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The mint versus Covid hypothesis

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Abstract

Recent lines of evidence suggest the intriguing hypothesis that consuming common culinary herbs of the mint family might help prevent or treat Covid. Individual citizens could easily explore the hypothesis using ordinary kitchen materials. I offer a philosophical framework to account for the puzzling lack of public health messaging about this interesting idea.

Keywords: COVID-19, Covid19, SARS-CoV-2, pandemic, coronavirus, Lamiaceae, perilla, sage, tea, caffeic acid

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Introduction

Evidence-based medicine has been defined as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients" [1]. This philosophical approach addresses the problem that human intuition is fallible, even for experienced physicians. An idealized gold standard of medical evidence might consist of large peer-reviewed randomized controlled trials (RCTs) that have been published in reputable journals and confirmed by independent investigators. Laboratory findings and observational studies (in which the health status of individuals who happen to have independently chosen different behaviors is retrospectively analyzed) can also provide useful evidence that generates testable predictions [2-4]. The television series *Dopesick* dramatizes the problems that can arise when physicians and patients assign undue evidentiary weight to the opinions of regulatory authorities and product sales representatives [5].

Evidence-based approaches are challenging in situations where the best available evidence is weak or equivocal. The infamous Tuskegee Study of Untreated Syphilis (TSUS) provides a grim illustration of the challenge. Although penicillin had become a standard treatment for primary syphilis by the 1940s, evidence of its utility for treating later stages of the disease was generally considered preliminary and inconclusive. Study organizers chose not to inform TSUS volunteers of the emerging treatment option [6]. The decision to passively allow patients to gamble with untreated syphilis rather than informing them of the newer option of gambling with unproven penicillin appears to have rested, at least in part, on the paternalistic bias that the African American study volunteers were too ignorant to make sensible medical decisions for themselves [7, 8]. A similar problem also existed in the contemporaneous society at large. It was standard practice at many major medical centers, including highly respected centers such as Stanford, to deny penicillin to all syphilis patients over age 50, based on the false assumption that the treatment would be unlikely to provide net benefit [9]. The underlying policy problem is attacked satirically in the "sit tight and assess" scene in the movie *Don't Look Up*, where political leaders decide to covertly wait for more conclusive evidence while an extinction-level comet bears down on civilization [10]. In short, discounting valid preliminary evidence can lead to the withholding of crucial information and the rationalization of "cautious" inaction that fails to avert a predictable calamity. Reliance on strictly proof-based medicine becomes particularly problematic during public health emergencies [11-13].

In situations where available medical literature doesn't support standard recommendations about how to proceed, physicians, patients, and regulators must

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resort to using inconclusive lines of evidence to generate rational "best bets" regarding the likely risks and possible benefits of various courses of action. The risks and benefits of inaction must also be weighed, but in some cases (such as syphilis infection) watchful waiting obviously isn't the best bet. In 1969, Surgeon General William Stewart asked:

> "Must we wait until we prove every link in the chain of causation? I stand firmly with Surgeon General Burney's [tobacco risk] statement of 10 years ago. In protecting health absolute proof comes late. To wait for it is to invite disaster or to prolong suffering unnecessarily." [14, 15]

Stewart and Burney were essentially echoing the public policy philosophy President Franklin Roosevelt articulated in 1932:

> "It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something. The millions who are in want will not stand by silently forever while the things to satisfy their needs are within easy reach." [16]

From a patient's perspective, the physician's goal in these challenging situations should be to help the patient understand the various unproven medical options well enough that the patient can rationally choose the course of treatment that best fits their own risk/benefit preferences.

Vaccination is a safe and effective way to prevent severe acute Covid, particularly if booster doses are employed [17]. Unfortunately, so-called "mild" Covid can still cause a wide range of serious long-term health problems, even among vaccinated individuals [18-33]. Vaccinated individuals are therefore advised to continue to protect themselves and others with high-filtration face masks [34, 35]. The antiviral therapeutic drug Paxlovid has recently become widely available, but "rebound" of the infection after completion of the standard course of treatment continues to be problematic [36]. It would be useful to have additional complementary prevention and treatment options.

