

# WATER CONTENT OF FATTY OILS WITH SPECIAL REFERENCE TO CASTOR OIL

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Water content of a clear fatty oil at ordinary temperature is generally very small, and the allowable upper limit for a refined vegetable oil appears to be specified as 0.2% in most cases. Castor oil which consists chiefly of the glycerides of ricinoleic acid, however, is considered to dissolve water to a somewhat larger extent than other fatty oils. There appears, however, so far as the authors know, no literature giving the water content of castor oil. In the present paper, the water content of castor oil and also some other fatty oils for comparison was determined, and an approximate solubility curve of water in castor oil was shown. The results of our experiments indicated that castor oil, as is expected, dissolves water to a considerably larger extent than other fatty oils.

The water content in sample oil was determined by the Karl Fischer method. For comparison, the absorption method in which the water evolved on heating the sample oil was absorbed in an absorption tube containing calcium chloride, was also used for castor oil and some other oil samples. The results obtained by these two methods were close to each other on the whole, although the Karl Fischer method in some cases showed a little higher value than the absorption method, the maximum difference being 0.04%.

## 1. Determination of Water in Castor Oil by the Karl Fischer Method and the Absorption Method

In the Karl Fischer method, the sample containing 30-50 mg of water was taken and dissolved in 10 cc of anhydrous methanol. An excess of the Karl Fischer reagent was added to the solution, and the solution was titrated back by a standard methanol. In the absorption method,<sup>1)</sup> 50 g of the sample was heated at 135-140° C for one hour with passing a current of dry nitrogen at a rate of 100 cc per minute, and the water carried off with nitrogen was absorbed in a calcium chloride tube. Three samples of castor oil were used for these experiments.

Sample No. 1. Commercial refined castor oil.

Sample No. 2. Sample No. 1 was subjected to a steaming for 3 minutes, cooled down to the room temperature (about 26° C), and filtered through a dry filter paper.

Sample No. 3. Sample No. 1 was heated for one hour on a water bath under a vacuum of 10 mm Hg.

The results are given in Table 1. The respective data are the mean values of three determinations.

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TABLE 1. Water Content of Castor Oil

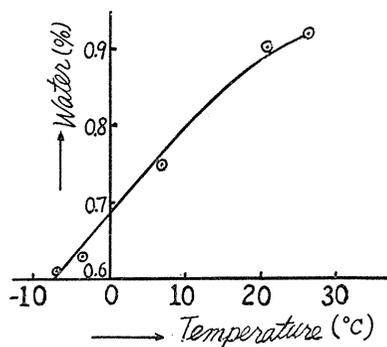
| Sample No. | Water (%)              |                      |
|------------|------------------------|----------------------|
|            | By Karl Fischer method | By adsorption method |
| 1          | 0.28                   | 0.26                 |
| 2          | 0.89                   | 0.85                 |
| 3          | 0.08                   | 0.05                 |

## 2. Solubility of Water in Castor Oil

The sample No. 1, immediately after being steamed for 3 minutes, was kept at 50° C in a well stoppered bottle, and a clear oil was separated. The oil sample thus obtained contained an extremely large amount of water. Also an oil sample of lesser water content was prepared in a similar way as the sample No. 3. Both samples were then mixed in various proportions so that samples of various water contents were obtained. Each sample thus obtained was tested for its cloud point and its clear point which is the temperature at which the turbid sample becomes clear. Based on the water content and the mean of cloud and clear points given in Table 2, an approximate solubility curve of water in castor oil is obtained as shown in Fig. 1.

TABLE 2. Solubility of Water in Castor Oil

| Water content (%) | Cloud point (°C) | Clear point (°C) | Mean (°C) |
|-------------------|------------------|------------------|-----------|
| 0.61              | -7.0             | —                | -7.0      |
| 0.63              | -4.0             | -3.2             | -3.6      |
| 0.75              | 6.5              | 7.2              | 6.9       |
| 0.90              | 19.3             | 22.5             | 20.9      |
| 0.92              | 25.0             | 28.0             | 26.5      |



It should be noted here that water dissolved in castor oil evaporates to some extent on standing at the room temperature. For instance, the water content of a sample placed in a beaker was decreased from 0.75% to 0.46% on standing for 3 weeks.

FIG. 1. Approximate solubility curve of water in castor oil.

## 3. Water Content in Several Fatty Oils

Several fatty oils were subjected to a steaming for 3 minutes and cooled to room temperatures of 23-27° C. After standing for 2 hours, the oils were filtered through a dry filter paper. The samples obtained in this way were tested for their water content by the Karl Fischer method in which chloroform was used as a solvent. The results are shown in Table 3. Among the oils used, rice bran oil

is a winterized oil, and other oils excepting Japanese camellia oil and sperm head and blubber oils are refined oils. The figures in the parentheses for rape and cotton seed oils are the values determined by the absorption method

TABLE 3. Water Content in Fatty Oils

| Fatty oil         | Acid value | Water (%)  |
|-------------------|------------|------------|
| Coconut           | 4.2        | 0.18       |
| Japanese camellia | 6.5        | 0.16       |
| Rape              | 0.9        | 0.10(0.09) |
| Cotton seed       | 0.4        | 0.11(0.11) |
| Linseed           | 0.5        | 0.08       |
| Rice bran         | 105.3      | 0.51       |
| Cod liver         | 1.4        | 0.09       |
| Cuttle fish       | 0.8        | 0.16       |
| Sperm head        | 0.7        | 0.07       |
| Sperm blubber     | 2.6        | 0.09       |

As is seen from Table 3, the water content of rice bran oil which contains a large proportion of free fatty acids, is, as is expected, considerably higher than other oils. Although the water content in fatty oil appears to be correlated with the mean molecular weight of its fatty acids, the iodine value and the content of unsaponifiable matter, no definite relation is found so far as the results obtained above is concerned.

#### Summary

Water content in several fatty oils was determined by the Karl Fischer method and the absorption method. The results obtained by both methods were close to each other, but the Karl Fischer method gave sometimes a little higher value, the maximum difference being 0.04%.

Castor oil dissolves somewhat larger amount of water than other fatty oils, and the cloud point of a castor oil sample containing 0.6% of water is below 0° C.

An approximate solubility curve of water in castor oil has been obtained.

#### References

- 1) L. B. Parsons and C. O. Holmberg: *Oil and Soap* **14**, 239 (1937).  
N. T. Joyner and S. J. Rini: *Oil and Soap* **16**, 233 (1939).