NEW POSSIBILITIES IN CALIFORNIA OLIVE OIL

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The purpose of the present work on olive oil being conducted at the University of California is to render the industry more profitable to manufacturer and grower by increasing the yield of oil or by improving its quality. The work falls in three groups which are, in the inverse order of their probable economic significance, pomace utilization, oil refining and oil standardization.

Pomace Utilization Possibilities

The present system of oil manufacture has one weakness in the fact that the pomace from the presses is either burned directly or thrown away. Since there is usually more pomace produced at a plant than can be used for fuel, there is a labor cost involved in the disposal of the excess. It would seem that such labor might well be engaged in the production of a by-product if one can be found which will be profitable.

Chemical analyses of the pomace, from various sources, are as follows:

	Brannt[1]	Hefter[2]	Cruess and Christie[3]	Du Vauchelle[4]	Nichols[5]
Water	13.20	10.7	—	13.0	25.4 —26.5
Fat	13.20	13.8	7.89—20.23	8.0	10.27—14.4
Ash	6.80	6.5	Ave. (18) 12.41	6.3	—
Non-nitrogenous matter including fiber	60.20	—	—	—	—
Fiber	—	33.7	—	22.1	—
N-free extract	—	28.1	—	43.7	—
Protein	6.00	7.2	—	6.9	—
Nitrogen	—	—	— 0.86	—	—

The tonnage of pomace produced in California in 1925-26 may be estimated on the basis of a total production of 300,000 gallons of oil from olives yielding on the average 40 gallons of oil and 1,200 pounds of pomace per fresh ton. This would result in a production of 4,500 tons of pomace

There appear to be two principal possibilities for the use of this material: first, as a stock feed, and, second, as a source of further oil. According to Cruess (6), olive pomace is a fair stock feed. DuVauchelle (4) reports its successful use as an ingredient in horse rations. Professor W. M. Regan of the Animal Husbandry Division at the University Farm at Davis is interested in the possibility of using it as a cattle feed and believes that if it proves sufficiently palatable it may have a value of approximately $25 per ton when dried and ground. As soon as fresh pomace is again available it will be possible to ascertain its value by actual test.

From the analyses given above, it is assumed that a moisture content of approximately 25 per cent and an oil content of approximately 12 per cent fairly represents the pomace produced in the State as a whole. Under these conditions it is believed that it should be a profitable source of oil. This oil might be obtained either by the use of greater pressure than is now used, or by extraction with solvents. A part of the oil could probably be recovered most economically by the use of greater pressure, either in a continuous screw press of the expeller type, or in a heavy hydraulic press. It is doubtful, however, if more than half the oil could be recovered in this way, reducing the oil content to 5 or 6 per cent as a minimum.

Anything like complete recovery of the oil appears possible only by the use of a solvent extraction process. When it is noted that the ordinary hydraulic pressing yields only about 68 per cent of the oil actually in the olives, it will be seen that the volume of oil added by complete extraction of the pomace would be large, amounting to 140,000 gallons for the whole State in 1925-26. This, when considered for use only as soap oil, would have a value of over $90,000 on the present market, and if it could be successfully refined for food it would have at least twice this value.

Experiments conducted at the Fruit Products Laboratory of the University of California this year indicate that it is easily possible to extract in this way at least 75 per cent of the oil contained in the pomace. In order to do so, however, it was found necessary to dry the pomace. In the case of pomace which had been dried to under 10 per cent moisture, yields of oil were obtained which ranged from 8.5 to 14.0 per cent of the weight of the pomace, using several different solvents, while pomace which still contained about 25 per cent moisture as when it came from the press yielded only about 5 per cent. The oil so obtained was of perfectly satisfactory quality for soap oil, and while this has not yet been accomplished in California, it would appear possible to refine it for use as food, and that claim is made by several manufacturers of refining equipment.

There are several systems in use for the extraction of oil from such materials as olive pomace. One is similar to the Soxhlet apparatus used in the laboratory for the determination of oil content. In this the solvent is kept constantly boiling, the condensed solvent flowing upon the pomace, dissolving the oil and siphoning off at intervals, and the oil recovered by boiling off the solvent after extraction is complete. Another system works upon the principle of a diffusion battery such as used in the production of sugar from sugar beets. In this the oil bearing material is contained in several tanks through which the solvent is run, flowing from the spent through the fresh material, and thus becoming constantly enriched with oil without the necessity of intermittently drawing it off and distilling the solvent. The oil is finally recovered by distillation of the solvent, as described above. Still another type is employed which is similar to the preceding systems, except that the solvent and pomace are kept in motion by agitators or by the rotation of the drums in which the process is conducted.

In the event that extraction plants were to be operated in California, it would appear that gasoline, or a similar petroleum solvent, could be used to best advantage since such solvents would be considerably cheaper than the others that are available. Some solvent is inevitably lost in the course of the operation, and a cheap solvent would reduce the expense resulting from such a loss, as well as reducing the cost of the initial supply.

It is believed that the cost of such a process, including the overhead and operating costs of drying and extracting the material, could be kept below $8 to $10 per ton of pomace under normal operating conditions with a plant handling 1,000 tons per season. If the yield of oil were 10 per cent, leaving 2 per cent in the pomace, the gross return would be at least $17 per ton. The extracted pomace, when sufficiently dried, would be nearly if not quite as good for use as fuel as it is under present conditions with its high moisture content. This, then, should be a profitable means of utilizing the pomace under conditions as they exist at present.