Although a wide range of traditional herbal remedies have not withstood careful scrutiny in RCTs, there have been a few notable success stories. Extracts of the leaves of various wormwood species (genus *Artemisia*) have been used as remedies for malaria symptoms for thousands of years [37-39]. Natural product screening efforts and RCTs have established that artemisinin, a compound found in wormwood leaves, is a potent anti-malarial therapeutic. Commercial artemisinin derivatives used in combination with other antimalarials, such as lumefantrine, are now front-line malaria therapies.

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More recent studies have found that preparations of whole wormwood leaves might serve as reasonable low-cost anti-malarial treatments, particularly for populations who can't afford artemisinin combination therapy [40]. In clinical trials, wormwood leaf-based treatments appeared to be more effective than much higher doses of purified artemisinin products. It has also been shown that the use of whole plant preparations could help combat the emergence of artemisinin-resistant parasites because the crude mixture contains a range of additional antimalarial compounds that complement or synergize with artemisinin [41-43]. Wormwood leaf preparations, including preparations of *Artemisia* species that don't contain artemisinin, have also been shown to block SARS-CoV-2 infection at a step downstream of infectious entry in cell culture systems [44-47].

Direct consumption of whole plant products might provide an additional approach to fighting infections. It is regrettable that this testable hypothesis is routinely neglected.

The Hypothesis

Humans must eat to survive and eating certain foods is likely to confer health risks or benefits. In an abstract sense, every meal is a poorly controlled mandatory medical experiment resting on inadequate scientific evidence. In light of the literature cited below, I hypothesize that eating common culinary herbs of the mint family (Lamiaceae) might help prevent SARS-CoV-2 infection or might help attenuate existing infections. The hypothesis could be tested with low-cost decentralized RCTs. While such trials are being developed, I propose that it is reasonable for citizen scientists to consider testing the hypothesis in their home kitchens.

Evaluation of the hypothesis

The subject of natural products that might inhibit the replication of coronaviruses has recently been reviewed [48-51]. This overview focuses on findings for common culinary herbs of the mint family.

In February 2021, Jan and colleagues published a high-profile peer-reviewed laboratory study testing the ability of herbal and fungal extracts to inhibit the replication of SARS-CoV-2 in culture [52, 53]. Water extracts of the leaves (but not the roots or seeds) of all tested mint family herbs were found to inhibit SARS-CoV-2 replication at dilutions of at least 64-fold (starting from a 25 mg/ml stock). Administration of water extracts of bohe mint (*Mentha haplocalyx*, also known as Chinese peppermint or field mint) or perilla (*Perilla frutescens*, also known as shiso) to SARS-CoV-2-infected hamsters at a dose of

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200 mg/kg/day significantly reduced viral loads. The bohe mint extract appeared to be slightly more effective than the perilla extract. If scaled for average human body size, the hamster dose would be roughly the equivalent of drinking two cups of mint tea per day, where each cup is made with three standard tea bags.

The SARS-CoV-2 inhibitory effects of perilla in a cell culture model were independently reported in a peer-reviewed study by Tang and colleagues and in a preprint by Le-Trilling and colleagues [54, 55]. An important aspect of the Le-Trilling study is that it used boiling water for the extraction, suggesting that the hypothetical antiviral compound or compounds are at least somewhat stable in hot water.

Two current preprints report RCTs examining candidate Covid therapeutic preparations containing mint family herbs. Lionis and colleagues found that Covid patients given a mixture of steam-distilled essential oils from three mint family herbs (conehead thyme (*Thymus capitatus*), Greek sage (*Salvia fruticosa*), and dittany (*Origanum dictamnus*)) suffered less-severe symptoms than the control group [56]. A preprint by Faramarzi and colleagues indicates that Covid patients who ate a complex herb mixture that included the mint family herb za'atar thyme (*Zataria multiflora*) showed improved survival [57].

A more recent version of Le-Trilling and colleagues' preprint [55] suggests that principal antiviral compounds in perilla may include caffeic acid, perilla aldehyde, and perillyl alcohol. The manuscript suggests that these compounds may exert anti-SARS-CoV-2 effects through induction of cellular innate immune responses marked by heme oxygenase 1 expression.

