# Comparative analysis of edible fixed (carrier) oils with chromatographic techniques

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## Abstract

Fixed or carrier oils are typically used in the cosmetics and pharmaceutical industries; however, with increasing consumer demand for healthier and alternative plant-based oils, edible fixed (carrier) oils are becoming increasingly popular in the food industry [1]. This comparative study aims to identify differences in the fatty acid profile of fixed (carrier) oils, obtained either from seeds or kernels. Fatty Acid Methyl Esters (FAME) of total lipids of 26 edible fixed oils were analyzed using an Agilent 6890 Series Gas Chromatograph paired with a flame ionization detector (GC-FID). Hazelnut oil presented the highest percentage of oleic acid, followed by almond, plum and pomegranate oil. The highest percentage of linoleic acid was noticed in evening primrose oil, followed by pine cone oil and walnut oil. Chia seed oil, followed by linseed, walnut and canola oil, contained considerable amounts of linolenic acid. C16:0 and C18:0 were the predominant saturated fatty acids (SFA) found in grapeseed oil, sea buckthorn, avocado kernel and mustard seed oil. Coconut oil contained significant amounts of SFA, especially C12:0 (55.5%), C14:0 (19.3%) and C10:0 (8.2%). Chlorophyll and beta-carotene content were measured by Lovibond RYBN protocol. Chlorophyll content did not affect the color of the oils, whereas b-carotene content increased with the increase of yellow tint. In addition, higher Lovibond blue (B) values significantly reduce the CIELAB lightness (L*) of oils. In conclusion, the Lovibond method and the CIELAB method are complementary and provide a more accurate analysis of the color of the oils.

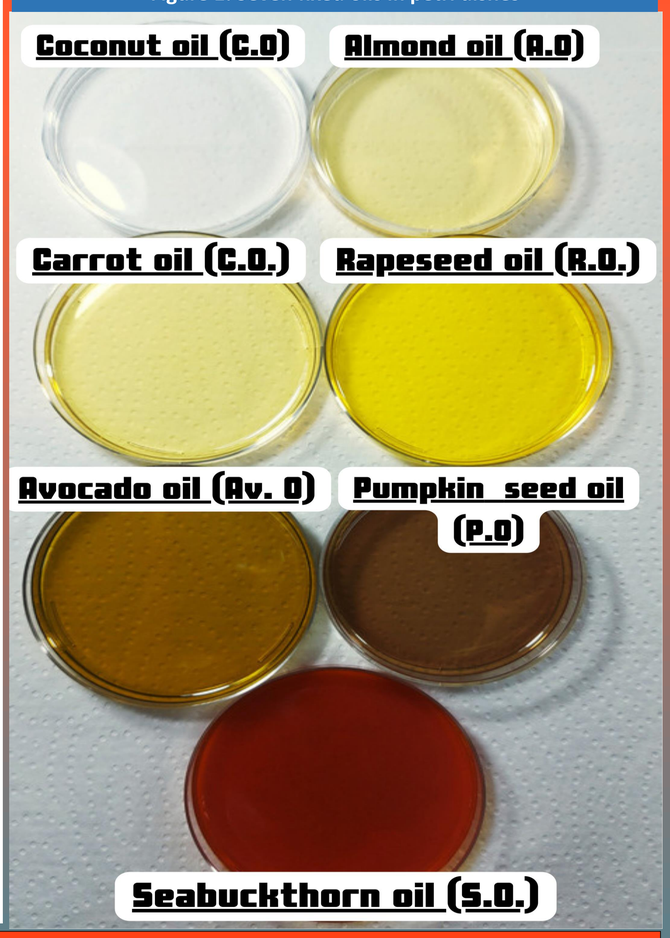
## Introduction

The growing consumer awareness of natural, innovative products with health benefits, as well as the search for products with a low environmental impact, has led to an increase in demand for fixed oils, as they are often derived from food industry by-products and are obtained by cold extraction, an environmentally friendly method that produces no chemical waste and preserves the nutrients. Fatty acids, which are valuable for maintaining good health, are the main constituents of fixed oils. They also contain other bioactive compounds like vitamins, terpenes and phenols. The study of fixed oils is considered necessary as many industrial sectors can use them and at the same time consumers can benefit from their properties. The objective of the study was to analyze the lipid profile of twenty-six fixed oils, derived from natural matrices and obtained by cold pressure, as well as to assess their color.

## Materials and Methods

Fatty acids of the fixed oils were analyzed by conversion to fatty acid methyl esters (FAMEs), followed by GC-FID. In the present work, an Agilent 6890 series gas chromatograph (Agilent Technologies, Palo Alto, CA, USA) with a capillary column (DB-23 capillary column) of 60 m × 0.25 mm i.d. and static phase thickness of 0.15$\mu$m was used (50%- Cyanopropyl-methylpolysiloxane). Injection was performed with a 1:10 split injection. Helium was used as carrier gas. The injector and detector were set at 250°C and 260°C, respectively. A gradient elution program was used, starting at 100°C and reaching 240°C. The analysis time was 55 min [2]. The Conica Minolta CIELAB colorimeter and the Lovibond Model Fx spectrophotometer were used to analyze the colors of the oils. The Lovibond RYBN protocol was used to obtain color parameters (Red, Yellow, Blue, Neutral). The RYBN Chlorophyll and RYBN b-carotene protocols were used to measure chlorophyll and β-carotene content in ppb. The L*, a*, b* and h parameters were measured using the CIELAB colorimeter, corresponding to lightness, red-to-green, yellow-to-blue and hue, respectively.

