of that after the determination of flowering, with the C_{18} acids the increase of synthesis rate is of 50-fold. The rates of synthesis of all acids during the period just preceding maturity decrease, apparently because of ceasing

synthesis. It is also possible to calculate the average amount of fatty acids synthesized during the individual periods per day per plant; it amounts for instance to c. 640 mg during the period of most intense synthesis. In general one may see that the predominant or typical acid (erucic acid here) is synthesized toward the end of maturation more intensely than at the beginning, as has been shown by other authors on other objects (GALOPPINI, LOTTI 1962, ROTINI

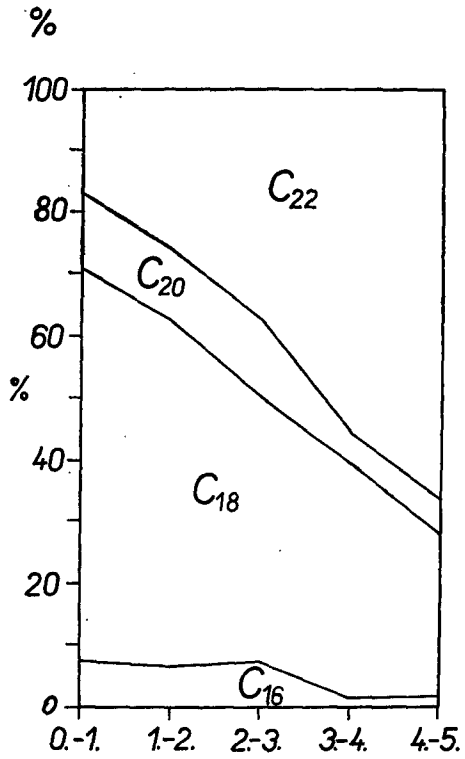

Fig. 4. Relative proportions of individual groups of fatty acids in the average absolute rate of synthesis of fatty acids.
Abscissa: Intervals between samplings, ordinate: % proportions in the rate of synthesis.

et al. 1962). Our results obtained in the rape are analogous to findings in mustard and nasturtium (KARTHA, SETHI 1963). Even in those plants erucic acid predominates in the course of ripening. It may be assumed that an analogous principle will be valid for other cruciferous oil-producing plants containing erucic acid.

From another point of view our results can be taken as a certain supplementation of the recently published papers on the genetic laws of biosynthesis of fatty acids in the rape (DOWNEY, CRAIG 1963, 1964) where it was shown that the enzyme system for the synthesis of both higher acids is independent of the fundamental enzyme system for the synthesis of common C_{18} acids. It may thus be concluded from the present results that this fundamental enzyme system is effective from the beginning of seed maturation and, only in the second half

Table 6.
Rate of synthesis based on the synthesized amounts od fatty acids

Interval between samples	Fatty acids				Total
	C_{16}	C_{18}	C_{20}	C_{22}	
Amount of fatty acid synthesized (g)					
Before 1st sample (27 days)	0·8	6·9	1·2	1·8	10·7
1st—2nd sample (6 days)	1·7	14·4	3·0	6·7	25·8
2nd—3rd sample (11 days)	20·4	121·8	35·6	106·8	284·6
3rd—4th sample (5 days)	2·8	60·7	8·1	90·0	161·6
4th—5th sample (12 days)	3·8	52·8	11·8	134·1	202·5
Mean rates of synthesis (in g/day)					
Before 1st sample	0·03	0·26	0·05	0.07	0·41
1st—2nd sample	0·28	2·40	0·50	1·12	4·30
2nd—3rd sample	1.85	11·07	3·23	9·71	25·87
3rd—4th sample	0·56	12·14	1·62	18·00	32·32
4th—5th sample	0·32	4·40	0·98	11·18	16·88

of the period is surpassed by the capacity of enzymes for the synthesis of higher fatty acids. If this system is not present (such as with varieties bred for oil production without erucic acid), the fundamental enzyme system develops the synthesis of common C_{18} acids to such an extent that after reaching maturity there is no apparent difference in the oil content as compared with normal rape varieties (DOWNEY, CRAIG 1964).

