



Why cook with bay leaves?

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ABSTRACT

Bay (*laurel nobilis* L.) is a popular culinary herb in many parts of the world. It has been suggested that the addition of bay leaves to a dish during (prolonged) cooking delivers a pungent (some would say strong) combination of pine, clove (spicy), floral (lavender), and eucalyptus notes. Often, chefs say that bay leaves add depth to a dish and that something is missing if the leaves are left out, thus suggesting that it may act as a kind of 'flavour enhancer'. At the same time, however, other commentators, including a number of chefs and spice experts question what, if anything, bay leaves add to a dish, suggesting that it has no taste/flavour whatsoever. Chefs and recipes also appear divided on the question of whether fresh or dry leaves impart a better, or more intense, flavour. Drying and storage conditions, as well as age, terroir, and seasonal effects (i.e., where, and at what time of year, the leaves were picked) all contribute to the volatile essential oils associated with this ubiquitous herb/spice. Adding to the confusion, in North America, California bay leaf (*Umbellularia californica*) is often used in place of the European variety (*Laurus nobilis* L.) despite having a distinct aroma/flavour profile. Any one of these factors may help to explain the marked differences concerning the perceived culinary value of bay in cooking. The point remains, however, that despite being a ubiquitous culinary herb, bay appears to divide popular opinion more than seemingly any other herb/spice.

1. Introduction

Bay (*laurel nobilis*) is a popular culinary herb (though sometimes it is referred to as a spice; Blank and Mattes, 1990; Raman et al., 2017). Historically, it has had both symbolic properties¹ as well as putative medicinal qualities (e.g., Batool et al., 2020; Parthasarathy et al., 2008). The essential oil of bay laurel is also widely used in the cosmetics and perfume industry in soaps, perfumes, as well as some dental products (e.g., Alejo-Armijo et al., 2017; Batool et al., 2020; Nigam et al., 1992). The plant originated from the Southern Mediterranean, and is native to most countries bordering the Mediterranean (John, 1857, pp 5–6; von Raab-Straube, 2018). Laurel, or bay laurel, sometimes also known as Roman laurel or daphne (Dobrosłavić et al., 2022), is now also found in the subtropics and tropics of Eastern Asia, South, Central, and North America, the Balkans, and Asia Minor (Batool et al., 2020; Singletary, 2021), that is, in temperate warm regions (Pino et al., 1993). Bay leaf is frequently used in Indian cuisine (Desai, 2023), and the evergreen perennial laurel is also used as an ornamental plant (Raviv et al., 1983).

1.1. Medicinal uses of bay

It is not only the leaf of the bay tree that is used medicinally (e.g., Batool et al., 2020; Lobstein et al., 2017; Patrakar et al., 2012; Ross, 2001; Sumono and Wulan, 2008), but also the bark, trunk, branches, flowers, berries, and the seeds that they contain (e.g., Bozan and Karakaplan, 2007; Fiorini et al., 1997; Nigam et al., 1958), though the chemical composition of the essential oil tends to differ depending on the part of the plant used. However, as for the majority of herbs and spices, convincing scientific evidence of the medicinal properties of the various parts of the bay tree awaits further, proper randomized-controlled studies. Nevertheless the preliminary evidence that has been published to date would appear to support a variety of medicinal uses (Batool et al., 2020; Kumar et al., 2000). Bay leaves have well-established antibacterial, anti-microbial, anti-oxidant, anti-inflammatory, and even analgesic properties (e.g., Basak and Candan, 2013; Biondi et al., 1993; Derwich et al., 2009; Nabila et al., 2022; Sayyah et al., 2003; Yilmaz et al., 2013). Furthermore, bay leaves contain cineole (sometimes referred to as eucalyptol), which is described

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¹ Laurel leaves and branchlets were made into fragrant crowns to be bestowed upon heroes on festive occasions in the ancient world (e.g., Beeton, 1861, p. 512; McGee, 1984/2004, p. 408; Skrubis, 1982), hence the term 'laureate' (Desai, 2023). In ancient times, laurel trees were planted near houses because they were thought to prevent lightning strikes (Singletary, 2021).

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as having both a fresh and penetrating sensory quality (McGee, 1984/2004, p. 392), and may act as a natural cockroach repellent (Verma and Meloan, 1981; see also Mediouni Ben Jemaa, Tersim, Toudert et al., 2012; Rovner and Rovner, 1982; though, in certain cases, the California bay may be a better insecticide; see Tabanca et al., 2013).

1.2. On the origins and varieties of bay

Bay (laurel) leaves, sometimes referred to as ‘sweet bay’, come from an evergreen tree or shrub that is native to the Mediterranean (*Laurus nobilis* L.). It belongs to the Lauraceae family (Skrubis, 1982), which comprises numerous aromatic and medicinal plants (Fiorini et al., 1997).² The genus *Laurus* Bay has somewhere in the region of 2500 species (Basak and Candan, 2013; Batool et al., 2020), though two species are traditionally found: *Laurus azorica* (native to the Azores) and *L. nobilis* (Batool et al., 2020). At the same time, however, there are also number of plants outside the genus *Laurus* with the common name bay laurel, including bay rum tree, or simply bay (*Pimenta racemosa*; Akgül et al., 1989). Indeed, there is a danger of poisoning with amateurs sometimes confusing the leaves of the bay laurel with those of the cherry laurel (*Prunus laurocerasus* L.), which is poisonous though looks visually quite similar (Malaspina et al., 2022) (see Table 1).³