Figure 1: Seven fixed oils in petri dishes




## Results

**Table 1** presents the main fatty acid composition of the examined edible fixed oils, analyzed by GC-FID. **Table 2** shows the R, Y and B parameters derived from the Lovibond method with the a*, b* and L* parameters derived from the CIELAB method. The concentration of chlorophyll and b-carotene in ppb is also presented.

Table 2. Representative data from the color analysis methods

| Fixed Oil | R | a* | Y | B | b* | L* | Chlor(ppb) | B-car(ppb) |
|---|---|---|---|---|---|---|---|---|
| Coconut | 0,7 | -0,14±0,05 | 0,9 | 0,5 | 3,83±0,20 | 26,03±0,01 | 0 | 2293 |
| Almond | 1,1 | -2,26±0,04 | 3,4 | 0 | 5,01±0,04 | **64,17±0,12** | 0 | 4054 |
| Carrot | 2 | -4,17±0,03 | 49 | 0 | 23,46±0,13 | 60,94±0,10 | 789 | 25196 |
| Rapeseed | 3,5 | **-4,79±0,11** | **69** | 0 | **35,76±0,20** | 63,17±0,59 | 1103 | **60121** |
| Avocado | 3,8 | 0,01±0,08 | 27 | **10,1** | 14,97±0,17 | 46,01±0,32 | 17611 | 55022 |
| Pumpkin | **63** | 3,26±0,11 | 0 | 8,7 | **-0,55±0,02** | 41,46±0,05 | 0 | 15324 |
| Sea Bu/rn | 7,4 | **8,17±0,15** | 10,1 | 4,2 | 8,58±0,19 | 39,90±0,43 | **30000** | 30000 |

Table 1. Representative fatty acids (% composition) of examined fixed oils

| Fixed Oils | Fatty Acids composition (%) | | | | |
|---|---|---|---|---|---|
| | 16:0 | 18:0 | 18:1 | 18:2 | 18:3 |
| Almond oil | 6.1 | 3.8 | **68.8** | 14,7 | ND |
| Apricot kernel oil | 5.6 | 1.5 | 64.5 | 23.6 | 0.1 |
| Avocado kernel oil | **18.5** | 0.8 | 57.5 | 8.2 | 0.6 |
| Black seed oil | 11.1 | 3.3 | 22.4 | 50.6 | 0.2 |
| Canola oil | 4.4 | 1.8 | 52.5 | 21.5 | **10.0** |
| Carrot oil | 10.3 | 6.4 | 38.3 | 40.2 | 0.3 |
| Chia seed oil | 8.8 | 3.7 | 7.7 | 20.6 | **54.3** |
| Coconut oil | 7.8 | 3.1 | 4.3 | 0.9 | ND |
| Coffee bean oil | 8.9 | 4.8 | 22.4 | 55.2 | 0.1 |
| Evening primrose oil | 5.8 | 2 | 6.6 | **75.4** | 0.4 |
| Grapeseed oil | **52.2** | 36.1 | 3.4 | 5.9 | ND |
| Hazelnut oil | 6.9 | 2.2 | **71.6** | 13.8 | 0.1 |
| Linseed oil | 6 | 4.3 | 19.9 | 15.6 | **48.5** |
| Macadamia oil | 7.6 | 2.7 | 49.9 | 2.1 | 0.2 |
| Milk Thistle oil | 8 | 5.4 | 20.7 | 53.5 | 0.2 |
| Mustard seed oil | **15.6** | 2.6 | 64.0 | 9.6 | 0.6 |
| Peanut oil | 8.4 | 2.6 | 56.7 | 26.4 | 0.1 |
| Pine cone oil | 4.8 | 2.6 | 22.6 | **63.4** | 0.2 |
| Plum kernel oil | 5.3 | 1.8 | **66.5** | 20.1 | 0.1 |
| Pomegranate oil | 9.9 | 2.8 | **65.8** | 9.8 | 0.7 |
| Poppy seed oil | 10.6 | 2.2 | 39.9 | 35.4 | 0.7 |
| Pumpkin oil | 10.8 | 5.6 | 26.8 | 45.2 | 2 |
| Sea buckthorn oil | **33.4** | 1.3 | 28.5 | 2.7 | 1.3 |
| Sesame oil | 8.1 | 5.8 | 36.8 | 44.1 | 0.4 |
| Soybean oil | 10.9 | 5.5 | 25.9 | 48.6 | 5.8 |
| Walnut oil | 6.5 | 2.7 | 15.4 | **58.7** | **10.2** |

## Conclusions

- Fixed oils obtained from seeds tend to have a higher percentage of MUFAs or PUFAs than the respective oils obtained from kernels
- Chlorophyll content did not affect a* parameter (corresponding to the red and green hue) of CIELAB method
- b--carotene content increased with the increase of the yellow hue. The L* CIELAB parameter decreases as the blue Lovibond (B) parameter increases, as shown on **Table 2** and **Figure 1**.
- Finally, the Lovibond and CIELAB methods are complementary and provide a more accurate color analysis of the oils.

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### References

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