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COMPARATIVE CHARACTERISTICS OF CANADIAN RAPESEED OILS

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The major constituents of rapeseed oil are the fatty acids combined with glycerol to make up 97 to 99% of the product. The remainder (1-3%) is composed of phospholipids, sterol esters and non-saponifiable constituents such as sterols, and hydrocarbons including chlorophyll or the green color. This presentation will be concerned with the fatty acid composition and to a minor extent the green color or chlorophyll.

The variation in fatty acid composition of any vegetable oil is due to two factors. The first is the genetic factor as represented by species and varieties; the second is the influence of environment for agricultural production of the seed which may involve soil type, soil nutrients, moisture, sunlight and length of growing period.

The environmental factors are a major influence on rapeseed production in Canada and this will be examined first. The first figure shows the rapeseed production in Western Canada. The major producing areas are found in the provinces of Manitoba, Saskatchewan and Alberta and are concentrated in the northern half. The soil types vary through light brown, dark brown and black to grey soil zones; the moisture varies generally increasing from south to north and the frost-free period in general decreases from south to north. The preferred area in terms of moisture or rainfall is in the northern half, but the other main factor which influences production is the frost-free period. A map of frost-free periods is shown in Figure II and can be divided into two areas; one with over 100 days and the other less than 100 days. In general, the area under 100 days is larger although there are some regional variations. This means that there are environmental effects which can influence rapeseed production in Western Canada. It should be emphasized at this point that the winter climate is too severe for the production of winter crops except for some limited areas and that agricultural production in Western Canada is from spring types or those crops which are seeded in the spring and harvested little more than 100 days later.

Two varieties of species of rapeseed are grown in Canada, Brassica napus and Brassica campestris and these are compared in Table I. The days to maturity for the B. napus varieties are similar to wheat or in the 100 days plus category whereas the varieties of B. campestris require less time to maturity.