According to Singletary (2021, p. 202): “The true bay leaf is not to be confused with similarly named substitutes such as Indian bay leaf (*Litsea glaucescens*), West Indian bay leaf (*Pimenta racemosa*), Indonesian bay leaf (*Syzygium polyanthum*), and California bay leaf (*Umbellularia californica*). These others plants do not exhibit the same odour and flavour profile as the genuine bay leaf and, in some cases, may have undesirable adverse effects when consumed (see Gooderham et al., 2020).” Contrary to Singletary’s suggestion, though, the Indian bay leaf is actually *Cinnamomum tamala*, the leaf of the cassia tree (see Aftab et al., 2000; Dighe et al., 2005; Raman et al., 2017) while *Litsea glaucescens* Kunth refers to the Mexican bay leaf (Flores-Gallegos et al., 2022; Tucker et al., 1992). Other members of the Lauraceae family include sassafras, Mexican avocado, cassia, and cinnamon (McGee, 2020).

2. Culinary usage of laurel

Harold McGee (1984/2004, p. 408) describes laurel as one of the most useful of European herbs, noting how the leaves are a standard ingredient in many savoury dishes.⁴ In fact, according to Skrubis (1982), more than 250,000 kg of dried leaves (sweet bay) were marketed as a flavouring material in culinary preparations such as soups, fish, and ragouts. Bay leaves are used in sauces, stuffings, pickles, condiments and confectionary as well; They are also used in teas, oils, cheeses, and liquors (Batool et al., 2020). While their culinary usage has likely increased in the four decades since the latter article was published, getting exact figures for the culinary use of bay leaf is difficult to come by given how many people grow their own, no wonder given that North

Americans apparently pay as much as \$10 (£8) for between 10 and 15 leaves (see Desai, 2023).

2.1. Laurel’s use in Mediterranean cuisine

According to Stefanaki and van Andel (2021), bay laurel has long been used to flavour meat and vegetable stews in Mediterranean countries such as Greece and Cyprus (*stiphado*), Croatia (*pašticada*), France (*coq au vin*), Spain, and Syria. Meanwhile, in Crete, it is used in traditional stews of rabbit, hare, and wild goat. Although a typical flavouring for stews, laurel is also a popular culinary herb in Spain, where it is added to sausages, snails, fish, and seafood. In Lebanon, it is added to soups, fish, and seafood dishes. In Italy, fresh or dried leaves are added to meat dishes, pasta, and fish and also in soups, or boiled with chestnuts in one of the country’s traditional dishes. In Turkey, laurel leaves are to be found in grilled fish and fish stews. Laurel is also used as a flavouring for the French goat cheese *chevre* (Millo and Todorovska, 2014) and in dried fig-based traditional pastries in both Croatia and the Greek islands. Herb mixes that include laurel are also widely used in a culinary setting (Batool et al., 2020; Stefanaki and van Andel, 2021). For example, a *bouquet garni* would traditionally have consisted of fresh laurel leaves, parsley, and thyme sprigs tied together in a bundle in French cuisine. Meanwhile, in Catalonia, such a bundle of herbs with savoury, thyme, and wild oregano tied in laurel leaves is called a *farcellet*. In the Mediterranean, therefore, different herbs and plants such as basil, laurel, bay, peppermint, rosemary, and sage are often used to increase the taste and flavour of food.

2.2. Bay leaf’s culinary use in English-speaking countries

Bay leaves have long been used in British cooking, where the herb was traditionally used in savoury dishes. In the Medieval period, dishes for the wealthy would have been heavily spiced (Bober, 2001; Spencer, 2003). Bay leaf also appears as an ingredient in traditional recipes for pound cake made using milk, sugar, butter, eggs, flour, and baking powder with bay leaves (Batool et al., 2020); Kitchiner (1817) includes bay in a recipe for a sweet *Newmarket Pudding* and in his recipe for boiled custards, while Soyer (1849) includes bay in a number of sweet milky puddings. By contrast, however, bay leaves were apparently not much used in old German recipes according to Klug et al. (2021). Nevertheless, in the contemporary era, bay leaf is mostly considered as a savoury herb (e.g., in contrast to sweet spices such as clove or cinnamon), despite it being called ‘sweet bay’ (Batool et al., 2020).⁵ Research from Blank and Mattes (1990) confirms that North Americans do not consider dried bay leaf to be ‘sweet’ either – unlike, say, vanilla, which is widely, and perhaps universally, considered to smell sweet (see Spence, 2022). Old Bay Seasoning, a popular in North-Eastern US spice mix, also incorporates the herb (Conaboy, 2016).

