

for assistance in obtaining data, and to Dr. A. L. Walters, F. E. Bibbins, H. W. Rhodehamel and Miss Lucile Carter for suggestions and criticisms.

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COD-LIVER OIL AND ITS BY-PRODUCTS.*

BY ARTHUR D. HOLMES.

Previous to the general adoption of the steam process, medicinal cod-liver oil was made by the direct fire method. At a still earlier period cod-liver oil was made by the rotting process. All three of these processes have desirable features. The steam process produces the best oil, but it requires considerable equipment and skilled labor. The direct fire process can be used when steam is not available, and experienced operators can produce very good oil by this method especially if water is used in the liver kettle. The rotting process requires practically no equipment or expense for labor. As a result all the processes are in use at the present time and a variety of oils are obtained, which range in appearance from an attractive straw yellow, edible cod-liver oil to a ruby red, nauseating, heavy oil known in the trade as "cod oil."

The uses to which the oils made by these processes are put are as diversified as the nature and the quality of the oils. They vary from the therapeutic use of highly potent medicinal oil as a source of the fat-soluble vitamins to the use of "cod oil" for industrial purposes.

Since the nature, value, and use of cod-liver oil depends to a large measure on the method of manufacture, it is of interest to sketch briefly some of the general conditions surrounding the manufacture of cod-liver oil and its by-products.

To make the highest quality cod-liver oil the livers from healthy fish should be removed as soon as possible after the fish are caught. They should be rendered very promptly, preferably by the steam method. As soon as the livers are thoroughly cooked, the oil will rise to the surface of the kettle and it should be skimmed off at once. As rapidly as possible it should be freed of water and all particles of liver tissue. The oil is then chilled and separated into non-freezing medicinal cod-liver oil and cod-liver stearin. Unless the oil is to be used at once it should be promptly bottled and sealed to protect it from the oxidizing action of the air.

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Any deviation from this general procedure for the manufacture of medicinal cod-liver oil results in a more or less inferior product. If the fish are kept as "round" fish for a considerable time after being caught, the oil obtained from their livers will not be of as attractive color and flavor as that produced from livers taken from fish that were dressed soon after they were caught. Also, the quality of cod-liver oil decreases more or less in proportion to the length of time that elapses between taking the livers from the fish and cooking them. The palatability of cod-liver oil decreases very rapidly if the oil is allowed to stand in contact with the liver tissue for any length of time after cooking has ceased.

If cod-liver oil is made by the process briefly outlined above, considerable oil remains in the kettle residue after the crude oil has been skimmed from the kettle. This oil may be obtained by subjecting the kettle residue to slow pressure. During the time required to completely express the oil, the liver residue undergoes some change which imparts a red color and objectionable odor and flavor to the oil. Accordingly this oil is ordinarily used for industrial purposes and is known in the trade as "cod oil," to distinguish it from edible cod-liver oil. The press-cake which still contains some water and a little oil is commercially known as "chum." Unless the "chum" is given prompt attention it decomposes rapidly and then is of value only for fertilizer.

The cod-liver stearin which is obtained when the crude oil is chilled and pressed is not a true stearin but is rather a mixture of oil and stearin that eventually separates into a solid and a liquid portion. The relation between the amount of oil and stearin in commercial cod-liver stearin depends upon a number of factors, chief of which are the conditions of chilling and the temperature at which the commercial stearin is stored. Regardless of the proportion of stearin and oil, commercial cod-liver stearin is a 100% fat containing more or less of the fat-soluble vitamin and its commercial value depends largely upon the manner in which it is prepared and stored.

If cod livers are allowed to stand at ordinary temperature, decomposition soon takes place. When the liver tissues have weakened the cod-liver oil is released and on account of its lower specific gravity rises to the top of the mass. "Sun-dried" or rotted cod-liver oil is made in this manner, although at the present time it is known in the trade as "cod oil." This oil is very viscous, of a dark red color, and of a nauseating odor. This type of cod oil as well as that obtained by slow pressure of cooked cod livers are of value in tanning leather. Cod oils are used in the manufacture of leather to lubricate the fibers. This of course serves to lengthen the life of leather which is subjected to constant bending.

