Selection of Breeding Materials with high Linoleic Acid and/or low Linolenic Acid Content in Soybean

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Abstract : In this research , one plant containing zero linolenic acid content was found with the "half - seed method" of capillary gas chromatography in the soybean strain 0358 - 5 -1-5. It was not reported in the world. The material will be very useful for breeding low linolenic acid content cultivated varieties and special for studying gene action for linolenic acid by the aids of biotechnology in soybean. [The Journal of American Science. 2006;2(3):29-32].

Keywords: Soybean; high linoleic acid; low linolenic acid; Lipoxygenase Null Mutants; half - seed method

1. Introduction

Soybean (Glycine max. L. Merrill) constitute the present world's third most important source of vegetable oil . They are widely adaptable and are grown under varied agroclimatic conditions. One of major goals for oilseed breeders to improve oil quality by selecting for higher linoleic acid and lower or no linolenic. It is well - known that linoleic acid is an essential fatty acid for human body and , therefore , any improvement in its content will be conducive to human health , whereas linolenic acid have has three double bonds sensitive to oxidation, thus resulting in its a unfavorable smell and taste.

Many people attach more importance to nutrition and the demand for good quality vegetable oil has kept increasing. In order to meet this demand , breeding of high yielding and good quality oilseed variety is very necessary.

In the experiment reported in this paper , a number of promising soybean lines were identified with the "half seed" method , which contain high linoleic acid and low/ or zero linolenic acid.

2. Materials and Methods

2.1 Plant materials. F4 self - pollination progenies of the combination "N98-9445A ×DongNong95018" were used in a field experiment. N98-9445A and DongNong95016, all characterized by high linoleic acid and low linolenic acid .

2.2 **Gas chromatography analysis.** Bulk samples of ten to twenty seeds of each plant tested were analyzed by gas chromatography. Fatty acid analysis was carried out according to the method of Lee et al [1]. A modified half - seed technique was carried out as detailed by Downey [2]. The harvested seeds of eight plants containing high linoleic and/or low linolenic acid content were subjected to half seed analysis. The seeds were steeped in water for half to one hour before they were separated to make it easier to separate the seed coat from the embryo. Then they were divided into two halves and the half without the embryo was used for half - seed analysis. The gas chromatography unit in this experiment was set as follows : Unit : Yanaco 6800. Column temperature : 200℃. Injection temperature: 200 ℃. Injection volume: 2 μl. Carrier gas and its flux: He; 40 ml/ min.

3. Results and Discussion

The breeding strategy for soybean generally aims at increasing the linoleic acid content to possibly 60 % and at the same time reducing the level of linolenic acid to the range of 3～5 % or less[3] . For realizing such a goal , the availability of proper breeding materials is of primary importance. With the mutant of soybean, Oro, Roy and Tarr succeeded in developing a new cultivar whose linolenic acid was 1.60～1.87% [4]. In our study , a unique plant material characterized by zero linolenic acid was identified with the half - seed technique. The composition of its fatty acid was found to be linolenic acid free and consist of palmitic acid 2. 99%, oleic acid 73.86% and linoleic acid 23.15% (Table 1). In their diallel mating of two soybean lines with distinctly different linolenic acid concentration (high vs. low), S. Pleines and W. Friedt (1989) used a material with very low linolenic acid content (2.99%) as parent and showed that linolenic acid content is mainly under the control of a nuclear gene of the embryo [5]. It is evident that the material 0358 - 5 - 1 - 5 will be very useful for selecting low linolenic acid and studying gene action for linolenic acid with the help of biotechnology.

Progress in selection for increased level of linoleic acid and reduced linolenic acid has been rather slow mainly due to a positive correlation between them as reported by many workers [6]. However, there is a hypothesis that the synthesis of linoleic and linolenic acid in summer turnip rape is controlled by two independently working enzyme systems. Based on this hypothesis, Jesson argued that it should be possible to reduce the linolenic acid content in rape and turnip rape oil below 5% [7] (1977). Up to now, many materials with low linolenic acid (<5%) have been developed, though no direct experiment evidence is available to support the hypothesis. The result in this study supported the assumption that linoleic acid and linolenic acid are positively correlated with each other (Table 2). But it is worth mentioning that for some individuals, such as 0358 - 5 - 1, striking difference existed between linoleic acid and linolenic acid contents, a fact that seems to support the hypothesis that the two fatty acids are conditioned by two independently working systems. In addition, as the data in the experiment suggest, a significant negative correlation is present between oleic acid and linoleic acid contents and between oleic acid and linolenic acid contents, which is in agreement with the results of other researchers.

Most of high linolenic and low linolenic acid plant has black or dark blue umbilicus In the descendants of this cross. It need to improvement for using in production. Take the material 0358 – 5 – 1-5 for example. Although it has the desirable characters of high linolenic and low linolenic acid , its small seed size and dark blue umbilicus limiting its application. There is a significant negative correlation between oleic acid and linoleic acid contents and between oleic acid and linolenic acid contents, which is in agreement with the results of other researchers. So some material had a linoleic acid content as high as 60.32%, But no materials with both high linoleic acid content (>60%) and low linolenic acid content (<3%) were found.

