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SEPARATION OF MENTHOL FROM MINT OILS BY CHROMATOGRAPHIC ADSORPTION

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1 Claim. (Cl. 260—631)

This invention relates to the separation of menthol from mint oils by chromatographic adsorption. The invention is particularly useful in the extraction of natural menthol from mint oils with a very substantial increase in the yield of menthol over that of existing processes.

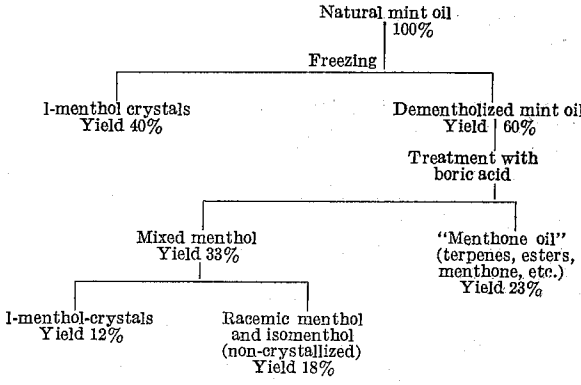
There are two general types of mint oils produced by the steam distillation of the peppermint plants: *Mentha piperita,* grown mainly in the United States and Europe, and *Mentha arvensis,* grown mainly in China, Japan, and Brazil. The oil produced from *Mentha piperita* is generally known as peppermint oil, while the oil produced from *Mentha arvensis* is usually designated as Chinese, Japanese, or Brazilian mint oil, according to its origin. The term "mint oil" will be used hereafter to include both types of oils containing a large amount of menthol.

Although the composition of mint oils is extremely complicated, the chief constituents may be classified as menthol, menthone, menthyl esters, and terpene hydrocarbons. The oil from *Mentha piperita* usually contains 40 to 65% of menthol and 14 to 40% of menthone, while the oil from *Mentha arvensis* usually contains 60 to 85% of menthol and 12 to 20% menthone. Menthol and menthone are the two compounds present in all mint oils in large quantities and, due to their similar physical properties, the separation of these two compounds is the chief problem in the production of menthol from mint oils.

The traditional method of producing menthol in China, Japan, and Brazil is to crystallize it from the mint oils at a temperature of about −10° C. The method consists of three steps, namely, formation of menthol crystals by freezing the natural mint oil, removal of the crystals from the residual oil by draining and centrifuging, and drying of the crystals. Since menthol is very soluble in other constituents in mint oil even at low temperatures, a large portion of menthol is retained in the residual oil. This so-called "dementholized mint oil" still contains about 50% of menthol and is sold mostly to Europe as a cheap substitute for peppermint oil at a price of about 25% of that of U. S. Pharmacopoeia grade menthol crystals. It is evident that by this method, the yield of menthol is low and drops rapidly for a small decrease of the original menthol content in the mint oil and only oil containing more than 50% menthol can be used for the production of menthol. The free menthol content in American and European peppermint oil is usually below 50% and therefore cannot be used as raw materials for the production of menthol by mere crystallization.

Some Brazilian manufacturers have tried to convert menthone in the mint oil into menthol by reduction, thereby increasing the yield of menthol from the enriched oil. While the natural menthol from the traditional crystallization process is laevo-active, the reduction of natural l-menthone in the mint oil yields, in addition to many undesirable side reaction products, several isomers of menthol, the separation of which is extremely difficult and expensive. The price of synthetic racemic menthol now on the market is only about two-thirds of that of natural l-menthol. Therefore, although the yield of menthol after the reduction may be higher, the price of the isomeric product will be considerably lower, the over-all result may not be economical. Evidently it is better not to try the reduction process until menthol has been separated from the mint oil as much as possible. If menthone can also be isolated first and then reduced, it is much easier to control the reduction and higher yield of menthol may be expected.

Recently, efforts have been made at the Kitami factory in Japan toward a more complete recovery of menthol by first converting menthol into a non-volatile ester of boric acid, thus rendering the menthol readily separable from other volatile components. After removing the volatile components in the mint oil by steam distillation, the menthyl ester in the residue is saponified with caustic alkali and the regenerated menthol is obtained by steam distillation again. Starting from an average mint oil containing 75% of menthol, the yield by this process is illustrated as follows:



By this method the total yield of l-menthol crystals increased from 40 to 52% of the natural mint oil but due to inversion in the process, part of the product could only be obtained as liquid isomeric menthol, the price of which should be even lower than that of synthetic racemic menthol. The "menthone oil" contains about 50% menthone, which is also racemized to a mixture of isomers, and is difficult to market.

