The Oil and Phosphatides Content of Some Petals and Stamens

BRUNO REWALD
Brenchley, Penn Road, Bucks, England

In the last few years many experiments have been carried out to determine the oil and phosphatide content of seeds and fruit of all types. The phosphatide contents of other plant parts, especially green ones, have been determined repeatedly (1). Apparently, however, it is not cited in the literature whether petals and the corresponding stamens contain fat-like compounds, in what quantities and of what composition. The only references which touch this subject are those regarding pollen (2).

From the biological point of view it is important to know whether these plant organs also contain fats or oils, in what quantities they occur and what functions can be ascribed to them. But these parts of the plant are also of practical interest, since many of them play an important role in the nutrition of our domesticated animals. Even though it seems at first that their mass is negligible, a small percentage of the total quantity consumed, which is very considerable, can be of reasonable importance. These were the reasons which prompted the following investigation.

To obtain the best possible view of the field, plants from different families were chosen. The plants were picked because they could be collected in large quantities and the different organs could be separated easily. The separation was carried out with the greatest care, but it is possible that in a few cases minute quantities of stamens were mixed with the petals, too little, however, to have an appreciable effect on the results. The plants were usually collected early in the morning and treated immediately to prevent any possible decomposition or enzyme action.

The investigation followed along the following broad outlines:

The fresh plant organs were weighed immediately (the fresh weight can only give an approximate idea of quantity since in cases of rain and dew, considerable quantities of moisture clung to the parts—all percentage figures are therefore given as dry weight), and then extracted at once with 96% alcohol at about 70°C. The only exception was the treatment of rose petals, where acetone was used first. The alcohol was frequently renewed, and in nearly all cases removed almost all of the flower pigments as well. In this manner the usual method of drying by heat was avoided to prevent any possible cases of decomposition, and the alcohol thus fulfills a double function: dehydrating and extracting. The collected alcohol extracts were freed of solvent leaving a brown or red colored residue which naturally contained large quantities of water and other components in solution, mainly carbohydrates. This aqueous residue was treated with petrol ether, until nothing further was taken up by this solvent. The petrol ether was then driven off from the extract and the residue dried in a vacuum. In this manner a "raw fat" was obtained. In most cases it was naturally impossible to separate the small quantities obtained into phosphatides and oils and fats, but in the one case where larger amounts were available (cultivated garden poppy petals), this separation could be effected. Usually these fat-like mixtures were of a dark brown colour and had a typically oily character. They were analysed as such by ashing with fusing mixture and determination of the P content by the magnesium pyrophosphate method. The estimation was based, according to the average factor for phosphatides, 3.8% P. The mixtures of fats and phosphatides gave a clear solution in all organic fat solvents; with excess acetone they showed the typical precipitation of phosphatides. Experiments with samples showed that the phosphatides contained lecithin and kephalin, as well as small quantities of sugars, a further typical and characteristic sign of plant phosphatides. The small quantities obtained unfortunately made a nitrogen estimation impossible and so the P : N ratio could not be determined, but from the properties of the P containing material, the solubility in fat solvents, the possibility of making water emulsions, the composition of the purified material, etc., it can be assumed with a great degree of certainty that these substances are phosphatides. With tulip petals, for instance, by precipitation with acetone from the fat extract, a substance was obtained containing 2.86% P, whereas "pure" lecithin contains 3.8%. From poppy petals a substance with 2.62% P was obtained, from the stamens with 3.07% P and from "seeds" with 3.25% P. If one considers that one is dealing with substances which have been purified only once and probably still contain certain amounts of carbohydrates and fats as impurities, these results can be considered favourable. In addition the appearance, the characteristic brown colour, the swelling with water, etc., gave further clues to the identity of the substance.

It was naturally expected that this method would neither extract all the fats or oils, nor all the phosphatides. It is a well known fact that a considerable proportion of plant phosphatides belong to the kephalin type—as was the case in these investigations —which is insoluble in alcohol, or at least sparingly so in the presence of fats, etc. A procedure was therefore followed of extraction with an alcohol-benzene mixture (1 : 4), a method which has proved to be very successful in previous experiments. In this case also (when there was sufficient material) very good results were obtained. It was, however, noticeable that the alcohol had already extracted most of the phosphatides. It would be interesting to conduct further experiments to see whether alcohol in the presence of water (and water is always present in fresh plant material, usually more than 90%—see table) has a better extracting effect than ordinary extraction on dried raw material.

