# INHERITANCE OF FAT CONTENT AND FATTY ACID COMPOSITION IN SEEDS OF ZERO-ERUCIC WINTER RAPE (B. NAPUS)

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The oil of zero-erucic rape seeds is characterized by high content of oleic acid (60%), linoleic acid (20%) and linolenic acid (10%). Further improvement of rape oil means lowering the linolenic acid content and increasing the linoleic acid content. The question of fat content in seeds remains very current. Recognition of the principles of inheritance of these characters is essential for the further improvement of winter rape breeding.

## MATERIALS AND METHODS

Six inbred lines on $S_5$ level, which differ in the fat content and fatty acids composition, were used for investigation (Table 1). Those lines were crossed in the full diallelic system. Diallelic crossings and field trials were repeated twice in two consecutive years.

Fat content in seeds was estimated by Newport Quantity NMR-analyser and fatty acids composition by means of gas chromatography.

The analysis of variance factors was made in each generation for every investigated character. Genetic parameters were estimated by analysis of variance according to B.I.Hayman. Coefficients of heritability were calculated on the basis of regression coefficients (b) of progeny to parents and on the basis of squares of correlation coefficients ($r^2$). Coefficients of correlation between contents of fat and of fatty acids were calculated for parental lines.

## DISCUSSION OF RESULTS

Components of variability, calculated for fat content in the seeds of zero-erucic winter rape, allow to state that its content is determined by the genotype of the mother plant (producing seeds) and that the influence of the genotype of the embryo is minimal (Table 2).

The fat content in $F_2$ seeds, which come from self-pollination of $F_1$ plants, is relevant to mother genotype, i.e. $F_1$. The almost equal additive operation of mother and father genes testifies to it. Interaction of parents has no influence on the inheritance of fat content. The contribution of non-hereditary variability to form this characteristic is high.

The inheritance of oleic acid content presents similar traits. The oleic acid content in the rapeseed oil is conditioned mainly by the genotype of the mother plant (Table 2). The influence of the father genotype is ten times lower. The interaction of genotypes of both parents and the influence of non-hereditary components are also significant.

The level of linoleic acid in rape oil is mainly dependent on the genotype of the mother plant, the influence of the father is five times less (Table 2).

The sum of parent interaction and of non-hereditary variability has greater influence on the linoleic acid content than the father genotype. The linoleic acid content in the seeds of $F_2$ generation which were obtained as a result of $F_1$ self-pollination, is like that which fits in with the mother genotype, i.e. $F_1$. It is manifested by the almost equal additive operation of father and mother genes.

The process of inheritance of linolenic acid has a different course (Table 2). The mother influence on the linolenic acid content is conspicuously many times greater than the father influence. The interaction of genes of both parents is very high and in quantity comes up to an additive operation of genes. Non-hereditary variability is a factor which modifies linolenic acid content in rape oil to a very high degree. However, on the basis of analyses of seeds obtained from self-pollination of $F_1$ plants, the equal influence of mother and father is far from being reached. This fact does not allow to draw any clear-cut conclusions.

Similarity between the systems of inheritance of fat content and of oleic acid content is also suggested by high coefficients of correlation between these two characters (Table 3). A significant minus correlation between fat content and linoleic acid and between oleic and linoleic acid was found. No significant correlation between linolenic acid and other investigated components was established.

The results of analyses of seeds obtained from self-pollination of $F_1$ plants were used to carry out the analysis of variance according to B.I.Hayman (Table 4).

The variance analysis of diallelic table for fat content revealed a high significance of general combining ability. However, no non-linear nor mother effect was stated. Lack of dominance is also manifested by lack of differences between the mean values for parents and for hybrids.

Similarly, a highly significant general combining ability of investigated lines was stated for oleic acid. Specific combining ability is insignificant, $b_1$ parameter denoting dominance is significant on the level 0,10. Partial dominance of genes which condition high oleic content, is also indicated by a mean value of hybrids which is higher than that of parents. These genes are symetrically distributed between parental lines. Significance of mother effects was not stated.

The investigated inbred lines show a highly significant general combining ability for linoleic acid content. Specific combining ability, just as for oleic acid, appeared insignificant. Partial dominance towards low linoleic acid content is significant on the level 0,10. Insignificance of $b_2$ coefficient showed on symetrical distribution of dominant genes between parental lines. Neither general nor specific mother effects have been stated.

The analysis of diallelic table for linolenic acid did not show any significance of any of the investigated factors.

Calculated coefficient of heritability is highest for linoleic acid, then heritabilities of fat content and of oleic acid remain on almost the same level, and heritability of linolenic acid equals zero (Table 5).

