A Unique *Mentha aquatica* Mint for Flavor

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The essential oil from peppermint, *Mentha x piperita* L., is one of the most widely used oils by the flavor industry for mint flavoring. However, abundant literature and experts' observations report the varying composition and organoleptic profiles of peppermint oils according to the region of production, climatic variation and harvest date.[1-3] Such variation is well illustrated and summarized by Brian Lawrence in his thorough reviews of peppermint oil.[4,5] Methods to standardize peppermint oils by adding specific mint fractions or compounds isolated from other mint species, as well as other natural non-mint isolates were explored by Moyler and Moss.[6] When fractions or isolates of oils from *Mentha* species other than *piperita* are used, as well as other natural flavors, the label of the blend must be identified as WONF (With Other Natural Flavors).[6] In this paper we present the oil from our selected *Mentha x aquatica* L. ("Aquamint") that can be blended to an *M. x piperita* oil to increase the menthofuran to match a standard "Yakima" oil.

Figure 1. A plant of Mentha x aquatica (Aquamint) (Source: Donald Roberts)

The Plant: Benefits to the Grower

Aquamint originated as a seedling from a poly-cross between the female (seed) parent *M. aquatica* L. and a pollinator from an unknown *Mentha* species. The parentage and chemotype of the selection strongly suggests that it is a hybrid plant from *M. aquatica*, and the DNA content as analyzed by flow cytometry is the same as that of *M. aquatica*. The seed parent is male sterile and rarely, though occasionally, outcrosses with other *Mentha* species. Seedlings that developed from the female parent were planted in observation plots; plant vigor and disease development were recorded. Selected seedlings were harvested and distilled for oil collection.

Aquamint, unlike its parent and many *M. aquatica* plants, has an upright and compact growth habit similar to *M. x smithiana* with lateral branches at each node of the main stem (Figure 1). The shape of the leaves of Aquamint confirms the variations of the species.[7] Mature leaves at the bottom of the main stems are ovate lanceolate, while leaves on secondary branches and immature upper leaves are more lanceolate. The inflorescence of Aquamint varies somewhat in shape and color. Floral arrangements are whorls in leaf axils similar to *M. arvensis*, but with small bracts similar to *M. aquatica*. Figure 1 also illustrates the capacity of Aquamint to develop runners (stolon), which shows the potential of the plant for rapid spread and field establishment.

The upright growth habit of Aquamint is a selected trait important for commercial harvest considerations. Twenty years of asexual reproduction by stem cuttings or by stolon from field grown plants confirmed that characteristics of Aquamint were stable under conditions in Oregon, true-to-form, and transmitted through vegetative propagation. As an example, Figure 2 illustrates the uniform growth, establishment and maturity of an Aquamint field. In this 2-year-old field located in Oregon's Willamette Valley, the mint grew to more than 2 ft in height; the density of plant material was equal to or greater than that of a typical commercial field of "Black Mitcham" peppermint.

Additionally, observations over the years have shown that Aquamint is resistant to mint rust caused by *Puccinia menthae*. It also has a higher level of resistance to mint wilt caused by *Verticillium dahliae* than Black Mitcham peppermint.

Quality of the Oil

Aquamint has an oil profile similar to its female parent (Table I). For comparison, Table I also presents the oil

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composition of a commercial *M. piperita* and an imported partially dementholized *M. arvensis*. Menthofuran and pulegone levels in the *M. aquatica* parent and its hybrid were 43.7 percent and 40.1 percent, and 8.9 percent and 8.1 percent, respectively. In contrast, both compounds were at 3.0 percent and 0.0 percent, and 0.7 percent and 0.9 percent in *M. piperita* and *M. arvensis*, respectively. Menthofuran is reportedly the major constituent of the oil of *M. aquatica* or its hybrids.[8-11] It may range from 50 percent to more than 80 percent. It varied from 50 percent to 60 percent in *M. aquatica* var. *hypeuria* grown in Italy.[12] Hefendehl and Murray studied the genetic control of the bioconversion of pulegone to menthofuran in *M. aquatica* and its hybrids, and reported from other authors contents of pulegone of 1.8 percent in plants having 50 percent menthofuran, while oils containing 60 percent to 80 percent menthofuran did not have any pulegone.[13]