A quick search for the herb in influential early English cookbooks that were famous in centuries gone by, reveals frequent mention of bay leaves in the recipes that appear in Kitchiner (1817; 27 mentions), Alexis (Soyer, 1846), 102 mentions), Mrs. Beeton (1861, 89 mentions), and in Hazlitt (1902, 2 mentions). At the same time however, Elizabeth David (1955, p. 5) in her *Summer Cooking* is noticeably cautious when introducing the British public to the benefits of adding a bay leaf when preparing a béchamel sauce, seemingly implying that bay leaf may not have been in widespread use in Britain after the war. In the contemporary era, it is just one of the herbs that has seen an uptake in sales

² Batool et al. (2020) suggest, albeit without providing any empirical support for the claim, that bay leaf may have originated in South Asia, where they suggest it spread to Asia Minor and thereafter all over the world. They also suggest, once again without providing support, that it has probably been used for 1000 years. However, evidence of bay trees being a feature of kitchen gardens in Pompeii dates their cultivation, and presumably use, back at least 2000 years (see Baker, 2018). What is more, a recipe for porridge flavored with bay and honey appears in Cato’s *On Agriculture*, which was written in 160 BC (see Banducci, 2018).

³ Beeton (1861, p. 180) seemingly gets these two confused, writing at one point that: “It ought to be known, that there are two kinds of bay-trees,—the Classic laurel, whose leaves are comparatively harmless, and the Cherry-laurel, which is the one whose leaves are employed in cookery. They have a kernel-like flavour,” (see also Beeton, 1861, p. 512).

⁴ As such, it is somewhat surprising that bay leaf doesn’t get its own entry in Segnit’s (2010) compendious volume *The flavour thesaurus*.

⁵ It is unclear why an herb that is commonly acknowledged to taste bitter should have been described as ‘sweet’.

amongst the British public since lockdown, up by 7% since 2018 (Davies, 2023). However, while bay is a popular herb in Mediterranean and British cuisine, the bay leaf does not appear in the cuisines of East Asia.⁶ The herb's widespread usage in both Mediterranean as well as British cuisine obviously begs the question of what it is doing there?

3. What purpose do bay leaves serve in cooking?

Does the addition of bay leaf provide a rich sources of nutrients? Does it have antimicrobial properties that may have been important in the days prior to widespread food refrigeration? Or, is its contemporary widespread usage attributable primarily to its taste/flavour qualities, perhaps making those foods to which it is added somehow more delicious (Dunn and Sanchez, 2021). Or could it be that the traditional inclusion of bay leaves in a dish no longer has any purpose? According to one influential suggestion, the reason why herbs and spices are used in cuisine is because of their antimicrobial properties. Support for this proposal originally came from the observation of a correlation between a country's mean annual temperature and the average number of spices in recipes, as well as from the observation that meat recipes tend to contain more spices than vegetarian dishes (given the higher risk associated with meat-based dishes; see also Ohtsubo, 2009). Unfortunately, however this explanation, in terms of Darwinian gastronomy (Sherman and Billing, 1999; Sherman and Flaxman, 2001; Sherman and Hash, 2001), has recently been discredited (Bromham et al., 2021; Zhu et al., 2013). In fact, it turns out that there are a range of more plausible alternate explanations for such correlational data (at least once the influence of relatedness, proximity and co-variation are removed). According to Bromham and colleagues' analysis of a global dataset of 33,750 recipes from 70 cuisines containing 93 different spices, the variation in spice use are not consistent with an infection-mitigation mechanism, but are instead part of a broader association between spice, health, and poverty.⁷

Appreciation for this herb during the course of human development may be facilitated by the fact that the dominant volatile chemical 1,8-cineole is transferred to the breast milk, if consumed by the mother (Kirsch et al., 2012; Kirsch and Buettner, 2013; cf. Spence, submitted). It can also been detected on the breath of those who have consumed such substances (Beauchamp et al., 2010). That said, more common sources for this monoterpene, include other herbs and spices such as basil, rosemary, sage, cardamom, ginger, and peppermint (Kirsch and Buettner, 2013), several of which may be left in a dish and hence consumed in a presumably more concentrated form than that imparted by bay.

3.1. On the taste and nutritional composition of bay leaves

According to Batool et al. (2020, p. 66), bay leaves have "a bitter and pungent taste", and provide a source of vitamin A as well as a number of other minerals. Bay leaf has trace amounts of fats so it has low caloric value. One ounce of bay leaves provides 54 calories, 1–1.2 g protein, 12–13 g carbohydrates, a trace of fat, 1–1.5 mg of iron (Fe), 51–53 mg of calcium (Ca), 2000–3000 IU of vitamin A, 14–15 mg of vitamin C, and a

⁶ It is, though, worth noting how many of the same flavour notes (volatile organic compounds) can also be found in cassia and cinnamon trees which are all part of the same family, Lauraceae (see McGee, 2020, pp. 196–198). One might wonder, therefore, whether the same culinary effect is achieved by means of the addition of a different herb/spice.