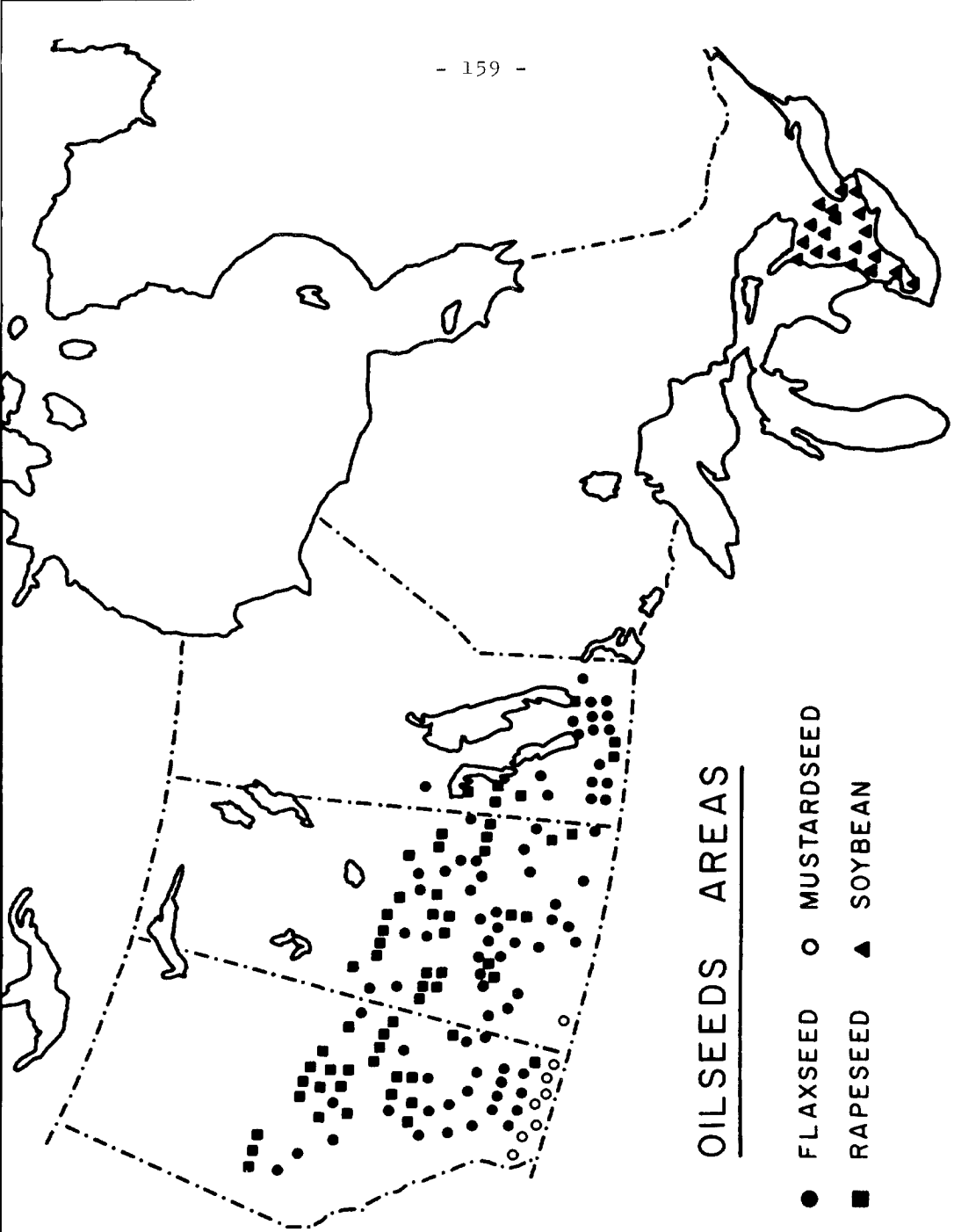

FIGURE I

OILSEED PRODUCTION AREAS IN CANADA

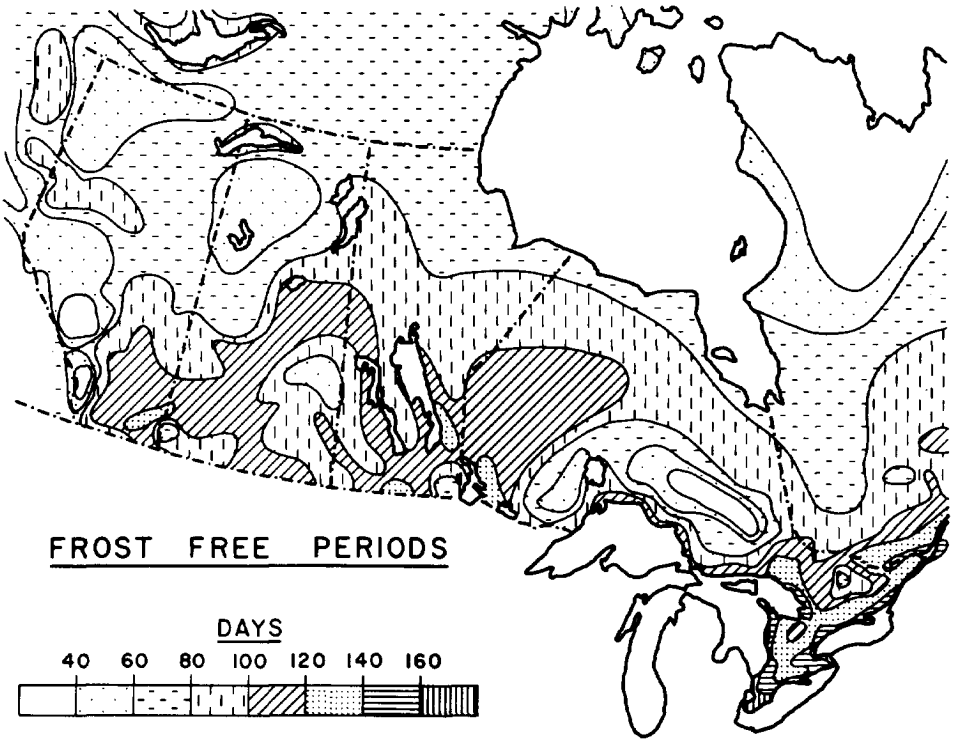

FIGURE II

FROST FREE PERIODS IN CANADA

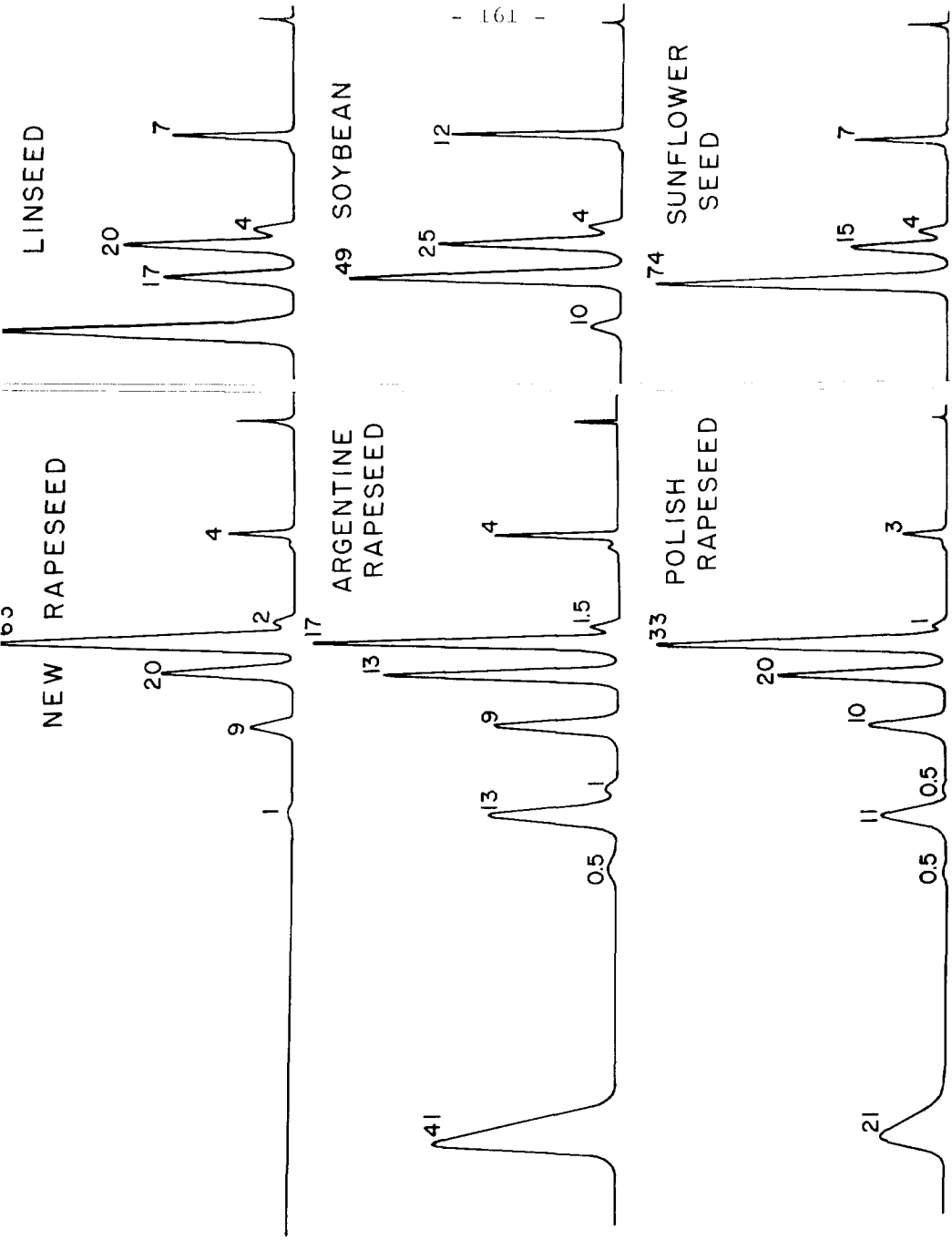

FIGURE III

GAS LIQUID CHROMATOGRAMS OF METHYL ESTERS OF THE FATTY ACIDS OF SOME VEGETABLE OILS

TABLE I

SOME COMPARATIVE CHARACTERISTICS OF TWO RAPESEED SPECIES GROWN IN CANADA

Property	Argentine B. napus	Polish B. campestris
Oil content, %	40 - 47	36 - 43
I.V.	93 - 106	102 - 114
Wt./1000 K (g)	1.2 - 2.0	.9 - 1.5
Chromosomes 2 N	38	20
Maturity	same as wheat	2-3 weeks earlier
Yield, lbs./acre	700 - 3000	25% less

Remembering the frost-free days consideration in the previous section, B. campestris varieties will be favored for the production of sound, fully matured seed. This is confirmed by examining Canadian production and finding that 75-80% of each commercial crop over the past ten years has been from B. campestris varieties.