Since the experiments reported here were not repeated in subsequent years, the values obtained have no absolute validity. Meteorological differences during the individual years and the effects of agricultural technology affect both the quantitative parameters (oil content, yield, water content) and oil composition, as was shown by earlier work in this institute (ZEMAN 1963, 1964, FIBY 1964) and also by other authors (CRAIG, WETTER 1959, CRAIG 1961, LÖÖF, APPLEQVIST 1964). It is believed, however, that the fundamental relationships found here have a general validity for winter rape, the parameters of which do not show a wide spread under normal conditions (ZEMAN 1963, VOŠKERUŠA 1965).

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I. Zeman, V. Kratochvíl, Výzkumný ústav tukového průmyslu, Ústí nad Labem, Výzkumná stanice olejnin, Opava: **Změny složení oleje ozimé řepky při zrání semen.** — Biol. Plant. **9** : 1—14, 1967.

Autoři sledovali průběh biosyntezy mastných kyselin v semenech ozimé řepky (*Brassica napus* L., subsp. *oleifera*, f. *biennis*) odrůdy „Třebíčská". Po odkvětu v pěti postupných termínech odebírali vzorky semen, po jejichž rozdělení do 4 frakcí podle velikosti stanovili váhu semen, vlhkost, olejnatost a plynovou chromatografií složení mastných kyselin oleje. Olejnatost ve všech, velikostních frakcích stoupá s časem, s výjimkou nepatrného poklesu při úplné zralosti. Větší semena mají i obsah oleje vyšší. Složení mastných kyselin se mění s časem v jednotlivých velikostních frakcích téměř spojitě, podobně je tomu při porovnávání semen různých velikostí z téhož odběru. Podstatou změn složení oleje je úbytek C_{18} kyselin ve prospěch C_{22} kyselin. Největší úbytky během zrání jsou u kyseliny olejové, menší u kyseliny linolové. V absolutních hodnotách možství všech syntetizovaných kyselin vzrůstá, nejvíce ze všech však přibývá C_{22} kyselin (t. j. převážně kyselina eruková). Z průměrných rychlostí syntezy jednotlivých skupin (C_{16}, C_{18}, C_{20}, C_{22}) mastných kyselin vyplývá, že podíl C_{22} kyselin na celkové rychlosti syntezy se neustále zvyšuje, kdežto podíl C_{18} kyselin stejným tempem klesá. Výsledky svědčí o tom, že nejintenzivnější synteza mastných kyselin probíhá v druhé polovině období zrání semen, přičemž hlavní podíl na tom má zrychlující se synteza vyšších kyselin, zejména typické kyseliny erukové.

И. Земан, В. Кратохвил, Институт жировой промышленности в Усти над Лабем и Станция масличных культур, Опава: **Изменения содержания масла в семенах озимого рапса при их созревании.** — Biol. Plant. 9 : 1—14, 1967.

Исследовался биосинтез жирных кислот в семенах озимого рапса (*Brassica napus* L., subsp. *oleifera*, f. *biennis*) сорта «Тржебичска». После окончания цветения отбирали образцы семян в пять сроков, разделяли на четыре фракции по величине и определяли вес семян, влажность, маслянистость и содержание жирных кислот масла газовой хроматографией. Маслянистость повышается во всех фракциях по величине со временем, за исключением незначительного снижения при полной зрелости. В более крупных семенах также более высокое содержание масла. Состав жирных кислот масла со временем изменяется почти непрерывно, подобно тому и при сравнении семян разной величины из того же отбора. В основе изменений масла лежит понижение содержания C_{18} кислот в пользу C_{22} кислот. Наиболее понижается содержание олеиновой кислоты, менее значительно — содержание линолевой кислоты. В абсолютных величинах количество всех кислот возрастает, более всего возрастает содержание C_{22} кислот (т. е. преимущественно эруковой кислоты). По средним скоростям синтеза отдельных групп (C_{16}, C_{18}, C_{20}, C_{22}) жирных кислот постоянно повышается доля C_{22} кислот в общей скорости синтеза, в то время как доля C_{18} кислот понижается в том же темпе. Синтез жирных кислот протекает наиболее интенсивно во второй половине периода созревания, причем главную долю в этом повышении имеет все ускоряющийся синтез высших кислот и в особенности типичной эруковой кислоты.