# Raw Material Basis for Biodiesel Components in Diesel Fuels

Germany-wide filling station sampling of „standard" diesel fuels – comparative investigation of summer and winter fuel 2013

## Sample selection

1. Only "standard" diesel fuels were analysed as samples, because so-called premium fuels do not usually contain biodiesel components (fatty acid methyl esters, FAME).
2. The samples – 60 filling stations in total – were taken from the areas surrounding various refinery locations in order to gain a representative picture of the fuel composition in Germany.
3. In the summer and winter campaign, the same filling stations were sampled (apart from two deviations).
4. In addition, the sampling was conducted corresponding to the market relevance of various fuel suppliers (cf. www.ed-info.de/edplus/ArtikelAnsichtArc.php?newsId=269).

## Analytical methods

1. In an initial analysis step, the biodiesel components of the samples were determined according to DIN EN 14078.
2. Samples with a biodiesel content greater than and equal to 1.4 % (V/V) were then processed in accordance with DIN EN 14331. For this, the diesel matrix was separated from the biodiesel.
3. Finally, the fatty acid patterns of the biodiesel fractions obtained were determined according to DIN EN 14103.
4. The fatty acid pattern obtained was compared with fatty acid patterns of known oils, such as rapeseed, soya, palm, palm kernel and coconut.
5. Ideally, the raw material basis of the analysed biodiesel was then identified by a simulation calculation.
6. Finally, various mixed samples were produced to enable conclusions to be drawn with respect to possible hydrated vegetable oil components (HVO). The analysis was carried out analogously to DIN EN 15440 (14C content by means of liquid scintillation measurement).

## Results

Figure 1 shows the distribution of filling station brands to be sampled for the winter campaign. Owing to the deviation in the case of two filling stations as described in the chapter „Sample selection“ under point 3, the market share of Aral for the summer campaign was 25 %, for Total 9 % and for Avia 8 %.

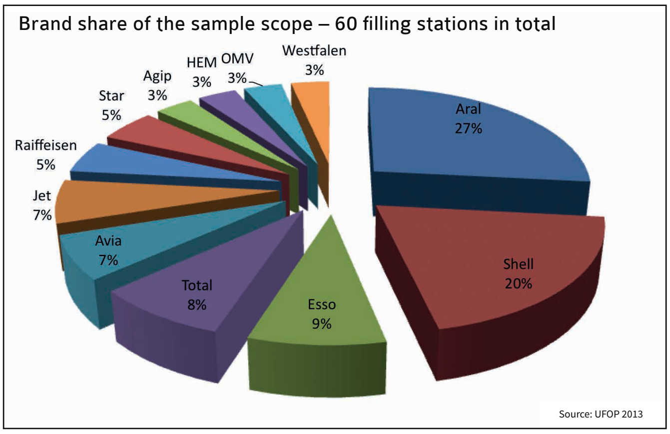


Figure 1: Representation of the brand share of the samples investigated in the total sample scope

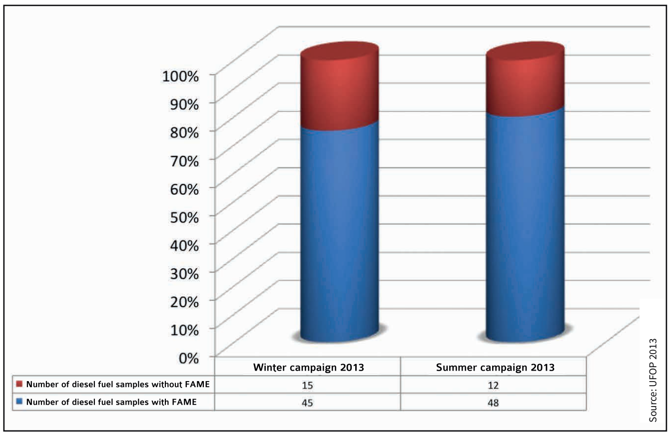


Figure 2: Representation of the percentage shares of diesel fuel samples with and without FAME

All samples with a biodiesel content of less than 1.4 % (V/V) were designated as diesel fuels without FAME component. This corresponds to a total number of 15 (winter campaign) and 12 (summer campaign) samples out of a total of 60 in each case. Expressed in percentages, 25 % of the samples were without FAME in the winter and 20 % in the summer.

The samples without FAME content can be differentiated further for both seasons. Of the 15 samples of winter fuel, 14 samples had a biodiesel content of less than 1.0 % (V/V) and 11 samples less than 0.5 % (V/V). For the 12 samples of summer fuel, 10 were found with a biodiesel content of less than 1.0 % (V/V) and 5 with a content of less than 0.5 % (V/V).

