HYDROLYSIS OF SOME OF THE COMMON VEGETABLE OILS.*

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The paper presents results of experiments relating to the hydrolysis of several vegetable oils. In the first series of experiments, tabulated, the oils were treated with an alkali, in the next with an enzyme, and in the third with both alkali and enzyme. One of the objects of these investigations is to determine, if possible, whether the relative saponification factor will convey a knowledge of their relative digestibility.

The use of the vegetable oils both for food and as medicinal agents dates back as far as recorded history goes. The recovery of these oils on a commercial scale has made necessary the use of technical appliances ranging from the simplest contrivances to the very elaborate machinery that is being used to-day. Pliny describes in detail apparatus and processes employed in the manufacture of olive oil in his time. The Chinese have employed for centuries the same series of operations which are now followed in the most advanced oil mills of modern times, viz., bruising and reducing the seed to meal under an edge tool or stone, heating the pulp in open pans, and pressing out the oil in a wedged press.

The invention of the hydraulic press in 1795 by Joseph Bramah effected a revolution in the oil industry, introducing a new, easily-controlled, and an almost unlimited source of power.

A study of some of the properties of oils is prompted by the rapid increase in their use commercially. The fact that in the year 1912 the cotton-seed oil products in the United States were worth $147,680,000 is a matter of much more than passing interest. Industries of this size are employing the best-trained chemists, as their success or failure is, in many instances, largely dependent upon laboratory findings. In few fields of endeavor is the chemist's work of more direct value to the average citizen. The vegetable oil chemist has arrived and is now reckoned with. The future seems to promise a great deal more for him.

Among the many lines of investigation which the oils offer, the writer feels that perhaps not one is of more interest than a study of the relative ease of saponification among them. The nature of the hydrolysis products of the individual oils has been very thoroughly studied by a number of men. We have been able to find little work, however, on the comparative hydrolysis of the common oils.

The experiments which we desire to report in this paper were arranged to determine, if possible, which of the common oils would saponify most readily under a given set of conditions. There may be some very practical relation between ease of saponification and digestibility. When the former has been definitely determined, feeding experiments covering a very wide range should be undertaken to establish this point. We used samples of a rather high degree of purity after having found their ordinary constants to be well within prescribed limits. We believe that the results obtained represented fairly what we should expect from good grades, ordinarily purchased in the open market.

In the first series of experiments the oils were treated with alkali only, in the second with some enzyme, and in the third with both alkali and enzyme.

The method followed in the first series was to determine amount of free acid in each sample and then bring them all to the same acidity by addition of oleic

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acid, rechecking each sample. The saponification number was taken, and from this the amount of potassium hydroxide necessary to saponify a given amount was calculated. Check samples of each oil were carefully weighed, and to each was added the calculated amount of alcoholic potash solution, plus exactly a 20 percent excess. Samples were agitated in the same amount, and heated to boiling for five minutes. The excess of KOH solution was titrated with half normal HCl solution, phenolphthalein being used as indicator. A blank was, of course, run in every case. As may be expected, all the oils—corn, cotton-seed and olive—were completely saponified in this experiment.

In the next group the conditions were duplicated, except that the temperature of 60° was maintained for the same length of time. The results are given in the following table:

Oil	Weight (grammes)	Percent saponified	Average
Olive	4.1462	83.857	82.611
	4.2634	81.366	
Cotton-seed	4.383	84.925	84.422
	4.3804	83.919	
Corn	4.2244	83.521	83.275
	4.5532	83.029	
Olive	4.3282	79.776	80.408
	4.3882	81.041	
Cotton-seed	4.3614	87.653	81.386
	4.363	85.120	
Corn	4.627	87.196	87.423
	4.540	87.651	
Olive	4.3856	74.276	76.946
	4.3586	79.616	
Cotton-seed	4.3876	84.898	85.624
	4.3463	86.351	
Corn	4.526	86.102	86.491
	4.505	86.881	
Average percent saponified: Olive			79.988
Cotton-seed			85.477
Corn			85.730

In this series the oils were heated for two and a half hours at a temperature of 37.5°.

Olive	4.1522	86.91	88.379
	3.973	89.848	
Cotton-seed	4.0522	91.283	88.886
	4.0108	86.389	
Corn	4.1502	90.983	89.428
	4.1738	87.879	
Olive	4.3486	87.469	84.366
	4.3734	81.264	
Cotton-seed	4.1598	86.379	85.732
	4.2174	85.085	
Corn	4.3408	86.775	89.050
	4.3154	91.266	
Olive	3.2526	Broken	76.581
	3.7146	76.581	
Cotton-seed	4.3136	86.602	86.954
	4.0054	87.307	
Corn	4.0932	88.261	88.417
	3.9788	88.574	

Oil	Weight (grammes)	Percent saponified	Average
Olive	4.1206	86.71	86.722
	3.862	86.734	
Cotton-seed	4.2098	85.371	85.631
	4.1890	85.891	
Corn	4.1830	84.506	84.501
	4.0448	84.496	

Average percent saponified	
Olive	85.073
Cotton-seed	86.788
Corn	87.849

A close inspection of the figures in these tables indicates, but by no means proves, that under the influence of alkaline solutions the oils hydrolyze in the following order: corn, cotton-seed, and olive. The results in the individual cases are not consistent, but the variations are not such as to warrant an entire discredit of the averages under each table. It will be observed that fourteen tests were made with each oil.

In the next series of experiments we attempted to compare the rate of hydrolysis of the same oils under the influence of a fat-splitting enzyme. The enzyme solution was prepared by dissolving 2 Gms. of pancreatin in 100 Cc. of water. Five Cc. of this solution was used in each determination. Ten samples of each oil were run in this series, and the appended table gives the results in terms of percent of each sample saponified. Experiment number five is omitted in the table, and the average of nine instead of ten is reported, data for number five being inadequate.