The yields of seed, the oil content and seed size are generally higher for varieties of B. napus. In terms of agricultural production the higher yields are offset by the shorter maturity time for the B. campestris varieties. Consequently, the varieties of B. napus are grown only under the more favorable circumstances.

The other characteristic difference between the two species shown in the Table is the iodine value of the oil. This would normally imply to the oil chemist either a difference in the relative amounts of saturated fatty acids such as palmitic and stearic or in the polyunsaturated fatty acids such as linoleic and linolenic. However, rapeseed oil differs from other vegetable oils in that the oil contains the long chain monoene fatty acids eicosenoic (20 carbon atoms) and erucic (22 carbon atoms). This can be more readily shown in Figure III by the GLC analysis of a number of vegetable oils. The presence of the long chain fatty acids is readily seen, when the oils from B. napus and B. campestris are compared to the new rapeseed oil. The new rapeseed oil (Canbra oil) is very similar in the number of fatty acids to other vegetable oils such as soybean and sunflowerseed. The two rapeseed oils are similar in the number of fatty acids but

different in the proportions. The B. campestris has less erucic but more oleic and linoleic acids which would account for the higher iodine value. In terms of commercial oil production a variation in fatty acid composition would depend on which species was used for seed production.

The extent of variation in fatty acid composition due to both, genetic and environmental influences can be illustrated by reference to a study which was carried out several years ago using varieties of rapeseed grown at different experimental stations in Western Canada (Table II). The variation in erucic acid due to environment is shown in the first half of the table. The B. napus varieties varied from a high of 44-45% to a low of 36-37% or a total of 7%. Similarly the B. campestris varieties showed a variation of 7% from a low of 23% to a high of 30%. The erucic acid content alone would not necessarily indicate the source of the oil. The environmental variation could not be explained by any single factor such as soil type or moisture. The variation in oleic acid content was similar to that of erucic and the other fatty acids showed much smaller variations which could be ascribed to differences in environment.

TABLE II

VARIATION OF FATTY ACID COMPOSITION OF RAPESEED OILS IN CANADA

Variation in Erucic Acid % Due to Environment

	Brassica napus		Brassica campestris	
	Argentine	Golden	Arlo	Polish
High	44	45	34	30
Low	37	36	27	23
Difference	7	9	7	7

Maximum Variation

	16:1	18:0	18:1	18:2	18:3	20:1	22:1
High	5	3	36	19	12	15	45
Low	2	1	13	12	6	8	23
Difference	3	2	23	7	6	7	22

The total variation due to both genetics and environment are illustrated in the second half of the table. The erucic and oleic contents varied by 22-23% each, indicative of a major effect due to species when compared to 7% for environment alone. There were also significant variations in all the fatty acids even though these variations were small compared to oleic and erucic acids. Perhaps the most interesting from the point of view of stability would be linolenic acid which had a high value of 12% and a low of 6%.

The relation between oleic and erucic acid is shown in Figure IV for the varieties in the study and an inverse linear relation exists between these two fatty acids. The B. napus species are in the high erucic sector and the B. campestris in the lower sector but the two species have the same linear relation and are not significantly different. A somewhat similar relation exists for linoleic and erucic acids. Thus the expected trend would be to higher oleic and linoleic values as the erucic acid content decreased.

These relationships for oleic and erucic acid gave support to the idea of further reductions in the erucic content of rapeseed oils through plant breeding selections and led to the ultimate isolation of a rapeseed oil which did not contain the long chain eicosenoic or erucic acids. The first isolation was in the B. napus species. Genotypes were isolated and the relation between oleic and erucic acids for five genotypes are shown in Figure V. Once again there is a linear relation for oleic and erucic in the genotypes containing erucic acid with a deviation for the zero erucic rapeseed due to the conversion of the eicosenoic acid, present as about 10%, to oleic acid. Further fundamental studies showed that the long chain fatty acids eicosenoic and erucic were synthesized from oleic acid by a separate biosynthetic mechanism. The dramatic changes in fatty acid composition seen in these rapeseeds took place with only minimal changes in oil percentage in the seed.