The following plant parts were investigated: rose petals, daffodil petals, dandelion petals, and stamens, tulip petals and stamens, poppy (cultivated garden variety) petals and stamens. In the case of the poppy a further part of the plant was examined, namely,

TABLE NO. 1

Raw material	Weight wet	Weight dry	Dry weight	Alcohol extract gr. Petrol ether	Alcohol extract % dry weight	Alcohol and benzol gr. Petrol ether	Alcohol and benzol extract % dry weight	Total fatty matter	Total fatty matter % dry weight
	gr.	*gr.*	*Pct.*		*Pct.*		*Pct.*	*gr.*	*Pct.*
Tulip petals	100	7	7.0	0.728	6.1	0.051 gr.	0.7	0.479	6.8
Tulip stamens	28	3	10.7	0.153	5.1	0.033	1.1	0.186	6.2
Poppy petals	892	80	8.97	2.931	3.66	0.927	1.16	3.858	4.82
Poppy stamens	297	33	11.1	2.744	8.3	0.267	0.81	3.011	9.14
Poppy seeds (unripe)	145	10	6.89	1.183	11.83	0.052	0.52	1.235	12.35
Dandelion petals	28	3	10.4	0.341	11.4	lost (very little)	.....	.....	.....
Dandelion stamens	23	3	10.4	0.421	14.0	0.027	0.9	0.448	14.9
Daffodil petals	50	7	14.0	0.525	7.5	0.078	1.1	0.603	8.6
Rose petals	177	14	7.9	0.713 (acetone)	5.1	0.141	1.0	0.853	6.9

the young, green seed capsules with the small green seeds, which were completely unripe (while still flowering). In this case it was impossible to separate the seeds from the surrounding tissues, so that the investigation includes the seeds and surrounding tissue. In the case of the stamens, too, the pollen is adulterated by the tissues of the complete organ since otherwise there would have been too little material to investigate. Although this is a disadvantage the results are nevertheless worth noticing, as can be seen from the following tables:

Table 1 gives the quantities of fresh raw material used and the corresponding dry weight and, further, the amounts of raw fat. The surprising effect is that the amount of fatty compounds, reckoned on dry weight, is relatively very high, much higher than would be expected. Excepting poppy petals, which contain about 5%, all substances investigated contained more than 6%, rising up to nearly 15% in one case. A very interesting result is the type of substance obtained and its properties. In all cases the products were semi-solid or completely solid at room temperature, and were readily soluble in ether, petrol ether, etc. In most cases the amounts were too small to carry out an analysis. Most remarkable is the oil obtained from unripe poppy seeds and surrounding tissues, which is completely different from the usual poppy-seed oil. It is a dark, semi-solid mass at room temperature and only gradually melts to a clear oil at higher temperatures. The iodine value was 95.1 compared with the iodine value of 132-143 of ordinary poppy-seed oil. It was also possible to estimate the iodine value of the oil of the poppy petals and poppy stamens; these figures were 87.8 and 97.1 respectively.

Table 2 gives the quantities of phosphatides in different raw materials and likewise Table 3 and Table 4 give the distribution of the phosphatides in some cases where larger quantities were available.

These figures are of interest in all cases for they prove that the oils of the plant organs investigated are extraordinarily rich in phosphatides. This is an unexpected and peculiar result. We know that even in seed oils, which are relatively very rich in phosphatides, the amount stays within comparatively narrow limits, but here we have fats of not less than about 45% phosphatide content (tulip stamens) and in nearly all cases the figure is above 20%. Where there was sufficient material, as with poppies, it was possible to precipitate the phosphatides directly from the raw oil with acetone. With seed oils this is usually difficult and must be preceded by increasing the phosphatides by other methods. It would be comprehensible if the direct sexual organs of animals and plants are rich in these compounds. It was completely unexpected to find such high concentrations in petals which, on the whole, have only the function of aiding fertilization by attracting insects, etc. It would be an important task to find out the significance of these phosphatide amounts and whether they are possibly transferred to the fruit after flowering is over.