TABLE 1

CHARACTERISTICS OF PARENTAL LINES - INBRED LINES ON $S_5$ LEVEL

| Line | Fat content % d.m. | Fatty acid composition: Palmitinic acid | Palmitooleic acid | Stearinic acid | Oleic acid | Linoleic acid | Linolenic acid | Eicosenoic acid |
|---|---|---|---|---|---|---|---|---|
| $P_1$-4161 | 36,4 | 6,2 | 0,7 | 1,6 | 58,2 | 23,4 | 8,7 | 1,1 |
| $P_2$-4162 | 39,9 | 5,9 | 0,7 | 1,8 | 58,7 | 23,0 | 8,7 | 1,2 |
| $P_3$-4164 | 35,2 | 5,7 | 0,9 | 1,6 | 57,3 | 22,9 | 10,7 | 0,9 |
| $P_4$-4166 | 44,5 | 5,6 | 0,5 | 1,9 | 67,5 | 15,4 | 8,3 | 0,8 |
| $P_5$-4167 | 44,6 | 4,7 | 0,4 | 1,5 | 66,9 | 17,1 | 8,0 | 1,3 |
| $P_6$-4169 | 42,5 | 5,0 | 0,2 | 1,6 | 61,6 | 20,0 | 10,4 | 1,0 |
| Variability coefficient | 10,00 | 10,22 | 44,18 | 9,03 | 7,29 | 16,78 | 12,40 | 17,82 |
| Standard deviation | 4,05 | 0,56 | 0,25 | 0,15 | 4,50 | 3,41 | 1,13 | 0,19 |

TABLE 2

FACTORING OF VARIABILITY OF HYBRIDS INTO EXPECTED VALUES BY MEANS OF FACTORIAL ANALYSIS /%/

| Source of variability | Seeds obtained from plants after cross-pollination: Fat | Oleic acid | Linoleic acid | Linolenic acid | Seeds obtained from isolated $F_1$ plants: Fat | Oleic acid | Linoleic acid | Linolenic acid |
|---|---|---|---|---|---|---|---|---|
| Mothers | 62,66 | 53,41 | 53,48 | 24,41 | 30,21 | 28,52 | 35,94 | 2,46 |
| Fathers | 0,84 | 5,24 | 11,15 | 3,52 | 26,20 | 41,90 | 41,27 | 33,78 |
| Parents' interaction | 0,00 | 19,79 | 15,11 | 28,27 | 0,00 | 15,96 | 12,03 | 22,46 |
| Error + environment | 36,50 | 21,56 | 20,26 | 43,80 | 43,59 | 13,62 | 10,76 | 41,30 |
| Together | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 |

TABLE 3

CORRELATION COEFFICIENTS BETWEEN FAT CONTENT AND FATTY ACIDS CONTENTS CALCULATED FOR PARENTAL LINES

| Character | Fat | Palmitinic acid | Palmito-oleic acid | Stearic acid | Oleic acid | Linoleic acid | Linolenic acid |
|---|---|---|---|---|---|---|---|
| Palmitinic acid | -0,7052 | | | | | | |
| Palmito-oleic acid | -0,8039 | 0,7418 | | | | | |
| Stearic acid | 0,2175 | 0,4321 | 0,1238 | | | | |
| Oleic acid | 0,9190** | -0,6354 | -0,6301 | 0,1830 | | | |
| Linoleic acid | -0,8904* | 0,6241 | 0,6122 | -0,2379 | -0,9839** | | |
| Linolenic acid | -0,5106 | 0,0084 | 0,1317 | -0,2620 | -0,5858 | 0,4609 | |
| Eicosenoic acid | 0,1121 | -0,2561 | -0,1281 | -0,4971 | -0,0261 | 0,1915 | -0,4342 |

TABLE 4

ANALYSIS OF VARIANCE ACCORDING TO B.I.HAYMAN FOR INVESTIGATED CHARACTERS

| Source of variability | Degrees of freedom | Mean square: Fat | Oleic acid | Linoleic acid | Linolenic acid |
|---|---|---|---|---|---|
| Additive effects /a/ | 5 | 27,08683** | 36,13905** | 28,96121** | 1,34398 |
| Non-additive effects /b/ | 15 | 0,27431 | 2,53000 | 1,20353 | 0,21091 |
| -dominance /$b_1$/ | 1 | 0,00820 | 14,32899 | 9,85468 | 0,00001 |
| -asymetry of distribution of dominant genes /$b_2$/ | 5 | 0,67404 | 2,24831 | 0,77938 | 0,24209 |
| -specific interaction of genes /$b_3$/ | 9 | 0,08180 | 1,37549 | 0,47793 | 0,21701 |
| General mother effects /c/ | 5 | 0,39282 | 3,08474 | 1,43464 | 0,33432 |
| Specific mother effects /d/ | 10 | 0,39834 | 0,54191 | 0,59527 | 0,20802 |
| Error | 396 | 3,45462 | 4,60978 | 2,64552 | 0,95635 |
| Mean of hybrids | - | 42,4538 | 62,5567 | 19,6906 | 9,3166 |
| Mean of parents | - | 42,4943 | 60,8638 | 21,0945 | 9,3182 |

TABLE 5

COEFFICIENTS OF HERITABILITY FOR VARIOUS CHARACTERS ESTIMATED ON THE BASIS OF COEFFICIENT OF REGRESSION /B/ OF PROGENY TO PARENTS AND ON THE BASIS OF COEFFICIENT OF DETERMINATION /$R^2$/

| Character | | |
|---|---|---|
| Fat content | 0,4579 | 0,4646 |
| Palmitinic acid | 0,3302 | 0,2073 |
| Palmito-oleic acid | 0,2268 | 0,0799 |
| Stearic acid | 0,1457 | 0,0570 |
| Oleic acid | 0,4277 | 0,3939 |
| Linoleic acid | 0,5556 | 0,5366 |
| Linolenic acid | 0,0000 | 0,0001 |
| Eicosenoic acid | 0,0121 | 0,0004 |