⁷ Reviewing the literature in this area, it is also worth noting how what counts as a herb/spice appears to vary from one study to another (see Spence, 2021), and not all antimicrobial ingredients are necessarily considered as spices (consider vinegar in this regard; Ohtsubo, 2009). What is more, if the antimicrobial account were to be correct it should presumably be the total antimicrobial potential of the spices used in a recipe rather than necessarily their variety that would be the most relevant variable.

small amount of potassium. According to Batool and colleagues, compounds such as eugenol (11%–12%), methyl eugenol (9%–12%, described as having a clove-like aroma), and elemicin (1%–12%) are significant contributors to the spicy aroma of bay leaves. However, while bay leaves may well contain small amounts of vitamin C (Singletary, 2021), they are presumably unlikely to provide a meaningful dietary source of such nutrients, given that the leaves are added during cooking and then removed (i.e., they are not consumed directly). Hence, there would seem to be little nutritional benefit to their addition during the cooking process.⁸

One might instead wonder whether the ubiquity of bay leaves in European cuisine is attributable to the 'deliciousness' they add to a dish (Dunn and Sanchez, 2021), probably through the release of essential oils held within the leaves during the cooking process. But how long do they need to be cooked to obtain the best volatile aroma profile? At the same time, however, it should be noted that their contribution to the flavour of the dishes to which they are added has itself been questioned (Conaboy, 2016; Desai, 2023). As Conaboy puts it, "What does a bay leaf taste like? Nothing. What does a bay leaf smell like? Nothing." One key question here is how long bay leaves need to be left in a dish as it cooks in order to impart their distinctive flavour. According to Cook's Illustrated, 5 min could well be enough (Bay Leaves 101, n.d.), though others have suggested (without evident empirical support) that they need to be left in a dish while it cooks for at least an hour. In fact, the chefs quizzed in an article by Conaboy (2016) also reveal a variety of opinions concerning whether fresh versus dried leaves are better (in terms of the flavour they can impart to a dish), how long they retain their flavour during storage, and how long they need to be left in a dish (Conaboy, 2016; see also Desai, 2023). According to one spice expert quoted in Desai (2023), "A good-quality dried herb will keeps its flavour for 18 months to 2 years" (quoted in Desai, 2023).

4. Why cook with bay leaves?

The question of bay's use in contemporary cuisine was recently brought to the fore by an article that appeared in *The Daily Mail* where a chef questioned whether their use was a waste of time (Desai, 2023; see also Williams, 2023). The article itself was titled: "Are bay leaves a scam and a vast conspiracy? Increasing number of chefs say they do NOTHING to food - experts reveal truth behind tasteless green leaves." In it, celebrity chef Ina Garten (the Barefoot Contessa) admitted that she didn't "know if they actually do anything" (though she also admitted that she had never bothered to find out either). Meanwhile, in the same article, Ethené de Vince a tea and spice merchant from Montreal was quoted as saying: "Now people are starting to wake up. It's just so neutral and bland. It's just a waste of money." (quoted in Desai, 2023). The question posed by the *Daily Mail Online* was picked-up a few days later in *The Times* (Moran, 2023).

Part of the difficulty here concerns the different profiles of the different varieties, or countries from which the leaves are sourced, that are consumed (see Raman et al., 2017), the potential influence of terroir (Chmit et al., 2018; Dhifi et al., 2018; Fidan et al., 2019; Marzouki et al., 2009; Pino et al., 1993), or area of cultivation (Ozcan and Chalchat, 2005), differences in whether fresh or dry leaves are used (often this is not specified in recipes; and many chefs would appear to have strong views, one way or the other; see Conaboy, 2016), the amount of time that has passed since the leaves were picked, and even the stage in the

⁸ Indeed, there is no history of the wide use of autumn leaves, or even leaf material of wild trees to support human nutrition in Europe. The few examples that exist in the literature are mainly from tropical areas such as Africa (Nohynek, 2017, p. 16).

Table 1

Various members of the Lauraceae family. Other members include sassafras, Mexican avocado, cassia, and cinnamon. See text for further details.

Bay laurel, also known as Roman laurel or daphne	<i>Laurus nobilis</i> L.	Native to the Mediterranean, but now widespread in temperate warm zones
California bay leaf, also known as the headache tree	<i>Umbellularia californica</i>	Found in California & Oregon
Cherry laurel	<i>Prunus laurocerasus</i> L.	Poisonous plant, though visually-similar to bay laurel
Indian bay leaf, also known as	<i>Cinnamomum tamala</i> (Ham.) Nees & Eberm	The leaf of the cassia tree; Has an aroma and flavour more similar to cinnamon
Indian cassia or Malabar leaf		
Mexican bay leaf	<i>Litsea glaucescens</i> Kunth	
West Indian bay leaf	<i>Pimenta racemosa</i>	Highly fragrant and aromatic
Indonesian bay leaf or daun salam	<i>Syzygium polyanthum</i>	

growing season when they were picked (Riaz et al., 1989).⁹ Under the hot and dry conditions that tend to characterize Mediterranean summers, aromatic plants such as bay produce larger quantities of essential oils, the chemical substances that are responsible for the plants' characteristic aroma and flavour (Stefanaki and van Andel, 2021). As such, laurel leaves that have been sourced from wetter and cooler climates, such as the United Kingdom early in the year, are unlikely to have anything like the same sensory qualities as their Mediterranean counterparts picked at the end of a long dry hot summer.

While similar problems likely also apply when it comes to assessing the chemical composition of many other herbs, bay would seem relatively unique, both in being such a ubiquitous addition to savoury dishes in European cuisine and elsewhere, but also because of the uncertainty, at least amongst commentators, about what it actually contributes to the flavour of the food to which it is added (Desai, 2023). The suggestion that a culinary herb such as bay leaf might be tasteless (Desai, 2023; see also Conaboy, 2016), contrasts markedly with the public's typical response to other herbs/spices that are increasingly incorporated into our food, such as garlic (Spence, submitted), chilli (Spence, 2018), or cilantro/coriander leaf (McGee, 2010; Spence, 2017). Díaz-Maroto et al. (2002, p. 4520) describe dried bay leaves as having 'a strong, spicy aroma', while Moran (2023) suggests that it is a highly aromatic herb. Some have questioned whether this dispute between those who claim that bay is pungent and those who say it is tasteless might simply reflect the fact that different people have different kinds of bay leaf in their spice racks (Raman et al., 2017).