Were the oil content of the pomace to be lowered to approximately 8 per cent by the use of more powerful presses, solvent extraction might become unprofitable, since the yield of oil would barely cover the cost of the process. It has been suggested that such further pressing might so reduce the moisture content as to render drying unnecessary, thus reducing the cost of the extraction process. While this may be possible, it has not yet been demonstrated.

Olive Oil Refining

In the refining of edible oils such as olive oil, there are usually three steps involved: neutralization of the free fatty acids, decolorizing and deodorizing.

In the neutralization process, an alkaline solution is added to the heated oil in the proper amount calculated from the free fatty acid content. For this purpose caustic soda is generally used commercially, though Cruess ([6]) prefers sodium carbonate which is cheaper and is less likely to saponify the oil itself rather than the free fatty acids. Experiments conducted at the Fruit Products Laboratory this year seemed to indicate slightly better separation of the soap when sodium carbonate was used under atmospheric pressure, although some of the soap always rose to the top in addition to that sinking to the bottom. Manufacturers of vacuum refining equipment claim a better separation of the soap as a result of the removal of the carbon dioxide which is produced when sodium carbonate is used or is present as an impurity in the lye, tending to become imbedded in and buoy up the soap. In any event, the neutralization of the free fatty acids, to the extent required in olive oil, is not usually troublesome when the carbonate or lye is added in a solution of such strength (12—17° Baumé) as to avoid the formation of emulsions with resultant difficulty in filtration. It is usually the case, however, that a slight excess of alkali must be added in order to secure the desired degree of neutralization.

The decolorization of the oil is also fairly simple when absorptive earths or decolorizing carbons are employed, at least in the oils which have so far been treated. In fact, the refined oils usually retain less color than is desirable, so that they must be blended with more highly colored oils.

The removal of objectionable odors and flavors, whose presence constitutes true rancidity, has proved much less simple and less certain of success, especially when using methods which could be used in the ordinary oil factory without special refining equipment. The neutralization and decolorizing processes, while they have some deodorizing effect, are not sufficient in the case of an oil which is badly off in flavor. Blowing air through oil at room temperature had but slight effect, and while air blown through heated oil had a marked decolorizing effect, it did not improve the flavor. A stream of carbon dioxide through heated oil was also of little if any value in this respect. Treatment of the oil with a current of steam under atmospheric pressure had considerable deodorizing as well as decolorizing effect, and the results seem fairly stable. By all means the most effective method is treating the oil with steam under a vacuum. Oil treated in this way was almost completely decolorized and deodorized. When this method is used commercially, superheated steam is employed, but as no means were at hand for superheating the steam at the laboratory, this was not tried. It is probable that no very definite conclusions should be drawn from this work until the oil has been observed through extended storage.

Olive Oil Standardization

It has been said that the greatest need of California olive oil producers is a system of standardization. With the continuance of the splendid co-operation given the University, it would seem that a suitable plan can be developed. Such a plan should include tests and standards for free fatty acids, color, odor and flavor, and should make it possible to produce with perfect regularity oil which will at all times conform to certain specifications from which the element of human judgment should be as far as possible eliminated.

The amount of free fatty acid, color, odor and flavor should be controlled wherever possible by care in handling the olives and the oil. This failing, resort must be had to the suitable refining processes and blending, though it is probably true that refined oils do not have the stability of those which are of satisfactory character without being so treated.

The free fatty acid content is easily and accurately determined by standard chemical methods, and if necessary can be controlled by neutralization. A standard for this characteristic could be readily established.

The color of some edible oils is customarily determined and expressed in terms of an instrument and set of standard color glasses, as the Lovibond tintometer. Such an instrument, with the color glasses needed for the range of olive oils would cost fifty to seventy-five dollars. Preliminary experiments with solutions of stable inorganic chemicals indicate that potassium bichromate and copper sulphate solutions of proper strength can be so used as to match the colors of olive oils and if this proves successful, it would permit control of color with very inexpensive equipment, and the expression of color standards indirectly in the Lovibond tintometer scale.

The question of odor and flavor, with respect to standardization, is again difficult and an elusive one. At present it is to such a large extent a matter of purely personal judgment that it can hardly fail to present innumerable occasions of dispute and dissatisfaction resulting from differences of opinion, no matter how honest and sincere the parties to the transaction may be. It is hoped that some chemical or physical method may be utilized or developed which will give results so closely correlated with odor and flavor that a standard may be inaugurated which will completely remove this problem from the realm of human judgment alone. At present no such test can be offered. Numerous tests for this purpose are under consideration and will receive careful study. In any event it is probable that rather extended research on this point will be required.

Along with the questions of the refining and standardization of olive oils, it would perhaps be worthwhile to suggest the possibility of establishing, at the proper time, a central plant for the purpose of handling the refining and blending which would be a necessary outgrowth of the establishment of a system of standardization. It would seem probable that such processes could be handled most efficiently under one roof, under the control of the Association, as a whole, and most readily financed and operated on the basis of the volume of oil handled for each member. Such a plan might be of considerable value in marketing as well as in production.

Summary and Conclusions

I. There is a field for increasing the return on oil olives through feeding the pomace to livestock, and through increasing the oil yield by the use of more powerful presses, or exhausting the oil content of the pomace by solvent extraction.

II. Neutralization of free fatty acids and decolorization are refining methods that can be utilized at any plant, but deodorizing is a problem that will probably require special equipment.

III. Work leading to the establishment of olive oil standards is suggested.

IV. In the event of the establishment of standards, a central refining and blending plant is suggested.

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(5) Nichols, P. F.—Unpublished observations.
(6) Cruess, W. V.—Calif. Agr. Exp. Sta. Cir. No. 279, p. 39.