A caffeic acid conjugate called rosmarinic acid acts as an inhibitor of the SARS-CoV-2 main protease [58]. High rosmarinic acid production is a distinctive feature of mint family herbs in the basil (Ocimeae), mint (Nepetoideae), lavender (Lavanduleae), and perilla (Elsholtzieae) subfamilies [59]. Rosmarinic acid is particularly abundant in Greek oregano (*Origanum vulgare*) and self-heal (*Prunella vulgaris*), both of which showed exceptionally high potency in Jan and colleagues' cell culture-based tests against SARS-CoV-2 [52].

Baicalein, which is found in skullcap roots (genus *Scutellaria*) and in thyme leaves (*Thymus vulgaris*) [60], shows antiviral effects against SARS-CoV-2 in a mouse challenge model [61-64]. An RCT of Shuang Huang Lian Wan, a traditional Chinese patent medicine that contains skullcap root and bohe mint, found that subjects who received the highest dose showed significantly reduced signs of Covid pneumonia [65].

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Free caffeic acid is relatively abundant in most mint family herbs. Interestingly, the antiviral potency of plants tested by Jan and colleagues in a cell culture infection model appears to at least roughly correlate with each plant's caffeic acid content (Table 1). The correlative analysis is complicated by the fact that the levels of caffeic acid and its conjugates can vary depending on which cultivar of a given plant species was used, how the plant was grown, how the leaf-drying process was conducted, how the dried leaves were stored, and how the extraction was performed and analyzed. In one example, Fletcher and colleagues found that spearmint plants (*Mentha spicata*) grown under conditions of constant heat stress showed reduced rosmarinic acid content [66]. Drying spearmint leaves at high temperature also significantly reduced their rosmarinic acid content. Similarly, reported values for the caffeic acid content of dried basil (*Ocimum basilicum*) have puzzlingly been reported as low [67, 68], moderate [69, 70], or high [71]. Jyotshna and colleagues found that the caffeic acid content of dried basil products depends on how the leaves were processed, with shed-drying being more effective for preserving caffeic acid than other methods [72]. Kwee and Niemeyer, who tested flash-frozen basil leaves, report that the caffeic acid content of different basil cultivars varied across a 20-fold range [73]. For instance, the Gecofure cultivar was found to have 770 µg of caffeic acid per gram of leaf material while the Spice cultivar had only 40 µg/g. If caffeic acid is a principal antiviral agent (or an effective proxy for antiviral activity) then Gecofure should have greater antiviral potency than Spice. This would be reminiscent of the situation for sweet wormwood (*Artemisia annua*) and African wormwood (*Artemisia afra*), which contain high or low amounts of artemisinin, respectively [44-46].

If closely related plants with different amounts of antiviral activity could be identified, it would open the possibility of a low-cost decentralized RCT in which volunteers could be randomized for receiving seed packets representing one or the other cultivar with instructions for growing plants. A third trial arm could be sent filler material instead of seeds. Participants in the seed arms would be instructed to eat home-grown plants *ad libidum* while maintaining the plants at a level that would enable them to eat a handful of fresh leaves each day for a week if a member of the household happens to test positive for Covid. Covid infection rates, as well as the duration and intensity of symptoms, could be reported using a smartphone app. The results would likely be noisy due to variables such as differing plant growth conditions or variable subject compliance, but given the very low cost of the intervention this problem could likely be addressed by sending seeds to a large number of volunteers. A caveat for the simplified seed-distribution approach is that volunteers might be able to unblind themselves by guessing whether they received the more or less potent cultivar. However, this was technically also an issue with Covid vaccine trials because volunteers could theoretically have gotten an

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on-demand commercial Spike serology test that would have revealed which arm of the trial they were in.

Since free peer-to-peer sharing of plant seeds has been common practice for thousands of years, it is hard to imagine how mint versus Covid discoveries could be monetized. RCTs would thus need to be administered by the public sector or by nonprofit organizations. The NIH ACTIV program is an example of a potentially suitable public-private partnership.

It might also be interesting to test the antiviral potency of yerba mate (*Ilex paraguariensis*), yaupon (*Ilex vomitoria*), and black chokeberry (*Aronia melanocarpa*), which have been reported to contain higher levels of caffeic acid than typical mint family herbs [66, 74-76]. Black chokeberry juice was found to inhibit SARS-CoV-2 in a cell culture infectivity assay [77]. Although sunflower seeds contain more moderate levels of caffeic acid, they could enjoyably be eaten in higher amounts than chokeberries or herbs.