4.1. The storage of bay leaves and its impact on taste/flavour

Online sources appear to provide conflicting evidence about bay concerning not only about whether adding the leaves to a dish while cooking is a waste of time (Desai, 2023; Goss, 2020), whether dry or fresh leaves deliver a better flavour (Conaboy, 2016), and exactly what impact the drying method has on the volatiles expressed by bay leaves (Díaz-Maroto et al., 2002). The medium-sized, tough, dry leaves accumulate oils in spherical glands in the leaf's interior (McGee, 1984/2004, p. 397). It has been suggested that bay leaves constitute one of the few herbs that contain aromatics that persist after drying (see Kekelidze et al., 1965). Air drying in the shade is considered by some

commentators to be best (Pruidze and Konsarum, 1965).¹⁰ However, according to Batool et al. (2020), chilling the leaves may be better than drying them. This is because drying reduces moisture content it may also lead to some loss of volatiles (Pruidze and Konsarum, 1965). The essential oils in leaves vary from 0.8% to 3% (Batool et al., 2020).¹¹

It has been suggested, though without obvious evidential support, that dry leaves are less bitter than fresh. According to Batool et al. (2020, p. 66): 'Better and deeper flavour is observed in freshly dried leaves.' According to Díaz-Maroto et al. (2002), air-drying, or oven drying at a temperature of 45 °C, resulted in hardly any loss in volatiles as compared to the fresh herb. That being said, their analysis revealed a 45% reduction in terpinyl acetate (which smells of lemon or lavender) and a 60% increase in eugenol (described as having a spicy, clove-like scent), which, with its spiced aroma might, they suggest, have an impact on sensory perception.

Cook's Illustrated performed some informal tests on dried bay leaves from a freshly-opened container, and compared the results with those obtained from a container of dried leaves that had been opened for three months (though kept stored in their original sealed jar during that time), as well as with bay leaves that had been sealed in a food storage bag and kept in the freezer for three months. A couple of bay leaves from each batch were simmered in two mugs of chicken broth and then tasted for potency. The broth made with the freshly-opened leaves tasted much more herbal than the broth simmered with the older leaves. However, contrary to expectations, the frozen leaves apparently "put out great, assertive bay flavour and aroma that was nearly as strong as the leaves from the freshly opened jar" (Bay Leaves 101, n.d). It is, however, unclear whether the tasters were blinded to the culinary condition of the bay leaves used in each preparation (i.e., fresh, old, or frozen). While such results are not scientifically rigorous, it is worth noting that this is close to the only empirical evidence that exists on the matter currently (see Table 1).

4.2. What do chefs say about bay leaves?

Conaboy (2016) quizzed a number of chefs about what they thought cooking with bay leaves added to a dish. The quotes in Table 2 highlight what several chefs have to say about the culinary use of bay leaf. It is worth noting how several of these descriptions make it sound that what bay adds is much like what is said of other flavour enhancers such as kokumi (Maga and Yamaguchi, 1983; Maruyama et al., 2012). Indeed, one might also wonder whether the compounds in bay leaf act as a kind of 'flavour enhancer' (Díaz-Maroto et al., 2002, p. 4520; Marion et al., 1994) or 'flavour modulator' (see Maga and Yamaguchi, 1983).¹²

What is interesting in the online discussion about bay leaves is the division between those chefs/herb and spice experts who love the powerful aroma (saying things like "bay leaves have a lot of flavour, they are quite strong", Desai, 2023), and those who think its addition to foods is nothing more than an expensive waste of time. One might wonder whether this difference reflects a selective anosmia in the former case (see Blakeslee, 1935) or perhaps is merely a question of the quality, sourcing, and storage of the bay leaves themselves (as suggested by some

⁹ The latter researchers extracted the oil from *L. nobilis*, leaves collected in March, July, September and November. Oil yield was lowest (0.13%) in March, and highest in September (0.36%).

¹⁰ According to Harold McGee (1984/2004), microwave the leaves is also a good, if rather unconventional way of drying them.

¹¹ Another relevant issue here, of course, concerns how the anti-microbial function of herbs, such as bay leaf (*Laurus nobilis* L.), are affected by drying. Should there be a significant difference, then this would lead to further predictions about their use in recipes. Research from Algabri et al. (2018) have shown that ground dried bay leaf may offer significant antibacterial, and antioxidant activity.

¹² Relevant to this notion, one herb specialist described how thyme "is essential to every kitchen because of its abilities to enhance combinations of herbs" (Hooker, 1971, p. 21). Concerning bay leaf, in particular, Batool et al. (2020, p. 69) write how "It is easily blended with many other herbs such as garlic, mustard, pepper, parsley, rosemary, thyme, and oregano."

Table 2
A selection of chef's opinions concerning the benefits of cooking with bay leaf (taken from Awl, 2016).