These developments expanded the variation in fatty acid composition. The extent of this variation is shown in Table III where the fatty acid compositions are given for both B. napus and B. campestris species. Nugget and Arlo are used as varieties representative of the B. napus and B. campestris species. The newer varieties Tanka and Target have erucic contents similar to Nugget and would be classed in Canadian terms as high erucic rapeseed oils. The Arlo variety shows a lower erucic acid content but is higher than the older Polish "variety" which contained 21-24% erucic acid. The newer variety Echo also has an erucic acid content slightly higher than Polish but still in the 25%

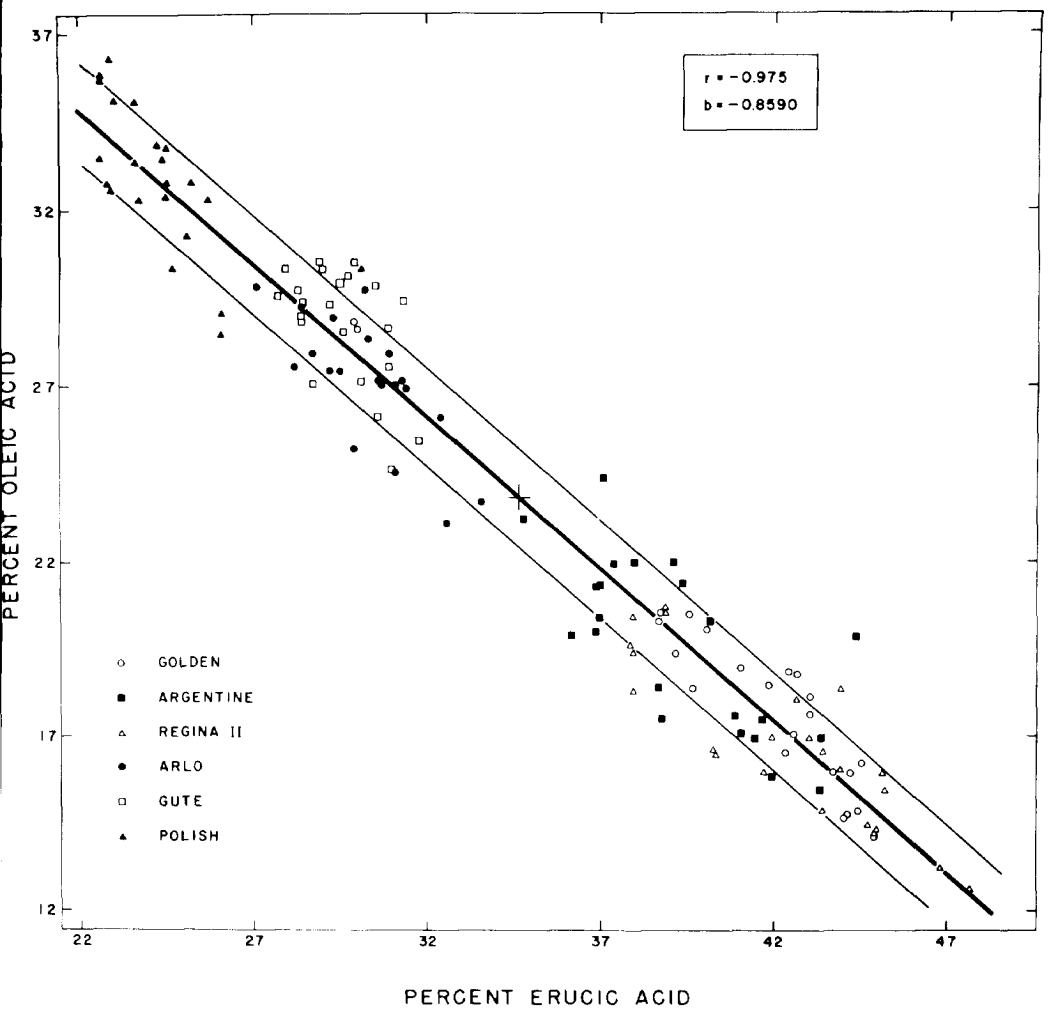

FIGURE IV

INVERSE VARIATION OF OLEIC AND ERUCIC ACIDS IN CANADIAN RAPESEED OILS

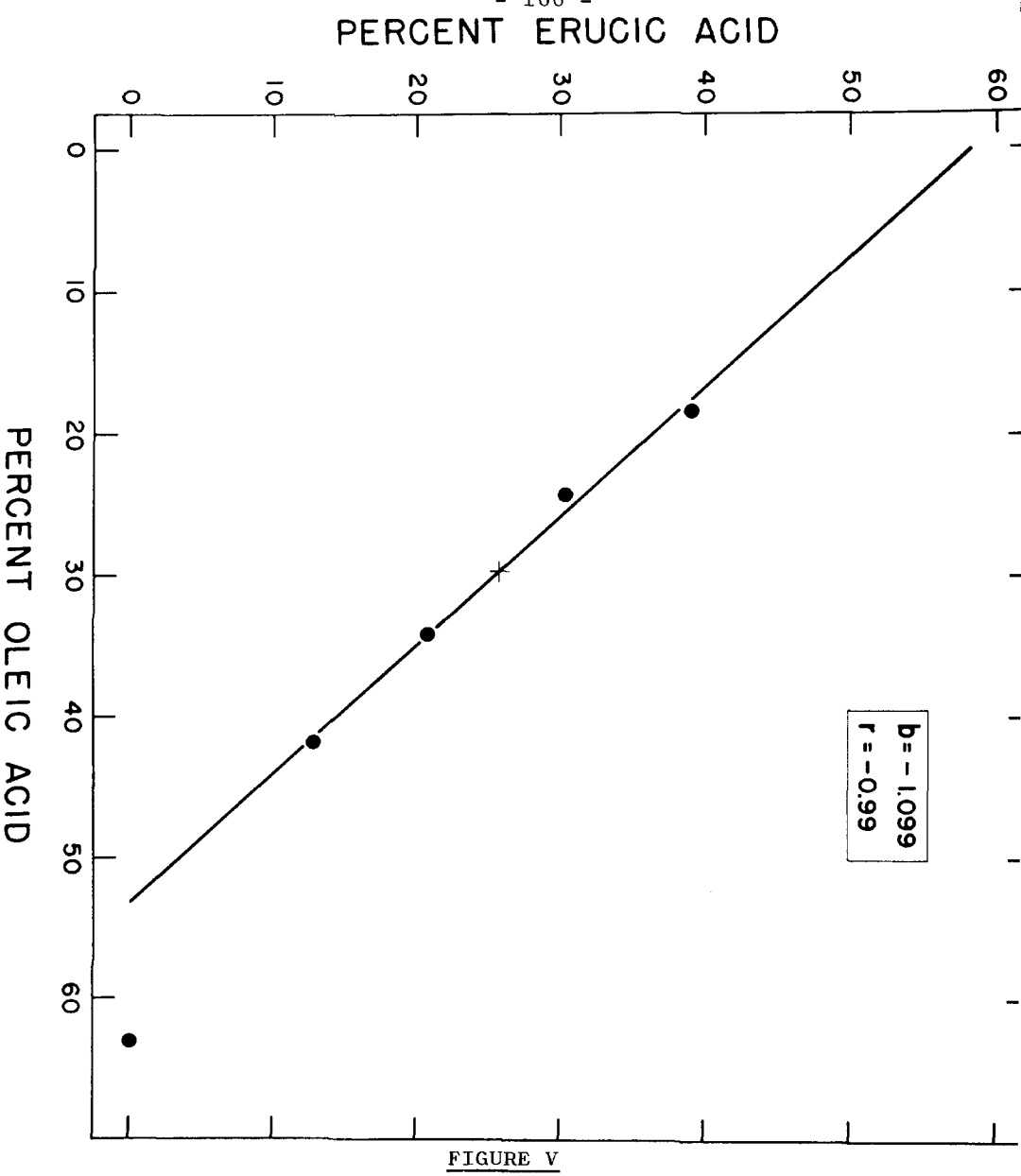

FIGURE V

RELATIONSHIP BETWEEN OLEIC AND ERUCIC ACID IN FIVE GENOTYPES ISOLATED FROM B. NAPUS

region. The two oils, the zero erucic rapeseed oils or Canbra oils have no erucic acid and likewise no eicosenoic acid which means a major difference to the commercial rapeseed oils.