Some mint family herbs contain compounds that may be hazardous when consumed at high doses [78, 79]. It is always wise to consult a licensed healthcare provider before making significant dietary changes. This is particularly true for individuals with food allergies, patients on drugs that might interact with herbal foods, and individuals who are pregnant or nursing.

Consequences of the hypothesis and discussion

The current lack of public health messaging about the possible antiviral value of mint family culinary herbs seems to fit a broader pattern of authorities passively waiting for the accumulation of conclusive proof before addressing an unfolding crisis. During the summer of 2022, Americans under age 50 were denied a second booster dose because some authorities felt the available evidence didn't conclusively prove the boost was necessary [80]. A different way of looking at the question would be to note that available evidence also didn't conclusively prove the booster dose was *not* necessary. Indeed, valid preliminary evidence clearly suggested that the second booster dose realistically *might* provide substantial net benefit. History teaches us that, in situations such as this, the safest overall approach may be to openly inform people of scientific uncertainties and then allow them to exercise the basic civil right of making medical decisions for themselves [13].

Early-pandemic guidance recommending the use of cloth face masks appears to be another example of the sit tight and assess fallacy. A 2015 RCT conducted by

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MacIntyre and colleagues provided preliminary evidence that medical masks with a melt-blown inner layer can effectively reduce the risk of respiratory infections in a healthcare setting [81]. Surprisingly, the trial also found that the use of cloth masks slightly increased rates of respiratory infection. More recent RCTs have confirmed that cloth masks conclusively fail to prevent SARS-CoV-2 transmission in a community setting [35, 82]. MacIntyre and colleagues' 2015 inference that "the results caution against the use of cloth masks" seems to have been ignored because authorities concluded that there was insufficient proof that SARS-CoV-2 is transmitted via cloth-permeable aerosols [83]. With hindsight, it would have been better to advise citizens of valid preliminary evidence suggesting it *might* be better to use medical masks or high-filtration respirators while waiting for more definitive proof addressing the question of aerosol transmission.

Mint family herbs are pleasant foods that are inexpensive, widely available, easy to prepare, nutritious, and generally recognized as safe at levels routinely consumed by humans for thousands of years. In my opinion, it would be reasonable for public health agencies to highlight valid preliminary evidence suggesting mint realistically *might* offer medical benefits that could complement proven interventions such as high filtration masks, vaccination, and Paxlovid. Just as there is no guarantee that second booster doses will work, there is no guarantee that mint tea will work. The point is that valid preliminary evidence indicates booster doses and mint tea have a fundamentally better risk/benefit profile than now-disproven approaches such as cloth masks and ivermectin [82, 84].

The pandemic has presented tremendous challenges for public health messaging - with disinformation, conspiracy theories, and wishful thinking obscuring crucial guidance. Although political leaders worldwide have vowed to "follow the science," this often seems to mean withholding recommendations until conclusive peer-reviewed RCTs have been independently confirmed by multiple groups and regulatory bureaucracies have issued final consensus opinions. In other words, modern public health policy tends to focus on the more confident final stages of the scientific method while failing to recognize that the earlier stages of the scientific method are designed to address intellectual *un*certainty. Pandemic policymaking seems to have lost the proactive spirit of Roosevelt, Burney, and Stewart. When conclusive best-practices are uncertain, following the science should not mean mandatory inaction - it should mean we use scientific evidence to formulate valid hypotheses and then proceed to experimental testing of our best bets.

Observational surveys could be used to search for correlations between consumption of mint family herbs (or other foods) and Covid risk [85, 86]. If mint consumption were

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found to correlate with resistance to infection, it would raise the interesting hypothesis that early humans who were attracted to the taste of mint family herbs might have enjoyed a modest evolutionary fitness advantage. This, in turn, might have enabled plant cultivars with especially high antiviral content to benefit from being widely distributed by humans [87].

In the longer run, it would be interesting to confirm the identities of candidate antiviral compounds in common foods, understand their mode of action both alone and in concert, file patents, subject purified pharmaceutical-grade products to large independently replicated peer-reviewed RCTs, and obtain regulatory authorizations for commercial products. In the meantime, mint family herbs are delicious.