Chef	Opinion about bay leaf
Emily Elsen Sohui Kim	"They add an earthy, bitter note that is distinct." "It is a potent form of aromatic ... undetectable to eye or even to the taste buds but packs a real je ne sais quoi, umami punch. In long slow cooking forms, I firmly believe in the power of the bay leaf."
Joey Baldino	"They give a depth of flavor that you can't get with any other herbs especially in fish dishes ... I use bay leaves in almost everything I cook."
Rich Landau	"They are irreplaceable in stocks as they lend a deeper, savory, herbal element that fresh herbs don't. When simmered in a tomato sauce they have a bright green citrusy note that lightens everything up and adds dimension."
Matthew D'Ambrosio	"Bay leaves are a great under-utilized spice."
Ryan Angulo	"They have a fairly strong flavor so too many in a stock or sauce can really be overpowering and disgusting, like brewing strong tea. One or two add something subtle that you might not be able to pick when they are in a recipe but might be the ingredient that makes you think 'something's missing' when omitted."
Rachael Polhill	"As a flavour in their own right I think it's amazing. It's truly unique not spicy, but fragrant almost floral and has great versatility for sweet and savory applications."
Claire Welle	Their addition: "can help highlight base flavours."

of those quizzed by Desai, 2023). However, should it be the latter then one would surely have expected people to notice the highly variable quality of the leaves, whereas instead it feels when people talk about it that there are typically talking about what feel like individual differences in people's perceptual appreciation of this culinary herb. Intriguingly, however, a third (33%) of the 85 participants tested by Pelosi and Pisanelli (1981) turned out to be selectively anosmic to 1, 8-cineole (this the essential oil with by far the highest concentration in bay leaves, having a camphor smell), with detection thresholds 60 times higher than others.

5. Chemical composition of essential oil of laurel leaves

Chomatographic analysis has revealed the presence of a variety of compounds such as 1,8-cineole, d-limonene, camphene, α -pinene, geraniol, methyl eugenol, linalool, and eugenyl acetate in bay leaf (*Laurus nobilis* L.; Skrubis, 1982) (see Table 3). Other volatile components that have sometimes been also detected in the oil extracted from the fresh bay leaves include: sabinene, myrcene, β -pinene, α - and β -phellandrene, p-cymene, and α -terpineol (e.g., Basak and Candan, 2013; Fiorini et al., 1997; Kekelidze et al., 1965; Kumar et al., 2000; Parthasarathy et al., 2008; Peris and Blázquez, 2015; Pruidze and Konsarum, 1965). Using simultaneous distillation extraction, Díaz-Maroto et al. (2002) isolated 22 distinct volatile compounds in fresh bay leaf extracts: α -thujene;

Table 3
Some of the key volatile compounds identified in bay leaves, and their percentages according to the results of a study by Batool et al. (2020). Note that exact composition likely depends on a wide range of factors (see text for details). Caputo et al. (2017) identified more than 50 volatiles in bay leaf.

Volatile	Sensory description
1,8-cineole (also known as eucalyptol)	Fresh penetrating camphor-like odour; A large portion of population are selectively anosmic to this volatile (Pelosi and Pisanelli, 1981)
α -pinene	Coniferous, herbaceous, grassy scent
β -pinene	Woody-green pine-like smell
Sabinene	Warm, oily-peppery, woody-herbaceous and spicy odour
Eugenol	Powerful, warm-spicy, rather dry and almost sharp odour
Methyl eugenol	Clove-like aroma
Elemicin	Spicy aroma
Estragole	Licorice and phenolic odour
Linalool	Floral, citric, fresh and sweet

α -pinene; camphene; sabinene; $\hat{\alpha}$ -pinene; 1,8-cineole; γ -terpinene; *trans*-thujan-4-ol; α -terpinolene; linalool; terpinen-4-ol; α -terpineol; nerol; *trans*-geraniol; linalool acetate; borneol acetate; eugenol; terpinyl acetate; methyl eugenol; elemicin (which has a spicy odour); spathulenol; β -eudesmol. Meanwhile, using a somewhat different technique, Caputo et al. (2017) isolated the presence of more than 50 volatile compounds from bay leaves. However, only a subset of these volatile compounds that had been identified are likely to contribute to the aroma of bay (cf. Dunkel et al., 2014). Furthermore, different volatiles that may, in principle, be perceptible, will typically have very different detection thresholds (Spence et al., 2017). Additionally, they will likely be present in markedly different and varying proportions (for the reasons mentioned above), and also to the flavour. One other complication is that how these different volatile compounds smell may differ as a function of whether they are sniffed in isolation, or experienced in the complex mixture of volatile compounds that are present in bay leaves.