TABLE NO. 2

Raw material	Total phosphatides in dry matter	
	gr.	*Pct.*
Rose petals	0.0733	0.523
Daffodil petals	0.095	1.36
Dandelion petals	0.089	2.97
Dandelion stamens	0.082	2.86
Tulip petals	0.123	1.76
Tulip stamens	0.066	2.22
Poppy petals	0.554	0.692
Poppy stamens	0.456	1.4
Poppy seeds	0.277	2.77

TABLE NO. 3

Raw material	Amount of phosphatides in the raw fats
	Pct.
Daffodil petals	18.6
Dandelion petals	26.0
Tulip petals	26.0
Tulip stamens	43.6
Rose petals	52.1 (alcohol and benzol extract)

TABLE NO. 4

Distribution of the Phosphatides in the Alcohol Extracts

Raw material	Total quantity	Acetone soluble (fat)	Acetone insoluble	Phosphatides
	gr.	*gr.*	*gr.*	*Pct.*
Poppy petals	2.931	1.619	0.527	2.62% P (= 70% Phos.)
Poppy stamens	2.744	1.933	0.536	3.07% P (= 81% Phos.)
Poppy seeds	1.183	0.825	0.321	3.29% P (= 86% Phos.)
Tulip petals	0.428	0.390	0.039	2.86% P (= 75% Phos.)

It must also be pointed out that all alcohol extracts had, as was to be expected, dissolved out considerable quantities of carbohydrates. These consisted of a small amount of monosaccharides, the rest were polysaccharides.

Conclusion

It was found that the petals of all plants investigated contained considerable quantities of phosphatides and that stamens also contained considerable amounts. The oils obtained from these plant organs,

as well as the oil of unripe poppy seeds, varied considerably in consistency from ordinary seed oils.

I am indebted to Mr. Charles M. Caines for the analyses of many of the raw materials and finished products.

REFERENCES
(1) Rewald, Bioch. Z. *202* (1928), page 399.
Rewald, Bioch. Z. *289* (1936), page 73.
Rewald, Enzymologia *3* (1937), page 10.
Chibnall and Chamon, Bioch. Journal *21* (1927), page 225.
(2) Anderson, Journal of Biological Chemistry *55* (1923), page 611.
Kiesel and Ricken, Hopp. Seyl. Z. Phyiol. Chemit. *182* (1929), page 241.

Abstracts

Oils and Fats

Edited by
M. M. PISKUR and SARAH HICKS

CONTINUOUS PROCESS FOR SOLVENT EXTRACTION OF TUNG OIL. R. S. McKinney, W. G. Rose, and A. B. Kennedy. *Ind. Eng. Chem. 36,* 138-44 (1944). The best prepn. of tung kernels and seeds for extraction by a continuous process was obtained by reducing them to a medium fine meal between corrugated rolls and passing this material between smooth rolls. Commercial tung press cake needs no special prepn. Successful solvent extractions of ground tung kernels and seeds, commercial tung press cake, and experimentally prepared tung press cake contg. 20% oil. were made in the Kennedy continuous countercurrent extractor using n-hexane as the solvent. In this process the oil-contg. material was moved slowly through a number of semicircular sections of the extractor by perforated blades of paddle wheels in each section, in a direction opposite to the travel of the solvent. Extraction efficiencies of 99% or better were obtained.

HYDROGENATED FATS. H. R. Mitchell. *Food Manuf. 18,* 360-73 (1943).

POLYHYDRIC ALCOHOL ESTERS OF FATTY ACIDS. Their preparation, properties, and uses. H. A. Goldsmith. *Chem. Revs. 33,* 257-349 (1943). The methods of prepn., the physical and chemical data, and the industrial applications of the higher fatty acid esters of polyhydric alcohols and of polyhydroxy ethers are reviewed. Triglycerides are not included.