Appendix: Recipe Development

The purpose of this Appendix is to report my individual efforts to translate available mint versus Covid literature into simple and enjoyable culinary approaches that might promote volunteer compliance in RCTs. I explored a wide range of fresh and dried herb combinations, both out of Epicurean interest and based on a desire to implement the general nutrition theory that eating a varied diet is healthy.

Throughout the pandemic I have carefully followed public health guidance on vaccination, testing, distancing, and masking. The hypothesis I am exploring is that mint might serve as an additional complementary measure that could further help me fend off Covid. Clinical trials of Paxlovid (and reasoning from general principles) suggest that entirely preventing SARS-CoV-2 infection may be more difficult than blunting the infection after a person has tested positive. At the same time, experience with SARS-CoV-2-neutralizing monoclonal antibodies supports the intuitively obvious concept that therapeutic agents are generally more effective for blunting an infection if taken early. In other words, even if a therapeutic doesn't fully prevent infection there might still be benefit in having the therapeutic onboard prior to testing positive for Covid infection. With these thoughts in mind, I explored ways to expand my routine day-to-day consumption of mint family herbs.

Loose-leaf single-herb domestic tea products were preferred, when available, in hopes that appearance and flavor could be used to guard against counterfeiting and adulteration [88-90]. I also reoriented a longstanding container-gardening hobby to focus more heavily on mint family herbs.

Recipe 1: Hot tea. A key early advance in the discovery of artemisinin was the realization that the antimalarial activity of wormwood leaves is degraded by boiling

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water [39]. Although Le-Trilling and colleagues showed that the anti-SARS-CoV-2 activity in mint family herbs persists in boiling water [55], it remains conceivable that some fraction of the hypothetical antiviral compounds in mint family herbs might be destroyed by high temperature. On the other hand, there could theoretically be antiviral compounds that are extracted more efficiently in boiling water. To address this dilemma, I perform a double extraction. Ten to 15 g (3-4 heaping tablespoons) of loose-leaf mint family tea products are placed in a French press (Frieling) and stirred together with a few hundred ml (1½ cups) of room temperature water for a few minutes. I then press the leaves and drink the extract. The drained leaves are re-extracted with several hundred ml of near-boiling water for >10 minutes. An infuser basket (OXO) also offers a convenient way to perform double-extractions.

Daily teas employ a rotating variety of fresh or dried herbs listed in Table 1. Staple products include bohe mint (Ouyang Hengzhi or Plum Flower), peppermint (Harts of America), spearmint (Harts of America) and thyme (Anthony's). Although perilla (Prince Herb) makes a somewhat strange-tasting single-herb tea, it contributes useful background complexity to mixed-herb teas. I enjoy small amounts of fresh oregano, rosemary, and sage in savory dishes, but I find teas made from the dried herbs unappealing. I'm also cognizant of the risk of consuming too much thujone, which is abundant in sage [78]. Self-heal flower spikes were as potent as oregano in Jan and colleagues' cell culture-based infectivity model (Table 1)[52]. In contrast to oregano, dried self-heal flower spikes (Plum Flower) make a mild-flavored tea that blends well with other herbs.

For many years, I have enjoyed a five cup per day coffee habit. During the Omicron waves, I adopted the new habit of substituting two or three daily cups of coffee with one or two batches of mixed-herb tea. For the substitute cups, I sometimes supplement the mint family mixture with yerba mate (Cruz de Malta), with the goal of adding both caffeine and caffeic acid. Yaupon, which is closely related to yerba mate, is also a good complement for the flavors of herb teas. Harts of America Super Antioxidant Green Tea (yaupon, spearmint) and Lost Pines Light Roast Yaupon are current favorites.

When I learn that a friend or family member has tested positive for SARS-CoV-2, I first recommend that they attempt to obtain Paxlovid [13] and then I send them a gift of mint tea. Celestial Seasonings Mint Magic (spearmint, peppermint, chickory, cinnamon, and orange peel) and Pukka Three Mint (peppermint, spearmint, field mint) ship quickly and make enjoyable teas. On the gift label, I advise the Covid-positive loved one to consider drinking two cups of mint tea a day, making each cup with four tea bags. I express the hope that they will enjoy mint tea as a hypothetical complement to proven Paxlovid therapy.

