stearic acid or the analogous nitro-nitrite compound. Undoubtedly other side reactions take place concurrently with those shown above, but reversible free radical -NO₂ addition to the double bond probably produces the cis-trans isomerization observed.

The rate of isomerization at 30°C is sufficiently slow (Fig. 1, top) that a simplified kinetic analysis of the reaction can be made. If one assumes that during the initial stages only cis to trans isomerization occurs and the reverse reaction can be neglected, then the effect of catalyst concon on the reaction rate can be determined. The increase in trans content during the first 15 min of the reaction is plotted against the amount of catalyst used (expressed as the theoretical g of HNO₃/100 g oleic acid) in Figure 6. A straight line is obtained passing close to the origin, indicating that reaction rate is directly proportional to catalyst concon (first order reaction).

If the isomerization rate has a first order dependence on catalyst concentration, this must mean that the transfer of -NO₂ from the water phase to the fatty phase is not the rate determining step. This agrees with our experimental results showing the rate of isomerization is not a function of agitation.

The use of HNO₃ for in situ generation of HNO₂ gave faster isomerization rates than H₂SO₄, HCl, H₃PO₄ or CH₃COOH. The superiority of HNO₂ might possibly be due to its ability to convert the by-product NO into addition NO₂ by the reaction:

$$\text{NO} + \text{H}_2\text{O} + \text{HNO}_3 \rightarrow 2 \text{HNO}_2$$

Abel et al. (43) and Kliman and Klima (44) have shown that this equilibrium reaction takes place at room temp. H₃PO₄ and CH₃COOH were probably less effective because of their lower pKₐ values.

**ACKNOWLEDGMENTS**

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1. Fouret, Ann. chim. et phys. (2) 38, 58 (1819). English translation available from Carter Littlefield, Dept. of Biochemistry & Nutrition, Texas Agricultural Experiment Station, College Station, Texas.


**Abstract**

Rape seed oil is used mostly in edible products. Four rapeseed oils, brown sarson and toria oils from West Pakistan, a Swedish oil and a Canadian oil, were characterized and examined relative to their suitability as edible oils. The various analytical data obtained are reported. The hydrogenated oils have consistency characteristics and plastic ranges which make them suitable for use as plastic fats.

**Introduction**

MOST OF THE WORLD PRODUCTION of rapeseed oil is consumed as an edible oil in the countries in which it is produced, principally China and India. Of the total area in West Pakistan devoted to growing oilseeds (not including cottonseed), 80% is occupied by the *Brassica oleracea* group. Rape seed oil is a fairly important food oil in Europe. In the U.S. only relatively small amount of the oil has been used, mostly in nonderead products. However, in Canada there is an increasing production of rape to obtain an edible vegetable oil and a replacement crop for wheat. This effort to establish rape in Canada is supported by an extensive research program.

The objective of the present investigation was to examine and characterize two samples of rape seed oil produced from the major varieties of rape grown in West Pakistan and to obtain addicional data on these and other rapeseed oils relative to their suitability as edible oils.
Source and Purification of the Oils

Two of the rapeseed oils examined were pure, representative samples obtained by the cold pressing of brown-seed sarson (Brassica campestris, L. var. dichotoma walt) and toria (Brassica campestris, L. var. toria, D. and F.). The seeds were supplied by the Oilseeds Section of the Agricultural Research Institute, Lyallpur, West Pakistan, and the actual extraction of the oil was carried out in West Pakistan.

The brown sarson oil was refined by AOCs Method Ca 9a-52 for peanut oil. The average refining loss of 30.9% was high owing to the formation of soft soap, which interfered with the clean separation of neutral representative samples obtained by the cold pressing of without further processing'. A quantity of Canadian seeds Section of the Agricultural Research Institute, the oil was carried out in "West Pakistan.

The refined, brown sarson oil was bleached with 4% neutral, activated clay by heating the mixture of oil and clay for 5 min at 110°C and filtering.

A sample of refined Swedish rapeseed oil was used without further processing. A quantity of Canadian crude rapeseed oil of commercial origin was refined in the laboratory by the procedure used for the brown sarson oil. Both oils were spot samples and not necessarily typical for these countries. It should be recognized, of course, that some characteristics of an oil are markedly affected by the quality of the seed and the methods of processing.