I have discovered that quantitative yields of both menthol and menthone can be obtained in a simple process operable on a commercial basis through the use of adsorbents and selective eluants. In one embodiment of my invention, the mint oil is dissolved in a relatively non-polar solvent and then passed over an adsorbent, the adsorbed material then being washed with eluants of increasing polarity to separate the menthone and menthol into clear-cut fractions. The pure menthol and menthone may be then separated from the solvents by any desired means, as, for example, by evaporating the solvents.

The adsorbents may be those usually employed in chromatographic analysis such as fuller's earth, activated magnesia, activated charcoal, activated alumina, etc.

The eluants are chosen with the object of obtaining rapid and complete liberation of one adsorbent at a time into clear-cut fractions. Non-polar solvents such as petroleum ether and carbon tetrachloride are preferably used first to elute menthone without washing off menthol, and after the complete elution of menthone, powerful eluants such as alcohols may be added to accelerate the elution of menthol in order to secure a more concentrated solution.

I found that the components in the mint oil possess slightly different adsorptive affinities towards certain adsorbents. By the application of the chromatographic adsorption method I have discovered that menthol and menthone can be obtained in substantially quantitative yields

as pure compounds and no isomerization occurs during the process.

When a solution of the mint oil is adsorbed at the top of an adsorption column and then washed with properly selected solvents, the adsorbed solutes are forced to migrate through the column. Under these conditions, the weakly adsorbed components migrate rapidly and the strongly adsorbed components migrate more slowly. As a result of this differential migration, the adsorbed components gradually separate from one another. The adsorption affinity of the chief constituents of mint oils is in the following order: menthol, menthone, menthyl esters, and terpene hydrocarbons, the last being least adsorbed. Terpene hydrocarbons and menthyl esters are only very weakly adsorbed and can be washed out readily by such weak eluants as petroleum ether. Menthol and menthone have quite similar adsorptive properties, but if the adsorbents and eluants are chosen judiciously, sharp separation of the two into clear-cut fractions can be obtained under properly controlled conditions.

Both menthol and menthone obtained from the process are laevo-active and chemically unaltered. The menthol obtained from the process meets U. S. Pharmacopoeia specifications and no further purification is necessary.

As specific examples of the process, the following may be set out:

Example 1

A Chinese mint oil containing 65.2% menthol, 12.5% menthone and 1.8% menthyl esters, was used as the raw material. Activated carbon (Carbide and Carbon Chemical Corporation, "Columbia" solvent recovery grade) was ground and sieved to 100 or 200 mesh and used as adsorbent. A 6.5 cm. inside diameter glass column was packed with 1200 grams of the aforesaid adsorbent to a height of approximately 50 cm. Freshly steam-distilled mint oil in the amount of 25 grams was dissolved in a hydrocarbon solvent with a boiling range of 77–115° C. (Skellysolve D) to make up 150 ml. of solution and was adsorbed at the top portion of the column. The column was then developed successively with 1000 ml. of a 80.20 by volume mixture of said hydrocarbon solvent (Skellysolve D):carbon tetrachloride, then with 600 ml. of pure carbon tetrachloride, and finally with 700 ml. of 90:10 by volume mixture of CCl_4:MeOH. The linear rate of flow of eluant was maintained at about 10 mm./min. and the oil to adsorbent ratio was 1:50. 100 ml. fractions of percolate were collected and the solvents were evaporated. Three clear-cut fractions were obtained: the terpenes and menthyl esters were washed out first; the menthone fraction came out next; and the last fraction contained only

menthol. The melting point of the menthol fraction was within the U. S. P. specified range of 41 to 43° C. The menthone fraction was nearly pure, as indicated by the refractive index. The yield of menthol and menthone were 95% and 90% respectively. The losses occurred mainly during the evaporation of solvent.

Example 2

The process was carried out as described above, except that petroleum ether and carbontetrachloride were used first to elute menthone and thereafter alcohol was added to effect the elution of menthol.

Example 3

The process was carried out as described in Example 1, except that the mint oil used as starting material was *Mentha piperita.*

In all of the examples set out above, the yields were considerably above 90%, and when extreme care was used in the evaporation of the solvent, quantitative yields were obtained.

While in the foregoing specification, I have set forth specific steps in considerable detail for the purpose of illustrating embodiments of the invention, it will be understood that such details of operation may be varied widely by those skilled in the art without departing from the spirit of my invention.

I claim:

In a process for the separation of menthol from naturally-occurring mint oils, the steps of dissolving a naturally-occurring mint oil containing menthol, menthone, menthyl esters and terpene hydrocarbons in a petroleum hydrocarbon solvent, passing the solution over an active adsorbent for all of said mint oil constituents, washing the adsorbent while said constituents are retained thereon with a petroleum hydrocarbon solvent to desorb the menthyl esters and terpene hydrocarbons, and then washing the adsorbent with a chlorinated hydrocarbon solvent to desorb the menthone, and finally washing the adsorbent with an alcohol solvent to desorb the menthol.

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