Cod oils made by the rotting process or occurring as a by-product of the manufacture of medicinal oil may be sulphonated or chemically refined which produces sulphonated cod oil or renovated (refined) cod-liver oil. Sulphonated cod oil is produced when cod oil is treated with concentrated sulphuric acid under carefully controlled manufacturing conditions. This is a heavy viscous oil which has special uses in tanning leather.

By chemically refining cod oil its taste, color and odor may be very decidedly improved. This is accomplished by deodorizing, decolorizing and alkali washing. Cod oil ordinarily contains a high percentage of free fatty acids. By heating cod oil with sufficient alkali to neutralize the free fatty acids, one obtains an oil with little or no acidity. With bleaching agents the dark red color of cod oil can

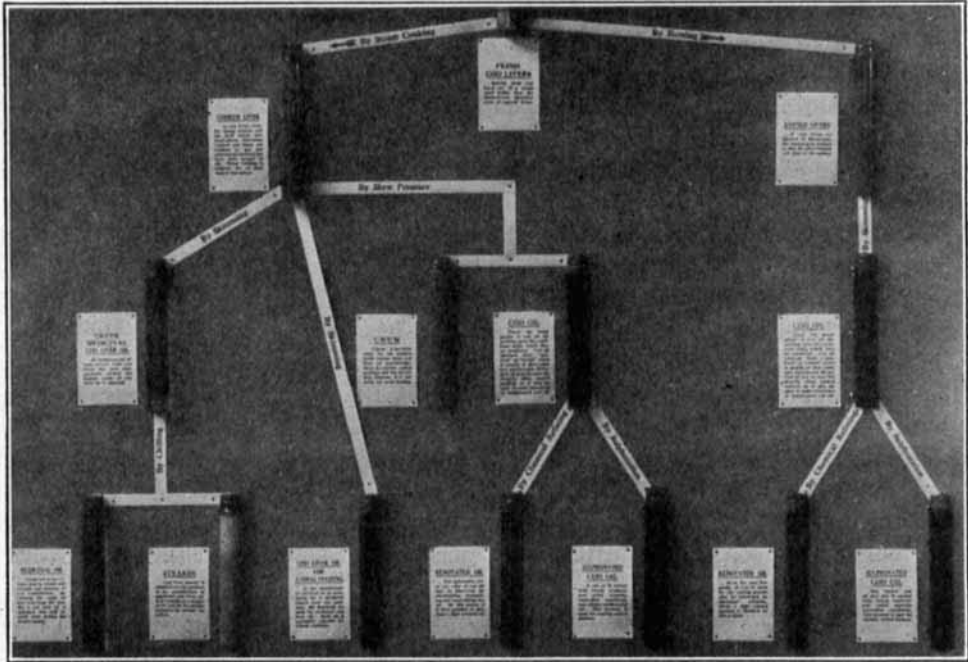


CHART SHOWING VARIETY OF PRODUCTS WHICH MAY BE PRODUCED FROM COD LIVERS.

The explanatory matter on the charts cannot be read, therefore, the wording is given as follows—beginning with the center chart, and that of the next at the left, in the second row to the right, and bottom row in like order. The charts explaining the second division, four in number, are read downward, and the chart at the extreme right is the last one of the series. It will be noted that all except the last four refer to the “steam cooking process.”