The results reported in this table are much more concordant than those in the experiments where alkali is used as the hydrolyzing agent. The percent saponified is much lower, however.

Oil	Weight (grammes)	Percent saponified	Time	Average
Experiment No. 1:				
Olive	3.020	1.850	22 hours	1.850
	3.035	1.850	22 hours	
Cotton-seed	3.019	2.490	22 hours	2.470
	3.000	2.450	22 hours	
Corn	3.001	1.370	22 hours	1.330
	3.002	1.300	22 hours	
Experiment No. 2:				
Olive	3.014	1.570	44 hours	1.590
	3.016	1.610	44 hours	
Cotton-seed	3.007	1.790	44 hours	1.795
	3.016	1.800	44 hours	
Corn	3.005	1.530	44 hours	1.520
	3.022	1.510	44 hours	
Experiment No. 3:				
Olive	3.014	1.740	44 hours	1.710
	3.020	1.690	44 hours	
Cotton-seed	3.028	2.040	44 hours	2.035
	3.003	2.030	44 hours	
Corn	3.017	1.770	44 hours	1.775
	3.027	1.780	44 hours	
Experiment No. 4:				
Olive	3.024	2.110	22 hours	1.980
	3.030	1.860	22 hours	
Cotton-seed	3.034	2.590	22 hours	2.340
	3.009	2.090	22 hours	
Corn	3.009	1.410	22 hours	1.405
	3.023	1.400	22 hours	

Oil	Weight (grammes)	Percent saponified		Average
Experiment No. 6:				
Olive	3.026	1.400	44 hours	1.400
	3.020	1.400	44 hours	
Cotton-seed	3.020	1.760	44 hours	1.765
	3.036	1.770	44 hours	
Corn	3.011	1.740	44 hours	1.710
	3.041	1.680	44 hours	
Experiment No. 7:				
Olive	1.508	5.830	22 hours	5.900
	1.517	5.970	22 hours	
Cotton-seed	1.518	5.690	22 hours	5.760
	1.525	5.840	22 hours	
Corn	1.517	3.440	22 hours	3.610
	1.522	3.790	22 hours	
Experiment No. 8:				
Olive	1.510	3.320	22 hours	3.280
	1.502	3.250	22 hours	
Cotton-seed	1.509	3.210	22 hours	3.630
	1.508	4.060	22 hours	
Corn	1.514	2.880	22 hours	2.910
	1.524	2.950	22 hours	
Experiment No. 9:				
Olive	1.521	3.140	22 hours	3.100
	1.527	3.070	22 hours	
Cotton-seed	1.519	3.720	22 hours	3.710
	1.524	3.700	22 hours	
Corn	1.506	3.410	22 hours	3.410
	Lost	Lost	22 hours	
Experiment No. 10:				
Olive	1.501	6.050	44 hours	5.930
	1.510	5.820	44 hours	
Cotton-seed	1.507	4.950	44 hours	4.900
	1.513	4.850	44 hours	
Corn	1.501	3.960	44 hours	3.720
	1.508	3.480	44 hours	

Average percent of each oil as per this table:	
Olive	2.970
Cotton-seed	3.150
Corn	2.370

It would appear that under the conditions as followed in these experiments cotton-seed oil is hydrolyzed more readily than the others. Not only is the average higher, but the percent is higher in thirteen out of the eighteen individual cases.

In the last series which we are reporting conditions similar to those in the intestine were attempted. Known weights of the same oils were carefully neutralized, and an amount of standard alkali proportional to the weight of oil was added to each sample.

Three samples of pancreatin, each the product of a different manufacturer, were used, each oil being treated with each enzyme, and with alkali alone as blanks. The samples were all agitated uniformly and kept at a temperature of 36° to 37.5° for twenty-three hours. The excess of alkali was then titrated with tenth-normal acid. We report averages only in this part of the work, as the complete table is more or less involved.

Average percent of added alkali consumed by—

Olive oil	41.800
Cotton-seed oil	38.800
Corn oil	44.300

Reported in terms of activity of the three enzymes used, we have the following:

Average percent of alkali consumed in presence of—

Enzyme No. 1	63.300
Enzyme No. 2	38.600
Enzyme No. 3	38.700
Oils only	15.900

SUMMARY.

The writer and his assistant, Mr. W. L. Irwin, to whom he is greatly indebted for much of the routine work herein reported, do not feel warranted in drawing any general conclusions from the experiments until a great many more of the same general nature have been run on these oils. This we propose to do as soon as possible, hoping to get a sufficient number of close checks to warrant some authoritative statement.

The whole investigation has proved most interesting, and we would be glad to have others take up the same task. The routine work is taxing, but we believe that the ultimate findings will be worth the effort.

MAKING GOOD.

Making good—business—is a fight, just like life—a continual struggle. Struggle there always has been and always will be—there must be. Depend upon it and prepare yourself for it, the struggle will be always. Life is activity. When you throw your efforts and your mental attitude in neutral, you'd better call for the undertaker.

Since YOU are all that you have got, you have got to be satisfied with yourself and take yourself for better or for worse and you'd better prepare yourself physically, mentally and morally for the battle.

You can only do this by association with people from whom you can learn something—not from people you have to tell things to. You've got to take care of yourself physically as well as mentally and you will not be physically fit if you have hobnobbed with a lot of going-to-bes and paraded down Main Street all evening in search for a skirt. Then when you get out the next morning, if you do get out, you can't expect to convince a man who takes care of himself that you are right. Better leave those fellows alone; they'll bring you down to their level. If you never see them again that will be soon enough!—*Exchange.*