It must be noted here that biogenic components for fulfilment of the quota obligation which are present, for example, in fuel based on hydrated vegetable oils cannot be detected using the test methods according to DIN EN 14078 (infrared spectroscopy) as applied here.

The following Figure 3 shows the calculated raw material mix in the analysed biodiesel components.

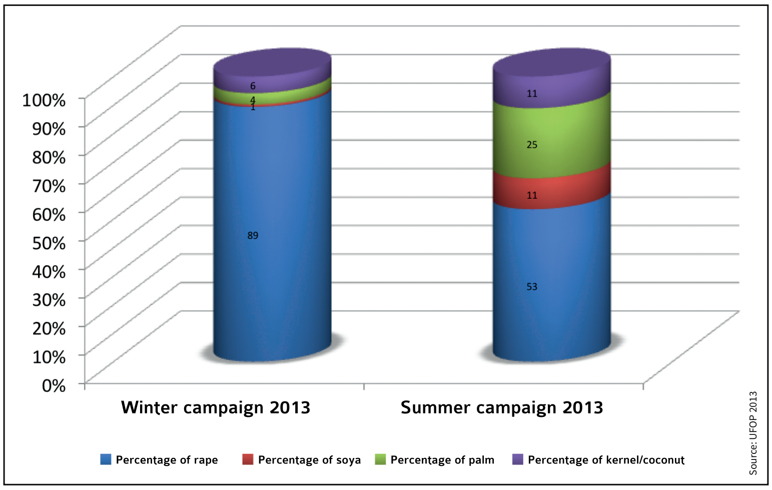


Figure 3: Raw material mix in the analysed biodiesel components

It becomes clear that rapeseed oil dominates as biodiesel raw material in the winter (89 %). The better winter capability of the resulting methyl ester is the reason for this. The percentages of soya, palm and palm kernel oil/coconut oil (fat) are reduced accordingly for the same reason. These raw materials are more or less only suitable for the production of biodiesel in the summer months.

As there are only very few differences analytically in the fatty acid distribution of a biodiesel originating from palm kernel or coconut, the violet coloured areas represent both raw materials. In no case was there evidence of the use of animal fats. Owing to the lack of analytical procedures, it was also not possible to state the content of so-called „used cooking oils" as a raw material for the biodiesel production.

Figures 4 and 5 show the regional distribution of the raw material mixes for the winter and summer campaign.

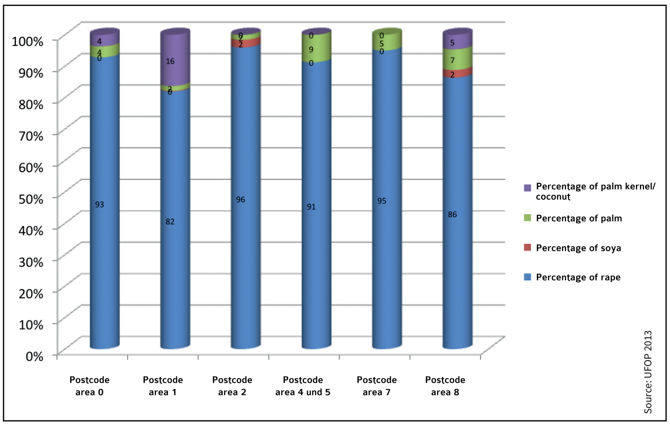


Figure 4: Regional distribution of the raw material mix in the analysed biodiesel components - winter

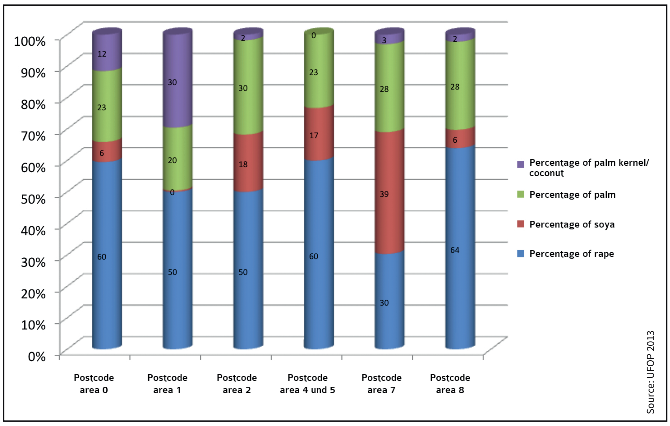


Figure 5: Regional distribution of the raw material mix in the analysed biodiesel components - summer

The regional evaluations show in some cases considerable differences in the raw material mix of the biodiesel components. While, for example, significant quantities of soya-derived methyl esters were detected in winter only in the postcode areas 2 and 8 (cf. Fig. 4), soya components could be found in almost the whole of Germany in the summer campaign samples.