Fresh Cod Livers—Strictly fresh cod livers are of a cream color rather than the characteristic chocolate color of animals' livers. *Cooked Liver*—As cod livers cook, the tissues weaken and the liver breaks into small pieces. Hot steam cooked cod livers are relished by any one who enjoys sardines that have been packed in oil. When cooking is stopped, the oil soon rises to the surface. *Crude Medicinal Cod-Liver Oil*—By skimming hot oil from strictly fresh cod livers that have been promptly cooked the highest grade of cod-liver oil is obtained. *Medicinal Oil*—Crude cod-liver oil contains stearin which will solidify and separate at low temperatures. By chilling the crude oil and removing the stearin, a cod-liver oil is obtained that will remain clear during the winter season. *Stearin*—Cod-liver stearin is obtained as a by-product of the manufacture of medicinal cod-liver oil. It is valuable as a source of fat and the fat soluble vitamins for animal nutrition. *Cod-Liver Oil for Animal Feeding*—In the manufacture of cod-liver oil an occasional lot is produced which does not quite meet the standards desired for medicinal cod-liver oil. Such oil is extremely valuable for animal nutrition. *Chum*—“Chum” is the trade name for the pressed kettle residue from cod-liver oil manufacture. Since it contains animal proteins and the fat-soluble vitamins, it is valuable for stock feeding. *Cod Oil*—When the cooked cod livers (skimmed or unskimmed) are subjected to slow pressure, a red oil is obtained. This is the highest grade of cod oil. It may be used in this form by leather tanners for oiling leathers. By refining or sulphonating it may be made into renovated or sulphonated oil. *Renovated Oil*—The undesirable color and odor of cod oil may be improved by decolorizing, deodorizing and neutralizing the oil. By this means it is often possible to produce a light-colored oil. *Sulphonated Cod Oil*—If cod oil is treated with strong sulphuric acid under carefully controlled conditions, one obtains sulphonated oil. This product is used for treating tanned leathers.

Rotted Livers—If cod livers are allowed to decompose, the tissues soon weaken so that the oil is released and rises to the surface. *Cod Oil*—There are many grades of cod oil depending upon the conditions under which they are produced. That obtained from “sun-ried” or “rotted” livers is usually of dark color and pronounced flavor. It may be used directly for oiling tanned leathers or it may be used to make renovated or sulphonated cod oil. *Renovated Oil*—Even the very low grades of cod oil made by the rotting process may be renovated by chemical refining. Often a light colored product is obtained by this process. *Sulphonated Cod Oil*—The “rotted” cod oil may also be treated with strong sulphuric acid under carefully controlled conditions. This product is used for treating tanned leathers.

be changed to the desirable straw yellow color of medicinal cod-liver oil. Also the offensive odor of cod oil may be more or less removed by different deodorizing processes but if it is removed by "blowing" the oil with air any vitamin content which the cod oil originally possessed is decreased as the result of the oxidizing action of the air.

Inasmuch as cod oil and non-edible cod-liver oils sell at a much lower price than medicinal cod-liver oil and the cost of chemically refining such oils is not at all prohibitive it is a profitable business to renovate non-edible oils and sell them as medicinal oil. Since such renovated oils are on the market it behooves the consumer who really desires an oil rich in the fat-soluble vitamins to demand information concerning the vitamin content of any oil in which he may be interested.

Studies of the vitamin content of oils produced by promptly rendering strictly fresh livers as compared with the vitamin content of oils produced by the rotting process have shown that the rotted oils contained relatively little vitamin A. Thus it is apparent that if one wishes a cod-liver oil rich in the fat-soluble vitamins he cannot be guided by physical appearance or chemical analysis of a given oil, for it is not at all difficult to produce a renovated oil which will meet all the specifications set for a medicinal oil and still such an oil may be lacking or nearly so in the desired fat-soluble vitamins.

From this it is evident that while it is possible by chemically refining to so improve a cod oil, that one obtains a renovated oil which is fairly satisfactory as regards color, odor and taste, chemical refining does not enhance the original vitamin content of cod oil. To be sure of obtaining a cod-liver oil with a high vitamin potency one must insist on an oil that has been biologically tested for its vitamin content.

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A PHYTO-PHARMACOLOGICAL METHOD OF ASSAYING DIGITALIS.*

BY DAVID I. MACHT AND JOHN C. KRANTZ, JR.†

INTRODUCTION.

During the last few years one of the authors in collaboration with various associates has been developing a study concerning the effects of drugs and poisons on plant protoplasm. In comparing the results thus obtained with the same substances on animal tissues a scientific phyto-pharmacological method of testing toxicity has been developed in contradistinction to the zoöpharmacological methods. This method has already yielded very interesting results in the study of the relative toxicity of various chemical substances on animal and plant tissues respectively.

Thus it has been shown that, while cocaine was very poisonous for animals, on the other hand certain poisons of animal origin were found to be much more poisonous to plants than to animal test objects. In connection with these phyto-pharmacological studies Macht and Lubin made a brief examination of various digitalis principles and studied their toxicity on the seedlings of *Lupinus albus*.

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