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Recipe 2: Iced Tea. Drinking a daily glass of strong iced tea is a convenient way to achieve a >200 mg/kg/day intake of mint family herbs. Approximately 50 g (1⅔ cups) of loose-leaf mint family herb tea products are mixed with roughly half a liter (one pint) of room-temperature water for about an hour. The cool-water extract is poured into a pitcher using a funnel fitted with a mesh strainer and the retained leaves are re-steeped in half a liter of near-boiling water for about an hour. The cooled hot-water extract is then strained and combined with the initial cool-water extract. An optional 25 g of honey (1 tablespoon) or 40 g (scant ¼ cup) of table sugar per liter of iced tea balances herbal bitterness without being overly sweet. Excellent iced teas can be produced with the same herb combinations used for hot tea.

Recipe 3: Fresh Herbs. For many years, I have been in the routine habit of enhancing daily salads with a small handful (5-10 g) of fresh herbs. Mint family herbs that are easy to grow and have enjoyable flavor profiles include – roughly in descending order of my personal preference for eating by the handful – basil, spearmint, peppermint, Vietnamese balm, perilla, sacred basil, lemon balm, Moldavian dragonhead, tulsi basil, self-heal, hyssop, oregano, rosemary, sage, and American skullcap (Table 1).

At times when I suspect my household might have been exposed to SARS-CoV-2, I serve mixed-herb pesto over pasta or beans [91]. Traditional pesto recipes call for breaking open plant cell walls using a mortar and pestle. Some modern recipes instead call for pre-softening plant cell walls by briefly blanching the herbs in boiling water prior to chopping in a food processor [92]. To avoid the possibility of losing hypothetical antiviral compounds to the blanching water [72] I instead freeze the herbs [93] just prior to chopping in a food processor.

Recipe 4: Other Foods. Although fresh self-heal leaves aren't particularly flavorful, they have excellent tender texture reminiscent of Bibb lettuce.

Perilla is sometimes used in ice creams, sorbets, and cocktails. A simple syrup made with red perilla powder (Prince Herb) develops an attractive red-plum color when acidified with lemon juice. The flavor of perilla cocktail syrup marries well with the herbal profiles of Lamiaceae-infused liquors, including vermouth (Lustau), absinthe (Tenth Ward), Chartreuse, and yerba mate soda (Materva).

All sampled brands of za'atar, which contains the mint family herb *Zataria multiflora*, are palatable sprinkled on bread, salad, or yogurt. Although nigella (*Nigella sativa*) is not a member of the mint family, its seeds have been preliminarily reported to have possible

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anti-Covid effects in an RCT [94, 95]. Nigella seeds are suitable for all culinary applications where one might use sesame seeds.

Dried black chokeberries (Powbab) are a pleasant food either eaten whole or as an adjunct to mixed-herb teas. Sunflower seeds are a convenient snack food and make a pleasant substitute for pine nuts in pesto.

Vitae

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Data Availability

No data are associated with this article.

Author Contributions

The author is solely responsible for all contents of this manuscript. The presented opinions reflect the individual views of the author as a private citizen.