Menthone and menthol were 17.6 percent and 47.3 percent, respectively, in the commercial *M. piperita* oil, and 22.6 percent and 39.8 percent, respectively, in the *M. arvensis* oil; the levels were 4.1 percent and 5.4 percent, respectively, in the Aquamint selection. In the context of explaining the differences between peppermint oils, Murray et al. stated that "normal peppermint oil had ideally about 20 percent menthone, 50 percent menthol and 8 percent ester."[1] The higher level of isomenthone is usually found in *M. arvensis* oil.[14,15]

Oil from distilled flowers of Aquamint contains more menthofuran and pulegone than oil distilled from leaves (Table II). Menthofuran and pulegone were 65.8 percent and 10.6 percent in the flowers, and 40.1 percent and 8.1 percent in the whole plant, respectively. This developmental difference with higher menthofuran and pulegone in oil distilled from flowers was also observed in peppermint oil.[1,16] Oil from *M. piperita* plants harvested later in the season with more flowers is known to have higher menthofuran content.[2,3] Therefore, like peppermint, the more flowers harvested on Aquamint plants, the higher the menthofuran can be expected in the oil.

Figure 2. Established field of Mentha x aquatica (Aquamint) in Oregon (Source: Donald Roberts)

Stability of the Aquamint Plant as a Variety

The analyses of oil from Aquamint collected in five different years are listed in Table III. The data presented for 1982 and 1995 are analyses of oil distilled from plants grown in small research plots and processed on a small, pilot size distillery. The data presented for 1998, 1999 and

Table I. Major compounds in essential oils of *Mentha aquatica*, Aquamint parent, *Mentha x piperita* and *Mentha arvensis*; all oils are from commercially grown fields except *M. aquatica* Aquamint parent

Compounds*	*Mentha aquatica* Aquamint parent	*M. x aquatica* Aquamint	*M. x piperita* US peppermint	*M. arvensis* Indian peppermint
α-pinene	0.7	1.2	0.8	1.6
β-pinene	0.9	1.8	1.0	1.9
l-limonene	4.0	5.3	1.5	3.4
1,8-cineole	4.5	8.4	4.8	0.7
3-octanol	0.0	0.4	0.3	1.2
l-menthone	1.3	4.1	17.6	22.6
menthofuran	43.7	40.1	3.0	0.0
d-isomenthone	3.1	1.0	2.7	12.1
menthyl acetate	10.1	8.0	6.7	2.4
neo-menthol	2.7	0.5	5.4	5.1
β-caryophyllene	2.5	0.8	1.2	1.3
l-menthol	5.5	5.4	47.3	39.8
pulegone	8.9	8.1	0.7	0.9

*Oils were analyzed on a HP 5890 GC-FID with a SupelcoWax 10 polyethylene glycol column (30 m x 0.25 mm, 0.25 μm film thickness); compound identification was by retention time comparison with authentic standards; percentages were determined by calculation of relative FID peak areas

Table II. Composition of Aquamint essential oils distilled from whole plant and flowers

Compounds*	Whole plant	Flowers	Compounds*	Whole plant	Flowers
α-pinene	1.2	0.8	d-isomenthone	1.0	0.0
β-pinene	1.8	1.1	menthyl acetate	8.0	1.4
l-limonene	5.3	4.9	neo-menthol	0.5	0.0
1,8-cineole	8.4	8.4	β-caryophyllene	0.8	0.4
3-octanol	0.4	0.0	l-menthol	5.4	1.8
l-menthone	4.1	1.4	pulegone	8.1	10.6
menthofuran	40.1	65.8			

*Oils were analyzed on a HP 5890 GC-FID with a SupelcoWax 10 polyethylene glycol column (30 m x 0.25 mm, 0.25 μm film thickness); compound identification was by retention time comparison with authentic standards; data, percentages, were determined by calculation of relative FID peak areas

Table III. Oil composition of Aquamint harvested from field plots (1982 and 1995) and commercial production (1998, 1999, and 2000)

Component	1982[a]	1995[a]	1998[b]	1999[b]	2000[b]
α-pinene	0.9	1.1	1.3	0.8	1.1
β-pinene	1.7	1.9	1.9	1.8	1.7
l-limonene	4.7	5.2	6.2	5.3	5.1
1,8-cineole	8.0	8.9	9.5	8.4	7.8
3-octanol	0.0	0.0	0.0	0.4	0.0
l-menthone	1.5	1.6	5.0	4.1	4.0
menthofuran	48.8	51.7	44.2	40.1	36.4
d-isomenthone	0.4	0.4	1.0	1.0	0.9
menthyl acetate	5.4	5.2	4.4	8.0	8.0
neo-menthol	0.4	0.3	0.5	0.5	1.1
caryophyllene	1.7	1.7	0.9	0.8	1.0
l-menthol	1.7	1.7	5.2	5.4	11.5
pulegone	7.1	7.1	10.0	8.1	8.5