Characteristics and Composition

Analytical data on the two crude oils from West Pakistan and on one of these oils after refining and bleaching were determined. The data obtained are recorded in Table I.

Colors as determined by the Wesson method using Lovibond glasses and by the spectrophotometric method did not agree very well. The rapeseeds oils contained relatively small amt of red pigments and the ratio of yellow to red apparently was quite different from that of the domestic oils used in developing the spectrophotometric method of determining color.

The visible spectrum of the crude brown sarson oil exhibited absorption peaks at 669,610,533,472,433 and 415 ms. Some of these peaks are attributed to the presence of pheophytin and carotene. The UV spectra of the refined and bleached oil indicated the presence of only trace amt of diene and triene conjugation.

The fatty acid composition was determined by gas chromatography for the Swedish oil and for refined and bleached samples of the brown sarson and Canadian oils. The oils were converted into methyl esters by a mild methanolation catalyzed by sodium methoxide. The crude ester-methanol solution was diluted with water, the methyl esters were extracted with petroleum ether and then the latter was removed from the esters by warming with an inert gas at a low temp. The analysis was made with 6 ft by 0.125 in. OD column packed with 80–100 mesh acid washed Celite coated with 10% diethylene glycol succinate polyester. Column temp was 180°C. The sweep gas was argon and a tritium detector was used. The data obtained are recorded in Table II. The refined and bleached brown sarson oil also was analyzed by a commercial processor of fats and oils and the data obtained conformed with that recorded in Table II.

The fatty acid compositions agree in general with those taken from the literature and recorded by Eckey (6), except that no traces of arachidic, behenic, lignoceric and docosadienoic acids were found. It is possible that the procedure used failed to separate any minor amt of these acids if they were present. A trace of palmitoleic acid was found in only one sample.

According to data cited by Eekey (6), rapeseeds oils contain 11-eicosenoic and 13,16-docosadienoic acids. Erucic acid is, of course, 13-docosenoic acid; and the oleic, linoleic and linolenic acids in the oils have their first double bonds in the 9-position. To established whether or not the brown sarson oil contained fatty acids having double bonds in positions other than those indicated, the refined and bleached oil was oxidized to cleave the double bonds and the mixture of dibasic acids obtained subsequently was analyzed by column chromatography. The oxidation and analyses were carried out essentially as described by Chahine et al. (4), except that the ozonides were cleaved by the procedure of Fore et al. (8). This method of analysis determines only the longer chain dibasic acids and their percentage in the mixture is calculated on the total wt of C8 through C14 dibasic acids. The following data were obtained:

<table>
<thead>
<tr>
<th>Dibasic acid</th>
<th>Wt found, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8</td>
<td>None</td>
</tr>
<tr>
<td>C9</td>
<td>54</td>
</tr>
<tr>
<td>C10</td>
<td>36</td>
</tr>
<tr>
<td>C11</td>
<td>None</td>
</tr>
<tr>
<td>C12</td>
<td>25</td>
</tr>
<tr>
<td>C13</td>
<td>10</td>
</tr>
<tr>
<td>C14</td>
<td>Negligible</td>
</tr>
<tr>
<td>C15</td>
<td>36</td>
</tr>
<tr>
<td>C16</td>
<td>None</td>
</tr>
</tbody>
</table>

Therefore, the brown sarson oil apparently contained only three unsaturated fatty acids which have been found heretofore to occur in rapeseeds oils, i.e., fatty acids having double bonds in the 9,10, 11,12 and 13,14 positions.

Suitability as a Salad Oil

None of the oils passed the AOCs cold test. When held at 0°C for 3.5 hr, small crystals of solid fat appeared. Yet, for practical purposes the rapeseeds oils were almost natural salad oils. Their melting points ranged between 4 and 5°C. Consequently, mayonnaise and similar products made from such oils could be stored in refrigerators without too great a breakage of the emulsion.

Because of the presence of linolenic acid, rapeseeds oils would not be expected to exhibit a marked resist-