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Common name	Species	Inhibitory dilution	Caffeic acid	Growth	Taste	Citations
Anise hyssop	*Agastache foeniculum*	nt	80	++	++	[96, 97]
Black chokeberry	*Aronia melanocarpa**	nt (>30)	1500	nt	+	[77, 98, 99]
Sweet wormwood	*Artemisia annua**	≥128 (~125)	150	++	++	[41, 45-47]
Cinnamon (twig)	*Cinnamomum cassia**	320	400	nt	++	[100]
Cuban oregano	*Coleus amboinicus*	64	640	+	++	[101]
Dragonhead	*Dracocephalum moldavica*	nt	75	++	++	[102]
Vietnamese balm	*Elsholtzia ciliata*	nt	50	+++	++	[103]
Sunflower (seed)	*Helianthus annuus**	nt	80	nt	++	[99, 104]
Fish mint	*Houttuynia cordata**	320	10	++	+	[105]
Hyssop	*Hyssopus officinalis*	nt	80	++	++	[97, 106]
Yerba mate	*Ilex paraguariensis**	nt	1500	nt	+	[74, 107]
Yaupon	*Ilex vomitoria**	nt	1500	nt	++	[108]
Lavender (flower)	*Lavandula angustifolia*	nt	150	++	+	[109, 110]
Lemon balm	*Melissa officinalis*	nt	300	++	++	[97, 111, 112]
Wild mint	*Mentha canadensis*	nt	<50	++	+	[113]
Bohe mint	*Mentha haplocalyx*	480	600	+	++	[114]
Spearmint	*Mentha spicata*	nt	200	++	++	[67, 97, 99, 112]
Peppermint	*Mentha x piperita*	nt	800	++	++	[115, 116]
Wild bergamot	*Monarda fistulosa*	nt	600	-	nt	[97]
Horsemint	*Monarda punctata*	nt	150	-	++	[97]
Japanese catnip	*Nepeta tenuifolia*	640	nt	nt	nt	
Catmint	*Nepeta x faassenii*	nt	250	++	+	[97]
Nigella seeds	*Nigella sativa**	nt	3000	-	+	[117, 118]
African blue basil	*O. kilimandscharicum × basilicum*	nt	nt	+++	++	
Lemon basil	*Ocimum x africanum*	nt	~100	+	++	[72]
Basil	*Ocimum basilicum*	64	~100	++	++	[72, 110]
Tulsi basil	*Ocimum gratissimum*	nt	<10	++	++	[70]
Sacred basil	*Ocimum tenuiflorum*	nt	~150	+++	++	[72]
Dittany	*Origanum dictamnus*	nt	600	+	+	[119]
Oregano	*Origanum vulgare*	960	2000	++	+	[99, 120]
Perilla (seed)	*Perilla frutescens*	<4	20	nt	nt	[121]
Perilla	*Perilla frutescens*	640 (~100)	300	+++	+	[122, 123]
Patchouli	*Pogostemon cablin*	64	nt	nt	-	
Self-heal (flower)	*Prunella vulgaris*	960	1800	++	++	[112]
Mountain mint	*Pycanthemum virginianum*	nt	nt	+	++	
Pineapple sage	*Salvia elegans*	nt	1500	++	+	[124]
Greek sage	*Salvia fruticosa*	nt	1700	nt	+	[125]
Chia (seed)	*Salvia hispanica*	≥128	60	nt	-	[126]
Red sage (root)	*Salvia miltiorrhiza*	<4	nt	nt	nt	
Sage	*Salvia officinalis*	nt (~100)	500	++	+	[67, 99, 110, 112, 124]
Rosemary	*Salvia rosmarinus*	≥128	100	++	++	[67, 99, 110, 112]
Baical skullcap (root)	*Scutellaria baicalensis*	32	nt	+	+	
Barbat skullcap	*Scutellaria barbata*	≥128	nt	+	+	[97]
American skullcap	*Scutellaria lateriflora*	nt	nt	++	+	
Conehead thyme	*Thymus capitatus*	nt	800	-	nt	[127]
Thyme	*Thymus vulgaris*	nt (~100)	300	+	++	[55, 67, 99, 112]
Coltsfoot (flower)	*Tussilago farfara**	480	2000	nt	nt	[128]
Za'atar thyme	*Zataria multiflora*	nt	nt	+	++	

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Table 1: Key characteristics of botanical products of interest. Entries refer to the leaves of the plant, unless otherwise indicated. Non-Lamiaciae species are marked with asterisks. The “Inhibitory dilution” column indicates the most dilute SARS-CoV-2-inhibitory dose (in fold dilution starting from a 25 mg/ml extract) reported Jan and colleagues' cell culture testing [52]. The abbreviation "nt" indicates not tested. In some instances, the rough equivalent inhibitory dilution observed in other studies is given in parentheses. The “Caffeic acid” column lists the rough average concentration of unconjugated caffeic acid (in micrograms per gram of dry plant material) reported in the cited references. The value should not be considered a comprehensive average of all available publications, but merely an aggregate based on references that seemed most salient in Google Scholar searches. The “Growth” column lists the vigor of plant growth in a pesticide-free drip-irrigated back-deck amateur container garden in Bethesda, Maryland, USA. The “Taste” column indicates the author's individual opinion about the culinary appeal of each plant product.