The evaluation of the regional distribution (by postcode area) is roughly oriented on the refinery locations in Germany. Based on the 15 or 12 diesel fuel samples without FAME content, Figures 3 to 5 represent a sample scope of 45 or 48 (instead of 60) samples. Table 1 clearly illustrates the relationship between postcode area and the approximate refinery location.

Table 1: Relationship between the postcode areas and the refinery locations

| Postcode areas | Refinery location |
|---|---|
| 0 | Leuna |
| 1 | Schwedt |
| 2 | Hamburg and Heide |
| 4 and 5 | Gelsenkirchen and Köln |
| 7 | Karlsruhe |
| 8 | Burghausen, Ingolstadt and Vohburg |

As described at the beginning, various mixed samples were produced at the end of the investigation to enable conclusions to be drawn with respect to possible hydrated vegetable oil components (HVO). For the mixed sample of the summer campaign, only such samples were considered whose fatty acid methyl ester content was analysed with a maximum of 1.0 % (V/V). In contrast, two mixed samples were produced for the winter campaign. On the one hand, also from the samples with a maximum FAME content on 0.1 % (V/V), and on the other hand with samples whose FAME content was between 0.2 and 5.0 %. The latter sample had a fatty acid methyl ester content of 1.3 % (V/V) or 1.1 % (m/m) - with an assumed average density of 883 kg/m³. Figure 6 shows the potential composition of the mixed samples for the summer and winter campaign. In addition, shown in table 2 is the number of samples with a FAME content of below 5 % (V/V). The use of biogenic fuel components which are not based on fatty acid methyl ester is concentrated in particular at the filling stations in the wider areas around the refinery locations of Hamburg and Heide as well as Gelsenkirchen and Cologne.

The calculation of the potential composition is based on the following procedure. The mixed samples were analysed in a laboratory specialised and accredited for liquid scintillation measurement. The result of the determinations was the percentage content of biogenic carbon. In conventional diesel fuels (without biogenic content), the average carbon content is c. 85 % (m/m). On the basis of this, the biomass content for the whole sample was calculated (e.g.: 7.1 % biogenic carbon corresponds to 6.0 % (m/m) biomass content). Assuming that, for example, hydrated vegetable oil (HVO) was mixed in, this results in an HVO volume content of 7.7 % (V/V) based on an average density of 780 kg/m³.

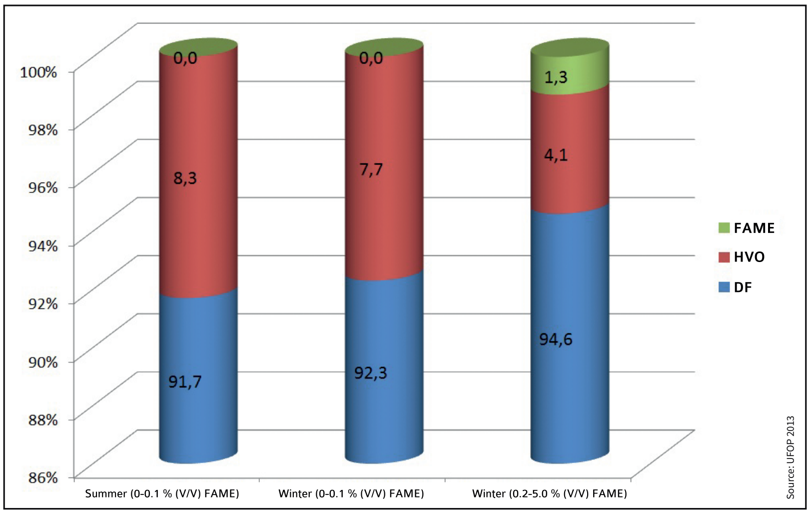


Figure 6: Potential composition of the mixed samples of the summer and winter campaign.

Table 2: Number of filling station samples with a FAME content of below 5 % (V/V)

| Postcode area | Winter campaign 2013 | Summer campaign 2013 |
|---|---|---|
| 0 and 1 | 0 | 1 |
| 2 | 11 | 9 |
| 4 and 5 | 11 | 10 |
| 7 and 8 | 0 | 0 |