It is important to remember that both drying and the particular extraction procedure used can result in the emergence of new compounds that may not be present in the fresh leaves. 1,8-cineole is typically the dominant essential oil that is found in bay leaves (Derwich et al., 2009), accounting for somewhere between 30 and 56% of the composition of essential oil (Díaz-Maroto et al., 2002). McGee (1984/2004) describes this particular volatile compound as having a fresh pungent character. Meanwhile, using GC/GC-MS, Basak and Candan (2013) analysed the essential oil of *Laurus nobilis* L. leaves (collected in June in Istanbul, Turkey) revealing the three main components to be 1,8-cineole (68.8%), 1-(s)- α -pinene (6.9%), and R-(+)-limonene (3.0%). Using GC and GC-MS, Caputo et al. (2017) found main compounds in the leaves of *L. nobilis*, collected in Southern Italy, to be 1,8-Cineole (31.9%), sabinene (12.2%), and linalool (10.2%) of the total essential oil.¹³

Pino et al. (1993) assessed the chemical composition of essential oil of laurel leaves from Albania, France, Italy, and Spain using gas-liquid chromatography, column chromatography, and GC/MS, and found 1, 8-Cineole to be dominant component accounting for 26.7%, 43.5%, 38.1% and 43.0%. The percentage of monoterpene hydrocarbons (α -pinene, sabinene, and β -pinene) was lowest in the Albanian sample (19.8%) and highest in the Italian sample (32.6%). Pinene smells of pine or Christmas trees, while sabinene has a warm, oily-peppery, woody-herbaceous and spicy odour (and is one of the compounds that contributes to the spiciness of black pepper). Linalool smells floral, citric, fresh and sweet (d'Acampora Zellner, Casilli, Dugo, Dugo and Mondello, 2007; Elsharif et al., 2015).

5.1. What contribution does the addition of bay leaf have on the taste/flavour of a dish?

In the best case, what exactly does the addition of bay leaf to a dish while cooking add? According to Harold McGee (1984/2004, p. 390, p. 408), bay leaves have a well-rounded mixture of woody/pine, floral, eucalyptus, and clove notes. Coucquyt, Lahousse, and Langenbick (2020 p. 282) suggest that dried bay leaf has fruity, citrus, floral, herbal, roasted, woody, and spicy notes. Meanwhile, they describe European bay leaf as having notes of fruity, citrus, green, herbal, vegetal, woody, and spicy (Coucquyt et al., 2020, p. 243). Batool et al. (2020) suggest that bay leaves have a peppery odour and a clove-like taste. According to Singletary (2021, p. 202): "The aroma of bay leaf is described as woody herbal similar to that of oregano and thyme. When crushed, a scent of menthol and eucalyptus is evident, and its flavour is considered astringent and bitter." According to Desai (2023), bay leaves carry a mix of eucalyptus, pine, lavender, and woody notes.

¹³ Other components were α -terpinyl acetate (5.9%), α -pinene (5.8%), α -terpineol (3.3%), methyl-eugenol (3.3%), neoiso-isopulegol (2.5%), eugenol (1.6%), β -pinene (1.4%), and γ -terpinene (1.0%).

5.2. European vs. Californian bay

According to McGee (2020, pp. 196–198), the California bay (*Umbellularia californica*), which is found in Northern California and Oregon, is a distant relative geographically and aromatically of the European bay laurel (*Laurus nobilis*). It is much less versatile because its leaves and bark are usually dominated by the harsh pungent/cooling terpinoid umbellulone (Tabanca et al., 2013). Indeed, it is known as the ‘headache tree’, because the inhalation of its vapours can sometimes give rise to severe headaches. The headache-inducing properties of *Umbellularia californica* is thought to be attributable to the monoterpene ketone umbellulone, which stimulates the TRPA1 channel which then activates the trigeminovascular system (Nassini et al., 2012). McGee (1984/2004) also suggests that the presence of sabinene (giving a fresh note) and eugenol (described as penetrating) is more noticeable in the California bay. Californian bay has a greater concentration of estragole (Chartier, 2012; McGee, 2020), which delivers a sharper cooling note to dishes, than bay laurel. According to Cook’s Illustrated, California bay leaves have a potent, eucalyptus-like flavour, whereas Turkish bay (presumably bay laurel) leaves have a tea-like, mildly menthol flavour profile (Bay Leaves 101, n.d.).¹⁴

According to François Chartier, bay leaves contain a cold-tasting molecule estragole, which is also found in apples, star anise, green basil, cinnamon, cloves, tarragon, ginger, fennel seeds mustard, sage and black licorice extract (Chartier, 2012). McGee (1984/2004, p. 392) suggests that estragole has an anise-like note and is only found in European bay. This cold-tasting volatile compound provides a refreshing quality to food and drink. Chartier (2012, p. 187) writes that: “These molecules activate the taste receptors for temperature between 46 °F and 82 °F (about 8 °C–28 °C), and so simulate cold.” Estragole presumably stimulate the trigeminal receptors (Viana, 2011; see also Simons et al., 2019),¹⁵ though it should be noted that there would appear to be some confusion between taste and smell in Chartier’s description (with the former normally being associated with sapid molecules while the latter is associated with volatile molecules instead).¹⁶

5.3. Informal assessment of the effect on flavour of cooking with different bay leaves

According to Cook’s Illustrated, California bay leaves have a potent, eucalyptus-like flavour, whereas Turkish bay leaves have a tea-like, mildly menthol flavour profile (Bay Leaves 101, n.d.). To get a closer read on what each of these different leaves bring to a dish, they conducted a couple of informal assessments. In one, they make a pair of *béchamel* sauces—one with what they describe as Turkish bay leaves (presumably *laurel nobilis* L.) and one with California bay leaves. The sauce made with the California bay leaf was described as tasting “medicinal” and “potent,” by the tasters, and “like something you’d put in a cough drop.” By contrast, the other sauce was described as having a “mild, green, and slightly clove-like” taste, and as being “far superior in nuance and flavor.”

