Hydrosol and the Alchemical Wonder of Distillation

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Jill Mulvaney is distiller, extractor and blender of aromatics and principal director of Alembics New Zealand. With over 25 years of experience, Jill now teaches and consults on all aspects of plant extraction, aroma, and natural flavour advancing ideas and products that can be utilized across a broad range of industries. Jill leads regular events and workshops that educate people about the exciting possibilities of botanical distillation, and plant extraction. Jill is passionate about the character of plants, the alchemical wonder of distillation, and enjoys sharing her knowledge with others. Jill's formative years, growing up on an isolated farm in Hawkes Bay, her recent teaching partnerships with internationally renowned phytochemists and aromatic distillers in Europe and America, and her experience distilling New Zealand and Australian natives, forms the basis of her deep engagement with the natural world—which remains her greatest inspiration.

Introduction

Hydrosol, sometimes known as a hydrolat, is a distilled aromatic water. When I started running distillation workshops 12 years ago, very few people had heard of hydrosol and only a select few understood what floral waters and misters were. Today, at least 50% of my students are familiar with the term 'hydrosol' and attend workshops primarily to learn how to distil and use them.

No discussion of hydrosol can commence without first acknowledging the 'godmothers' of modern hydrosol. Jeanne Rose, now 83 and living in San Francisco, coined the name hydrosol in 1990 principally because it was easy to say and remember. *Hydro,* meaning water, and *Sol,* meaning soluble. (Rose, 1990) Soon after, Ann Harman, Jeanne Rose's student, took the distillation of hydrosols using traditional copper alembic stills, to the next level. Ann is the author of 'Harvest to Hydrosol, a classic text on the art of hydrosol distillation

I have read *'Harvest to Hydrosol'* many times and, for those interested in hydrosol or making hydrosol, I strongly recommend reading it as it's suitable for both therapeutic practitioners and beginners alike. A few years ago, Ann Harman invited me to teach alongside her in Washington State and we have been close friends and colleagues ever since. We often work collaboratively on research, testing and experimentation, and our workshops and courses have seeded interest that has spread throughout Europe, the USA, Australia and New Zealand.

Aside from texts written by the two inspirational women above, there are now plenty of excellent blogs, articles and books about hydrosol. But it's important to note that while there is a growing body of current research on hydrosol, published work on the topic remains in its infancy with clinical testing results restricted to invitro and enviro forms. Very few clinical trials on human participants have been conducted, and there is still plenty to learn.

The revival of an ancient craft

Distilled aromatic waters are certainly not new, even though they have a new name. Hydrosols have been used by humankind for centuries. The oldest alembic still discovered is reportedly 4,000 years old. Archaeologists uncovered it on the island of Cyprus in 2005 at an ancient site dedicated to the production of scented oils and aromatic waters. Many history books claim that distillation first appeared in the eleventh century when the renowned chemist and alchemist Avicenna was based in Persia. Avicenna improved the efficiency of distillation processes by adding a coil feature to existing distillation hardware, rather than inventing distillation from scratch. (Belgiorno, 2016)

As early as the seventeenth century, dedicated still rooms were often essential features in European bourgeois homes—industrious spaces where beer, wine and spirits were routinely made by the 'women of the house' alongside distilled aromatic waters for cosmetic and medicinal purposes. During this period, early versions of hydrosol could also be purchased from chemist shops.

In recent years, small-scale artisan distillation has become immensely popular again thanks to a close-knit, international group of dedicated and passionate distillers and educators and a growing collective desire from women and men to connect in a deeper way with plants and their potential for wellbeing.

The allure of hydrosol

I am not a practitioner; I am a specialist educator and a maker working exclusively in the field of botanical distillation and extraction and this article is written from that perspective. This article details my understanding of hydrosol based on my own experiences and relationships with plants and distillation. I leave it to you—the experts, to decide on the appropriate therapeutic application. Hydrosol is very different from essential oil. Hydrosol consists primarily of water and small amounts

of water-soluble constituents. Unlike essential oils, the subtle water solubility of hydrosol means that they are generally safer, and easier for the body to absorb.

It's important to have some understanding about volatile organic compounds (VOC) and solubility (that which is soluble or not in water) to understand the appropriate and effective application of hydrosols. If something is water-soluble it means that it can be taken internally and metabolised. It also means that it can be absorbed externally, by spraying on the face or body.