*Oils were analyzed on a HP 5890 GC-FID with a SupelcoWax 10 polyethylene glycol column (30 m x 0.25 mm, 0.25 μm film thickness); compound identification was by retention time comparison with authentic standards; percentages were determined by calculation of relative FID peak areas; [a]experimental pilot size distillation; [b]commercial distillation

2000 are analyses of oil distilled from plants grown in the same commercial field and processed in a commercial mint distillery. The higher menthofuran content in the oil obtained from the pilot distillery in 1982 and 1995 is consistent with observations of the differences between pilot and commercial distillation techniques.[3,17] Certain factors — including delay between harvest and distillation; distillation of the whole, cut or "cut and rolled" plant; steam temperature and pressure — were shown to affect the menthofuran content of the oil. Additionally, as seen in Table II, flowers have significantly more menthofuran than the vegetative part. A commercial harvest when flower heads were not fully developed partially explains the lower menthofuran content in the oils collected in 1998, 1999 and 2000, while plant harvested from the research field in 1982 and 1995 were more mature. Overall, the data in Table III indicate the reproducibility of the Aquamint oil produced commercially.

Potential Use of Aquamint Oil in Blends

Menthofuran was found to be an important compound of peppermint oil by gas chromatography-olfactometry.[15] It imparted a rubbery note by descriptive analysis, and made the peppermint oil distinct from cornmint oil. If one wished to increase the concentration of menthofuran in commercial mint oils it would be possible by blending it with Aquamint oil. The remaining components in the commercial mint oil would not be significantly changed in such a blend because of the relatively low concentrations of the other components present in our selection of *M. aquatica*. Examples of such blends were made with double cuts of *M.*

Table IV. Essential oil profiles of *M. x aquatica* Aquamint (aqua) and *M. x piperita* Yakima Black Mitcham (B.M.) single cut, double cuts, and double cuts with 9 percent aquamint added

Component	Aquamint	Yakima single cut	B. M. 1st cut	B.M. 1st cut + 9 percent aqua	B.M. 2nd cut	B.M. 2nd cut + 9 percent aqua
α-pinene	1.4	0.8	0.8	0.7	0.9	0.9
β-pinene	2.2	1.1	1.0	0.9	1.2	1.2
l-limonene	6.3	1.8	1.5	1.6	1.7	2.1
1,8-cineole	9.8	4.9	5.1	4.8	6.4	6.5
3-octanol	0	0.3	0	0	0.3	0.3
l-menthone	5.1	16.7	20.1	17.9	17.3	15.9
menthofuran	43.4	5.5	1.1	4.2	1.1	4.6
d-isomenthone	1.0	2.9	3.1	2.8	2.4	2.2
menthylacetate	4.5	5.8	3.5	4.1	7.5	7.6
neo-menthol	0.5	5.8	6.3	6.2	5.8	5.4
caryophyllene	0.9	1.3	1.6	1.4	1.1	1.1
l-menthol	5.0	41.8	45.7	42.7	44.7	41.3
pulegone	9.8	3.7	1.5	2.2	0.3	1.2

*Oils were analyzed on a HP 5890 GC-FID with a SupelcoWax 10 polyethylene glycol column (30 m x 0.25 mm, 0.25 µm film thickness); compound identification was by retention time comparison with authentic standards; percentages were determined by calculation of relative FID peak areas

piperita Black Mitcham from the far west in order to match the level of menthofuran of a standard Yakima Black Mitcham peppermint oil (Table IV). By adding 9 percent of Aquamint oil to first or second cut peppermint oils, the menthofuran was raised from 1.1 percent to 4.2 percent and 4.6 percent, respectively. Menthone and menthol were lowered by about 2 percent and 3 percent, respectively. The organoleptic quality of such blends was comparable to that of the Yakima oil.

Conclusion

Mint oil producers are continually searching for means to be more efficient in their production of mint oil. This is driven by competition from growers in different production areas, both in the United States and globally, which tends to drive the price of their oils lower. In an effort to increase yield, producers in some areas have taken two harvests in the growing season. This has resulted in higher oil yields but has changed the quality of the oil from that of a single cut they once produced. Mint oils, which are both low in menthofuran and thought to have an inferior quality, may be improved by blending with an Aquamint oil. The final oil blend should be labeled WONF.

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