¹⁴ Although less frequently studied, the West Indian variety of bay is said, at least by its admirers, to be especially aromatic with additional notes of cinnamon and clove (Desai, 2023). Meanwhile, Coucquyt et al. (2020, p. 274) suggest that Indian bay leaf imparts a ‘green’ note.

¹⁵ The participants in Jones, Roberts and Holman’s (1978) study of odour similarity rated the smell of *Laurineae Umbellularia* as perceptually similar to mint.

¹⁶ Note here only how compounds such as menthol have a minty aroma, a possibly bitter taste, as well as delivering a cooling sensation (Nagata et al., 2005), thus stimulating all three of the chemical senses simultaneously.

6. Summary

Bay leaves have long been used in a wide range of savoury dishes (Stefanaki and van Andel, 2021). However, despite its ubiquity in savoury recipes (McGee, 1984/2004), its presence in many recipes has been questioned by those who consider it to be a tasteless herb (Desai, 2023; Conaboy, 2016; Goss, 2020). Under the appropriate conditions, bay leaf can add a spicy note to the dishes to which it is added. While the type of bay (e.g., European vs. Californian) is rarely specified in recipes; even in food science research; e.g., Blank and Mattes, 1990), even within *laurus nobilis* L., many different factors influence how aromatic the leaves are. At the same time, different cooking protocols will likely result in leaves having a somewhat different flavour profile, as will the use of dry or fresh leaves. At the same time, however, the selective anosmia to 1,8-cineol, the principal volatile in the essential oil of the bay leaf, exhibited by a third of the participants tested by Pelosi and Pisanelli (1981) is likely also an important factor in explaining the differing views that people have about the value of adding bay leaves to cooking.

In the literature, currently, there is a notable absence of data concerning how the essential oil profile are lost during storage, and the temporal profile of their transfer to the dish (depending on the specific cooking protocol/medium) as well as the presumable loss of essential oils to the atmosphere during prolonged cooking. What is noticeable about many of the chefs’ opinions is how it adds ‘depth’, which is often a descriptor that one finds people use in the context of other flavour-enhancers. However, should that be the case, then suggestions that bay’s influence should be assessed simply by boiling the leaves in water and tasting the result – as when Conaboy (2016), writes: “People say, “Boil a bay leaf in some water and then taste the water if you want to know what a bay leaf tastes like.”” – would not necessarily work. What is more, one would really need a proposed mechanism to help explain any such flavour-enhancing function should it be demonstrated to exist. Bear in mind here though that fats tend to provide a much more effective vehicle for the absorption of volatile aroma in food and drink (Pollan, 2013), and there is relevant research concerning the development of flavour in stocks as they are reduced (Snitkjaer et al., 2010).

6.1. Future development of bay leaves in dietary habits

Should future well-controlled scientific research be conducted in order to more formally assess the chemical and perceptual consequences of cooking with bay leaves, then chefs may be able to make better use of this currently ubiquitous herb in their cooking, and thereby transmit their insights concerning the use of this flavoursome and beneficial herb in people’s dietary habits more generally. One particular direction for health-related future research involves the use of aromatic herbs/spices as a means of reducing the salt content of foods, while preserving a desirable flavour profile. Other researchers, have recently been investigating the potential use of flavored sea salts as a strategy to reduce daily salt intake (Dougkas et al., 2019; Ghawi et al., 2014; Rosa et al., 2022a,b). At the same time, however, the marked variations in volatile profile of commercial bay leaves (which, as has been shown, depends on a wide range of factors), together with the widespread selective anosmia to the key volatile in bay leaves (1,8-cineole; Pelosi and Pisanelli, 1981) means that convincing consumers/chefs to integrate this aromatic herb into their cuisine may be more challenging than is likely to be the case for many other herbs.

Implications for gastronomy

Bay is a popular culinary herb in many parts of the world. According to its proponents, the addition of bay leaves to a dish during (prolonged) cooking delivers a pungent (some say strong) combination of pine, clove (spicy), floral (lavender), and eucalyptus notes. Many chefs believe that bay leaves add depth to the flavour of a dish and that something is missing if the leaves are left out, possibly hinting at its role as a ‘flavour

enhancer'. At the same time, however, others claim that bay have no taste/flavour at all. Chefs and recipes are divided on the question of whether fresh or dry leaves should be used, and which are 'better' (i.e., more flavourful). Food chemistry research suggests that drying and storage conditions, as well as age, terroir, and seasonal effects (i.e., where, and at what time of year, the leaves were picked) contribute to the flavour imparted by this ubiquitous herb/spice. In North America, California bay leaf (*Umbellularia californica*) is often used in place of the European variety (*Laurus nobilis* L.) though it has a distinct aroma/flavour profile. Any one of these factors may help to explain such marked differences of opinion as to the consequences, and hence value, of adding bay leaves while cooking. The striking difference in opinion concerning the culinary value (i.e., whether it adds to/enhances the flavour or not) of a ubiquitous herb such as bay is both surprising, and seemingly unique amongst the commonly-used herbs and spices.

Declaration of competing interest

The author confirms that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. The manuscript has been read and approved by all named authors and there are no other persons who satisfied the criteria for authorship but are not listed. I understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office).

Data availability

No data was used for the research described in the article.

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