The distillation of hydrosol is a process of separation. Plant VOC become vapour at different temperatures. The aim of distillation is to separate the VOC from the original plant material by using water, heat, and a closed system (the still). The plant material is placed in the pot (hydro-distillation) or column (steam distillation), or both (combo-distillation) of a still. Water is added to the pot which is then heated. As the water heats, the cells of the plant are ruptured, and the VOC are released and are carried over in the vapours of the water (steam) through the still. When the vapours reach the condenser bucket, which has cooling water flowing through it, it turns back into a liquid state. This liquid outcome is collected and called hydrosol.

Pouring hydrosol into an essential oil separator, copper Alembic Column Still in the background – Photo credit: Peter Rees

Hydrosol is primarily water saturated with both water-soluble (that which dissolves in water) and traces of nonpolar (that which doesn't dissolve in water) compounds. Depending on the plant, the saturation ranges from .001% to .1% which translates to 10 and 1000 mg of VOC per 1 litre of water.

Interestingly, there are no vitamins, minerals, amino acids, tannins, flavonoids, carotenoids, bitters, alkaloids present in hydrosol. These compounds generally do not evaporate because they are not a volatile organic compound. Their molecules are too large and heavy or too attached to water molecules by kinetic energy to be able to come across in the still. Some VOC are slightly water-soluble and it's these that give taste and aroma to hydrosol. Neither water nor VOC have any nutritional value.

I encourage practitioners interested in hydrosol to experiment by first making small batches at home or in suitable workspaces. A hands-on approach builds a deeper relationship with the plant of your choice and the process of distillation. I also encourage practitioners to learn about the various plant extraction techniques so that they understand the difference between infusions, decoctions, extracts, essential oils and hydrosol and how they can be used in unison in a healing modality to support well-being.

The plant

Having a heading called "The plant" is misleading when it comes to distillation as you can distil anything. This is clearly illustrated in Patrick Suskind's book *"Perfume, The Story of a Murderer"* famous for its visceral descriptions of aromas and the final distillation of a virgin. But for our purposes, we will stick to all of the parts of a plant – roots, barks, resins, aerial parts and seeds.

Choosing a plant to distil is a subjective, personal process for me as I am not a commercial producer and I don't cultivate plants specifically to distil. My purpose is to experience the plant through visual and sensory observation, build a relationship and find the right time to harvest and distil. The distillate then carries a memory of that exploration.

The plant might be growing in my garden, or in a friend's garden or one I regularly pass by on my daily walks. I watch and observe them through a season, they take my eye, they become luminous and I may wake at night with them in my dreaming eye and smell their aroma. The connection I have to them prompts me to investigate them further. It's important for me to correctly identify the plants I choose to distil so that I understand its specific ancestry and place. If I don't already know, I look for the botanical name, the plant family and research how it has been used historically. I also look for information on constituents, VOC and if it's been distilled by others and why.

Throughout the seasons, I come to understand when a particular plant's energy is high and producing strong VOC. Often it is at a certain time of year to repel predators, protect itself from fungal and bacterial attacks, or to attract pollinators, or to communicate with other plants. From these observed cues I know the optimum time to harvest for the distillation.

Water

Water is the primary component of hydrosol, therefore, the type of water used to make it is very important. Filtered rainwater and groundwater are ideal. Chlorinated water is not recommended as the action of chlorine destroys matter suspended in the water and in doing so, produces the typical unpleasant smell of chlorine. This can pass over in the distillate and give your hydrosol an unpleasant chemical note. Distilled water doesn't offer anything to the distillation of hydrosol as it has been denatured already by distillation. When choosing your water, a reflection on the nature of water, its sacred history and importance to life will guide you to the best source. Distilled water and chlorinated water have both been tampered with by man-made processes, so in this sense have lost that sacred energetic element.

Chemical composition of hydrosol

Compounds that are soluble, or slightly soluble, in water are found in hydrosol. Terpenes are nonpolar molecules so will not be present in hydrosol or only in trace amounts. Terpenes can be divided into two groups, monoterpenes and sesquiterpenes. Some examples of common monoterpenes are limonene (found in citrus peels), a-pinene (conifers and pines). Examples of sesquiterpenes – beta-caryophyllene (black pepper, patchouli), chamazulene (German chamomile).

The main compounds found in Hydrosol therefore are:

Monoterpenols: for example, linalool (Lavender, Basil), menthol (Peppermint) terpinen-4-ol (Tea Tree, Manuka, Sweet Marjoram), geraniol (Geranium, Citronella).