DETERMINATION OF AIR IN BUTTER. W. Mohr and Elfriede Eysank. *Fette u. Seifen 50,* 143-8 (1943). A new rapid method for the detn. of air in butter is described. The amt. of air, escaping from the butterfat when the latter is heated in an evapg. dish half filled with glycerol, is collected in an inverted funnel with graduated stem closed by a rubber stopper and resting on a wire cross over the dish, and can be read off directly in c.c. *(Chem. Abs.)*

OBSERVATIONS ON FISHINESS IN BUTTER. R. V. Hussong and S. Quam. *J. Dairy Sci. 27,* 45-51 (1944). Fishy butter from different plants commonly had lower pH values than non-fishy butter from the same plants at about the same periods. In various instances in which fishy butter had a relatively high pH value, it contained comparatively large amounts of copper. Proper control of the pH of butter requires recognition of any unusual condition which develops. Certain sources of copper are very obvious but others, such as exposed copper in cheese plants supplying cream for butter manufr. are much less obvious. When fishy butter was separated into fat and serum, the fishy flavor was conspicuous in the fat but there was little or no fishiness in the serum.

THE KINETICS OF THE ANTIOXYGENIC SYNERGISM OF QUINONES WITH ASCORBIC ACID IN FAT SYSTEMS. V. P. Calkins and H. A. Mattill. *J. Am. Chem. Soc. 66,* 239-42 (1944). The absolute reaction rate of oxidation of ascorbic acid in ethyl esters of lard fatty acids has been measured in the presence and absence of quinone. The synergism of quinone with ascorbic acid in the stabilization of these esters has been shown to be due to the catalytic action of quinone. Quinone acts as a catalyst by being reduced to a semiquinone, which latter regenerates quinone by being oxidized by the activated peroxide radicals; this reduction of the peroxide radical prevents the accumulation of peroxides and thus protects the substrate. Quinone serves as an intermediary agent in the ascorbic acid-ester system by lowering the free energy of formation of the activated complex to such an extent that it doubles the number of particles of ascorbic acid possessing sufficient energy of reaction. The results follow closely the views of Michaelis on compulsory univalent oxidation, and on the basis of these data a mechanism for the synergistic action of quinone with ascorbic acid is proposed.

VITAMIN A IN SHARK-LIVER OILS. SHALLOW-WATER SHARKS AND RAYS OF THE FLORIDA REGION. S. Springer and P. M. French. *Ind. Eng. Chem. 36,* 190-1 (1944). The potencies of liver oil samples from sharks and rays of the Florida region vary from 35 to 340,000 U.S.P. units of vitamin A per gm. and individual sharks of the same species may provide oil in a wide range of potency.

PATENTS

METHOD OF TREATING FISH LIVERS TO REMOVE THE OIL THEREFROM. L. O. Buxton and S. T. Lipsius (National Oil Products Co.). *U. S. 2,325,367.* In a process for treating fish livers comprises the steps of admixing comminuted fish livers with an oil adsorbent vegetable material, adding thereto an amt. of an alkali not to exceed 5% (dry wt.) based on the wt. of the livers, digesting the mass by means of heat, and then removing the vitamins and vitamin-bearing oils contained therein by extg. with a suitable solvent for vitaminiferous materials.

SALAD DRESSING. B. F. Buchanan and R. C. Drury (American Maize-Products Co.). *U. S. 2,338,083.*

EDIBLE OIL AND FAT. Sol Shappirio. *U. S. 2,338,207.* The method includes incorporating edible cottonseed oil with non-pathogenic bacteria, warming the mixt. and maintaining the said substances in contact until antioxygenic substances are transferred from the bacteria to the oil and separating the bacterial residues from the treated oil.

SYNTHETIC DRYING OIL COMPOSITION AND METHOD OF PRODUCING THE SAME. C. C. Allen and V. E. Haury (Shell Development Co.). *U. S. 2,317,663.* The mixt. comprises a natural drying oil dissolved in an unsatd. ketone condensation product of acetone having at least 12 carbon atoms per mol.

POLYESTER RESINS FROM PHTHALIC ANHYDRIDE PENTAERYTHRITOL AND SOYA BEAN OIL. A. G. Hovey,