TABLE III

FATTY ACID COMPOSITIONS OF RAPESEED OILS

Fatty Acid	B. napus		B. campestris	
	Nugget	Zero	Arlo	Zero
16:0	4	5	3	4
18:0	1	2	2	1
18:1	19	63	27	55
18:2	14	20	18	31
18:3	8	9	9	10
20:1	14	1	12	--
22:1	40	--	31	--

There are interesting factors concerning the other fatty acids. The saturated acids, palmitic and stearic are similar for all the rapeseed oils and are all low when compared to other commercial vegetable oils such as soybean, corn, sunflowerseed, olive etc. The linolenic acid contents of all the rapeseed oils are also similar which could be viewed as surprising since linolenic and oleic acids are usually related in the biosynthetic pattern. The linoleic acid varied with oleic acid in the same manner as for erucic containing rapeseed oils. The value for Canbra oil from B. campestris at 31% is higher than the 20% shown for B. napus. It should be pointed out that all of these oils contain small amounts of other fatty acids such as palmitoleic, the saturated C_{20} and C_{22} and a C_{24} fatty acid.

The fatty acid composition of the Canbra oils are compared to other vegetable oils in Table IV. The saturated fatty acids palmitic and stearic acids are low compared to soybean, olive, corn and sunflowerseed, and this characteristic offers an advantage in the preparation of salad oils as described by another speaker on the program. The linolenic acid contents are similar to soybean indicating possible similar stabilities to soybean or to the erucic containing rapeseed oils. The proportion of linoleic acid is lower than for the other vegetable oils.

It is obvious that there is a wide range of fatty acid composition particularly in erucic acid in Canadian rapeseed varieties and selections. The Canbra oils have been commercially produced in

TABLE IV

COMPARISON OF ZERO ERUCIC RAPE (CANBRA) WITH OTHER VEGETABLE OILS

F. Acid, %	B. napus	B. campestris	Soya	Olive	Corn	Sunflower
Palmitic	4.7	4.4	11.5	13.4	12.1	9.2
Stearic	1.8	0.1	3.9	3.1	2.3	4.1
Oleic	63.3	54.8	24.6	76.2	28.7	16.2
Linoleic	20.0	31.1	52.0	5.5	56.2	72.5
Linolenic	8.9	9.7	9.0	0.6	0.7	--
Eicosenoic	1.3	--	--	--	--	--

limited quantities in Canada and the varieties have been grown under specified conditions to guarantee no admixture with erucic acid rapeseed oils. Thus, the variation in Canadian rapeseed from a commercial viewpoint is concerned with the present varieties of B. napus and B. campestris. Since there is no general effort to separate the species in the commercial grain trade, the commercial rapeseed oil can vary somewhat. If 80% of the rapeseed grown is from B. campestris and 20% from B. napus the overall erucic acid content should be below 30%. In more specific terms rapeseed oil with 40% or over erucic acid can only be obtained by selection of seed from particular agricultural areas. In the same manner rapeseed oil with around 25% erucic acid can also be obtained by seed selection from specified areas.

Canadian rapeseed oil will have then a lower erucic content than other producing countries due to a combination of two factors, the predominant use of varieties from the B. campestris species and the use of spring types of rapeseed.

There has been a limited amount of research in Canada on phospholipids etc. and the variation due to species or varieties. Characteristic problems encountered in hydrogenation of rapeseed oils are generally related to maturity of the seed and the plant control during oil extraction.

One factor which can have an effect on utilization of Canadian rapeseed and rapeseed oil has been the green colour in the seed and in the resultant oil. This factor usually occurs with early fall frosts producing immature rapeseed. In normal years the factor is adequately covered in the grading system used in Canada for commercial rapeseed and this is demonstrated in Figure VI. The commercial grade which is a reflection of the amount of damaged seed is related to green colour of the oil. The No. 2 rapeseed shows a small colour increase over No. 1 but the No. 3 and sample grades show very marked increases.

In conclusion then the quality of Canadian rapeseed has shown steady improvement through the development of improved varieties suited to Canadian conditions and through improved cultural practices developed by the Canadian farmers. Improvements in rapeseed oil quality have also been effected by the Canadian processors and refiners. There is some variation in fatty acid composition due to varieties and environment which is minimized in the commercial handling of the seed. The climate in the areas of production in most years is favorable to the production of sound mature rapeseed which is the key to the successful production of a high quality edible rapeseed oil.