Therapeutic effects of Monoterpenols: antibacterial, anti-fungal, analgesic, sedative, antispasmodic.

Plants that when distilled may contain high percentages of monoterpenols: basil *(Ocimum basilicum),* Lavender *(Lavandula angustifolia),* kanuka *(Kunzea robusta, Kunzea sinclairii, Kunzea ericoides),* sweet marjoram *(Majorana hortensis),* peppermint *(Mentha piperita)* Rose *(Rosa damascena)* tea tree *(Melaleuca alternifolia).*

Phenols: for example, thymol (thyme), carvacrol (oregano), eugenol (clove bud)

Therapeutic effects of phenols: rubefacient, anti-infectious. *(Essential oils containing higher percentage of phenols can be irritating on the skin, but this is rarely the case with hydrosols as the percentage of phenols are low due to already being so diluted in water).*

Plants that when distilled may contain high percentages of phenols: cinnamon leaf *(Cinnamomum zeylanicum),* clove bud *(Eugenia caryophyllus),* oregano *(Origanum vulgare),* summer savoury *(Satureja hortensis),* thyme *(Thymus vulgaris).*

Aldehydes: for example, citronellal (Citronella), neral (Lemon Balm), geranial (Ginger).

Therapeutic effects of Aldehydes: possible calming properties, anti-infectious agents, *(Like the phenol group, essential oils containing high percentage of aldehydes can be skin and mucous membrane irritants. As a precaution, patch testing hydrosols first especially for those with known skin sensitivity.)*

Plants that when distilled may contain high percentages of aldehydes: lemon eucalyptus *(Eucalyptus citriodora),* lemon balm *(Melissa officinalis),* ginger *(Zingiber officinale),* lemongrass *(Cymbopogon citratus).*

Ketones: for example, menthone (Peppermint). Camphor (Rosemary) thujone (Wormwood).

Therapeutic effects of Ketones: reducing mucosal secretions, wound healing, anti-viral. *(Essential oils with a high percentages of ketones may have neurotoxic effects, the low percentage in hydrosols is unlikely to have an adverse reaction if used for external use.)*

Acids and esters: for example, linalyl acetate (lavender), isobutyl angelate (Roman chamomile), methyl salicylate (Wintergreen).

Therapeutic effects of acids and esters: antispasmodic, sedative, anti-inflammatory, analgesic.

Plants that when distilled may contain high percentages of acids and esters: clary sage *(Salvia officinalis),* lavender *(Lavandula angustifolia)* roman chamomile *(Anthemis nobilis).*

Phenyl methyl ethers: for example, methyl chavicol (basil), eugenol (clove bud), trans-anethole (sweet fennel)

Ethers have strong smells and can be detected at low percentages.

Therapeutic effects of Phenyl methyl ethers: antispasmodic, anti-infectious.

Plants that when distilled may contain high percentages of acids and esters: basil *(Ocimum basilicum),* sweet fennel *(Foeniculum vulgare),* tarragon *(Artemisia dracunculus).*

Cyclic ethers or oxides: for example, 1,8 cineole (Eucalyptus), menthofuran (Peppermint), rose oxide (Rose) and Contribute significantly to the aroma of a hydrosol.

Therapeutic effects of oxides: expectorant, anti-inflammatory.

Plants that when distilled may contain high percentages of cyclic ethers or oxides: most members of the Eucalyptus family, Rose *(Rosa damascena and Rosa centifolia),* Rosemary *(Rosemarinus officinalis),* bay *(Laurus nobilis)*

Harvesting Bay Laurel – Photo credit: Peter Rees

Kawakawa hydrosol

Some plants I harvest throughout the seasons, for example, kawakawa, (Piper excelsum) because the quality stays consistent throughout the year. In the case of kawakawa, this might be because it's not a particularly aromatic plant—meaning it doesn't produce large amounts of terpenes and other VOC. Although I have heard that the actives in the plant are stronger when the leaves have holes, a sign that the kawakawa looper caterpillar is feeding on its leaves. The damage this causes is believed to provoke the plant to produce more VOC to repel insect attack.

While kawakawa buds and flowers are not especially aromatic, they are tasty. Kawakawa relies on the wind for pollination, so the plant bears male and female flowers which are produced on separate plants. There is no need for kawakawa to waste precious resources producing abundant VOC's to attract insects or to fill flowers with nectar to attract birds in order to reproduce. Kawakawa is an example of a plant that can be successfully distilled as a hydrosol even though it doesn't yield an essential oil of significance. Despite this, kawakawa is still rich in water-soluble compounds.