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Table 1. Fatty acid composition of F4 individual plant through half - seed selection

Plant Materials	C16 :0 (Pal)	C18 : 1 (Ole)	C18 : 2 (Lin)	C18 : 3 (Lnl)	Plant Materials	C16 :0 (Pal)	C18 : 1 (Ole)	C18 : 2 (Lin)	C18 : 3 (Lnl)
0358 - 4 - 1 – 1	3. 50	33. 78	42. 38	20. 34	0358 - 4 - 12 – 2 7	3. 38	39. 47	45. 56	11. 60
0358 - 4 - 1 – 2	3. 17	41. 76	42. 73	12. 34	0358 - 5 - 1 – 4	4. 28	70. 16	20. 76	4. 80
0358 - 4 - 1 – 3	3. 02	42. 76	42. 63	11. 59	0358 - 5 - 1 – 5	2. 99	73. 86	23. 15	0. 00
0358 - 4 - 1 – 4	3. 94	41. 25	42. 09	12. 72	0358 - 5 - 1 - 9	3. 74	72. 53	19. 78	3. 95
0358 - 4 - 1 – 5	4. 39	35. 23	50. 42	9. 95	0359 - 8 - 5 – 1	2. 88	71. 77	20. 56	4. 79
0358 - 4 - 1 – 6	4. 99	38. 88	45. 69	10. 44	0359 - 8 - 5 – 2	2. 63	79. 30	13. 73	4. 33
0358 - 4 - 7 – 1	3. 72	39. 43	44. 56	12. 30	0359 - 8 - 5 – 6	3. 19	74. 16	18. 92	3. 73
0358 - 4 - 7 – 3	2. 65	38. 34	44. 74	14. 27	0359 - 8 - 5 – 10	2. 14	73. 34	20. 83	3. 68
0358 - 4 - 7 – 7	4. 66	41. 08	45. 23	9. 04	0359 - 8 - 5 – 11	3. 13	71. 54	21. 73	3. 60
0358 - 4 - 7 – 8	5. 77	30. 81	52. 32	11. 11	0359 - 8 - 5 – 13	2. 94	61. 61	32. 45	3. 01
0358 - 4 - 7 – 9	3. 02	40. 64	42. 06	14. 28	0359 - 8 - 5 - 14	2. 35	74. 50	20. 48	2. 66
0358 - 4 - 12 – 3	3. 80	42. 66	43. 54	10. 00	0359 - 8 - 5 – 15	2. 66	77. 20	16. 79	3. 34
0358 - 4 - 12 – 5	3. 96	40. 79	42. 91	12. 33	0359 - 8 - 5 - 17	2. 44	74. 50	19. 07	3. 98
0358 - 4 - 12 – 7	5. 37	34. 50	46. 16	13. 97	0359 - 8 - 5 - 20	2. 15	70. 15	22. 97	4. 74
0358 - 4 - 12 – 8	3. 32	39. 33	46. 54	10. 81	0359 - 8 - 5 – 21	3. 48	79. 11	14. 13	3. 28
0358 - 4 - 12 – 18	3. 20	43. 83	45. 67	7. 31	0359 - 8 - 5 - 22	2. 61	80. 36	14. 23	2. 80
0358 - 4 - 12 – 19	3. 88	41. 91	46. 30	7. 92	0359 - 8 - 5 - 23	2. 35	75. 62	19. 01	3. 02
0358 - 4 - 12 – 21	3. 80	41. 20	44. 60	10. 41	0359 - 8 - 5 – 24	1. 99	82. 92	10. 9 2	4. 17
0358 - 4 - 12 – 23	2. 98	42. 85	44. 07	10. 09	0359 - 8 - 5 – 25	2. 23	67. 30	27. 52	2. 95
0358 - 4 - 12 – 24	3. 30	39. 19	47. 59	9. 30	0359 - 8 - 5 - 29	2. 79	72. 99	20. 23	3. 99

Table 2. The correlation coefficient of between oleic, linoleic and linolenic acid, linoleic & lin/ole* and lin/ole &lin/lin* for strain selected plants

Plant Materials	No. Sample	Oleic &linoleic	Oleic & linolenic	Linoleic & linolenic	Lin/ ole & linolenic	Lin/ ole & lnl/ lin
0358 - 4 – 7	10	- 0. 987**	- 0. 581	0. 451	0. 429	- 0. 451
0358 - 4 – 12	30	- 0. 952**	- 0. 595	0. 331	0. 528	- 0. 170
0358 - 5 – 1	30	- 0. 801	- 0. 677	0. 149	0. 311	- 0. 004
0359 - 8 – 5	30	- 0. 985	- 0. 404	0. 249	0. 262	- 0. 511
Total	100	- 0. 988	- 0. 827	0. 736	0. 771	- 0. 201

* Lin/ ole : linoleic and oleic acid ratio , lnl/ lin : linolenic and linoleic acid ratio.

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