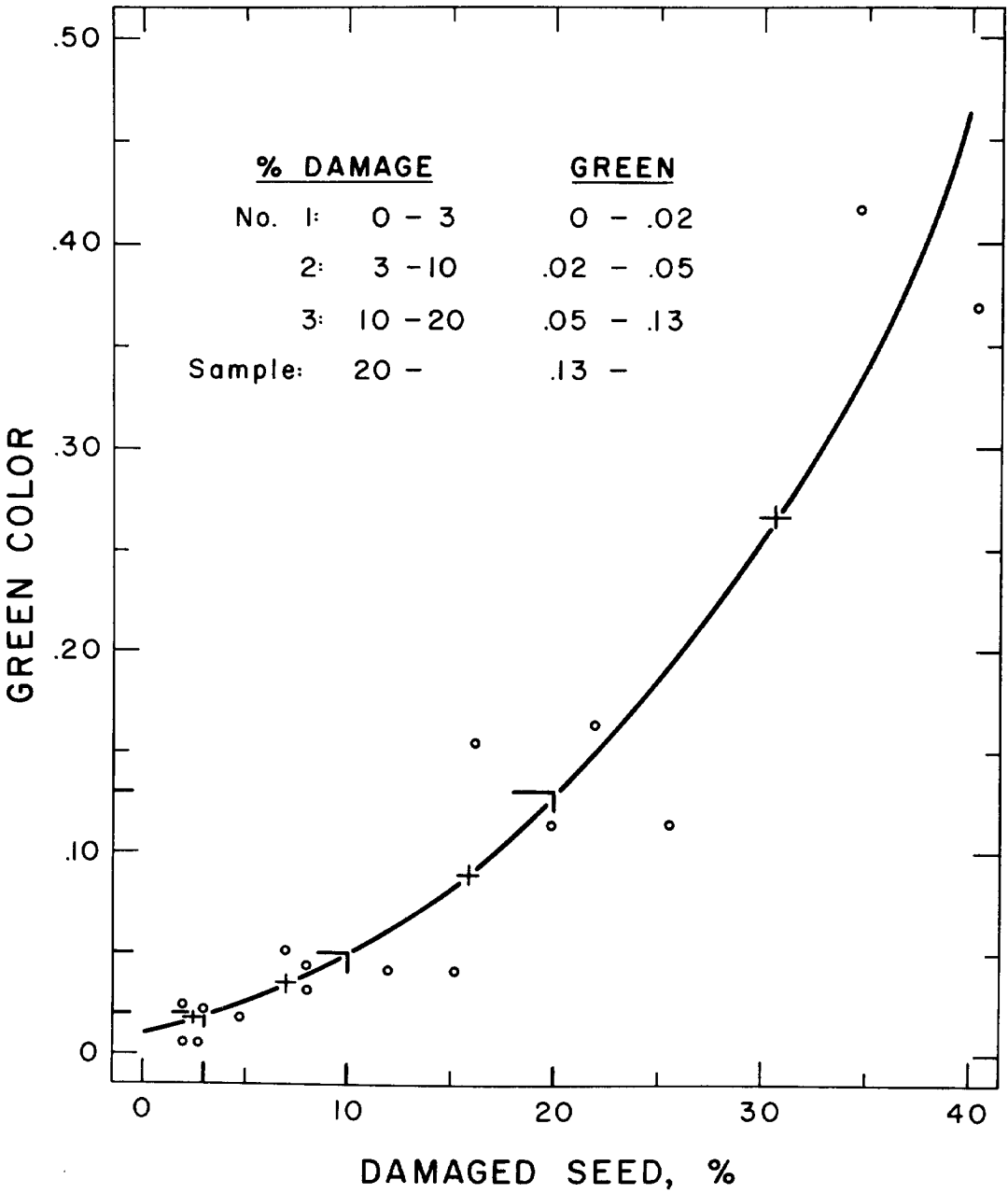

FIGURE VI

RELATIONS BETWEEN GREEN COLOR IN RAPESEED OIL AND CANADIAN GRADING SYSTEM FOR RAPESEED