Here are nine major constituents out of a total of forty identified by a GSMS report from Phytochemia from a sample of kawakawa hydrosol distilled Dec 17th 2018 in a copper alembic still.

Identification	(mg/L) ††	%	Class
Myristicin	19.1	28.07	Phenylpropanoid
Elemicin	11.6	17.04	Phenylpropanoid
1,8-Cineole	6.2	9.11	Monoterpenic ether
Linalool	3.8	5.58	Monoterpenic alcohol
Dihydroxycinnamic acid	2.5	3.67	Phenylpropanoid
2-Heptyl acetate	2.1	3.09	Aliphatic ester
Methyleugenol	1.7	2.50	Phenylpropanoid
Camphor	1.6	2.35	Monoterpenic ketone
(E)-Cinnamyl acetate	0.3	0.44	Phenylpropanoid ester

Phenylpropanoids are a large family of compounds that are produced by plants to protect against infection, ultraviolet irradiation, wounds, and herbivore attack. Myristicin is found in nutmeg *(Myristica fragrans),* Elemicin is also in nutmeg and elemi *(Canarium luzonicum)* (Stevenson, Aslam, 2006).

Myristicin and Elemicin have been linked to causing hallucinogenic reactions however, the amount present in the hydrosol would be unlikely to have that effect. Both these compounds have been noted for their insect repellent activity, anti-inflammatory action, and a digestive stimulant.

1,8 Cineole or Eucalyptol and Linalool is a relaxant, antiseptic, anti-inflammatory.

2-Heptyl acetate, an Aliphatic ester even in small amounts, contributes to aroma and flavour. It has a green fruity waxy, oily aroma profile (TGSC Information System, n.d.).

Methyleugenol, another Phenylpropanoid, has a spicy, cinnamon, clove, fresh, peppery, woody aroma profile (TGSC Information System, n.d.).

Camphor, minty phenolic herbal woody, used as an insect repellent and an antibacterial agent. It contributes to the aroma of a hydrosol (Jeon,, Park, Chung, Lee, 2014, pp. 1355-60; Wikipedia, 2020).

(E)-Cinnamyl acetate aroma is described as sweet, floral, spicy, balsam. It has insect repellent actions and is antibacterial.

How I use Kawakawa Hydrosol

Kawakawa has a delicious flavour and aroma. It makes a great alternative to alcohol. 10-15ml over ice with a slice of fresh lemon and some ginger syrup topped up with soda water is delightful. I sometimes co-distil kawakawa with chopped up fresh lemon and ginger root and this also makes a refreshing drink. 15-30ml to a litre of water works well and can be sipped throughout the day.

Combined with rosemary and nettle hydrosol, kawakawa is an excellent hair tonic, keeping the scalp healthy and hydrated. It's also fantastic combined with Kanuka or Manuka as an all-over body spray, not only hydrating and moisturising but soothing to both the skin and the mind.

Kawakawa mixed with lavender water, or just on its own, makes a soothing spray for eczema and irritated red skin. And finally, a kawakawa glycetract makes a very effective insect repellent.

Combination Hydrosols

As I've grown more confident in my distilling practice, I've learnt to play and experiment with combination hydrosols. A combination hydrosol, as the name suggests, is where more than one plant type is distilled. One of my favourite combination hydrosols is called The Green Pharmacy, inspired by Barabara Griggs, the author of *'The Green Pharmacy: The History and Evolution of Western Herbal Medicine'.*

My own green pharmacy hydrosol is made from five different botanicals, some of which are rich in VOC and some which aren't. Nettles *(Urtica dioica)* make up the bulk of the blend, with small amounts of rosemary *(Rosmarinus officinalis),* wild mint *(Mentha arvenisis),* peppermint *(Mentha piperita),* fennel leaves and flowers *(Foeniculum vulgare).*

I often use this as a base for herbal botanical cocktails and as the water phase in creams for insect bites, swellings and pain. The hydrosol can also be used as a hair tonic and a deodorant. A more thorough discussion of combo hydrosols can be found here: https://www.alembics.co.nz/the-green-pharmacy/

Chemical Analysis of Green Pharmacy combo hydrosol by GCMS - Phytochemia

I have included this analysis as it illustrates not only the class of constituents but their function and aroma/taste profile.

Identification	(mg/L) ††	% of total Volatiles	Class	Possible actions and aroma profile
Carvone	70.11	30.57	Monoterpenic ketone	Phenylpropanoid
Fenchone	27.77	12.11	Aliphatic alcohol	Phenylpropanoid
Menthol	21.83	9.52	Monoterpenic alcohol	Monoterpenic ether
1,8-Cineole	12.20	5.32	Monoterpenic ether	Monoterpenic alcohol
Borneol	10.23	4.46	Monoterpenic alcohol	Phenylpropanoid
(E)-Anethole	8.39	3.66	Phenylpropanoid	Aliphatic ester
Unknown	8.08	3.52	Unknown	Phenylpropanoid
8-Hydroxy-neo-menthol	5.92	2.58	Monoterpenic alcohol	Monoterpenic ketone
Linalool	3.97	1.73	Monoterpenic alcohol	
Thymol	3.83	1.67	Monoterpenic alcohol	
Menthone	3.18	1.39	Monoterpenic ketone	
para-Anisaldehyde	3.10	1.35	Simple phenolic	
(3Z)-Hexenol	2.90	1.26	Aliphatic alcohol	
α-Terpineol	2.84	1.24	Monoterpenic alcohol	
Terpinen-4-ol	2.46	1.07	Monoterpenic alcohol	
Verbenone	2.08	0.91	Monoterpenic ketone	Phenylpropanoid ester

Sustainable distilling practices and quality control

It takes a lot of plant material to produce hydrosol and essential oil. Essential oil sales in particular, are rising exponentially every year due to aggressive marketing by multinational organisations. These companies do not always have thorough sales training programmes in place and have been known to encourage the ingestion of essential oils. This puts the buyer and industry at risk and takes a huge toll on the aromatic plants it relies on.

Frankincense and myrrh are already endangered, and overproduction encourages monoculture which often requires the use of insecticides and other harmful chemicals. It can also promote widespread wildcrafting which can mean the plant material may not be the correct species or it is mixed with other plants. Uncontrolled and unregulated wildcrafting can alter the ecology of an area dramatically and put it at risk.

Most commercial hydrosols are the by-product of essential oil distillation using high pressure and heat. Hygiene protocols may not have been part of this process as these distillations tend to be made in large quantity batches and the quality of the distillate waters may be questionable. Good quality hydrosols are best made from freshly harvested healthy plants, in small batches, with lower heat and pressure. It's the water-soluble compounds that make hydrosol unique, and it's these we want to capture. If there is some essential oil produced alongside the distillation, that's a bonus and a by-product and should be separated from the hydrosol.

A proper hydrosol distillation should be a closed distillation, where the hydrosol does not come into contact with the outside environment. This is so it is not contaminated with dust and microbes. Ideally, all collecting vessels should be sterilised. Hydrosol distilled with good hygiene practice can last for several years, however, like all-natural products, should be made in small batches and used in a matter of months.

Regular testing of hydrosols is recommended. A basic test can be made using a water testing kit, one you would use to test a spa or rainwater tank. If you are selling them as commercial products I would recommend regular testing through a certified laboratory Assure Laboratories, for example, will test for a wide range of microbes, yeast and fungus. Good testing ensures your hygiene protocols are effective.

Summary

Hydrosols are the waters of distillation, not only the by-product of essential oil production. Hydrosol consists primarily of water and small amounts of water-soluble botanical constituents. They are usually highly aromatic and flavoursome. And although hydrosols have a long history of use, our knowledge of them remains largely experiential, gained from that which has been learnt and passed down. Some research is now being done to support the efficacy of use however, further clinical studies and trials are needed.

From my own personal experience, hydrosols are useful for skin and hair hydration and toning, oral hygiene, they make great soothing compresses, are good for odour management, cleaning, water therapy, in the water phase of emulsions, and mixed with clays for masks. Many hydrosols also make great alternatives to alcohol beverages.

Because hydrosols contain low levels of VOC and are naturally diluted in water, they are safer to use on children, the elderly and those with mental and emotional sensibilities. Finally, care should always be taken in choosing an appropriate plant to distil, understanding its identity, history of use and complying with sustainable harvesting and correct distillation practices.

In the next article, now we have the what is a hydrosol out of the way, I will focus on the how to of hydro-distillation, steam distillation and combo distillation with the view to producing high quality small batch sustainable and appropriate hydrosols and essential oils. ♣

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Further Study

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