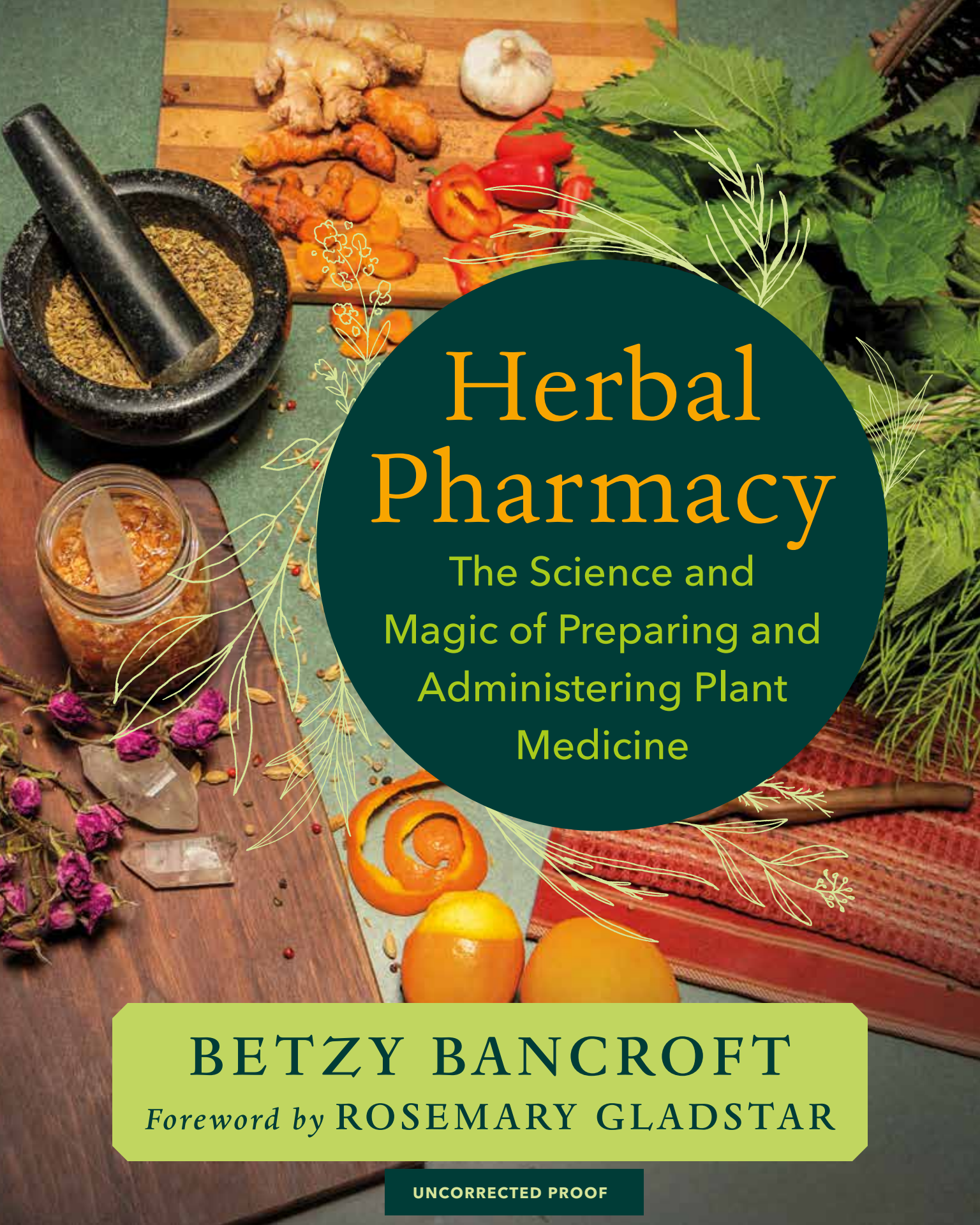

Herbal Pharmacy

The Science and Magic of Preparing and Administering Plant Medicine

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Foreword by ROSEMARY GLADSTAR

PART 1

Preparing Plant Medicines

CHAPTER 1

Principles of Extraction

Preparing remedies from plants is a common and sacred act. Herbal medicine is still used by most people on Earth, whether as traditional primary health care, a complement to modern technological medicine, or something between. Consuming them can be as simple as soaking a tea bag in a cup of hot water and drinking the brew, or taking the recommended dose of bottled tinctures or capsules. To me, one of the things that makes herbal medicine unique is that plants are living beings. This means we can observe their physical properties such as their chemistry as well as their spirit and vitality. Both science and magic are relevant, and if you as an herbalist gravitate toward one of these two fields, I invite you to explore the other, as well. When we make our own herbal medicines, we can incorporate all the factors that are important to our needs and the needs of our loved ones, community members, clients, and patients. Whether someone's illness is spiritual or biochemical (or both!) in origin, well-made herbal medicine can address those roots. (Pun very much intended.)

Another key principle separates herbal medicine from pharmaceutical medicine: herbalists trust that all the constituents in a plant are important and provide useful synergy. Herbalists do not desire to extract only one or a small range of constituents. The reductionist approach of extracting individual

components typically leads to more side effects, or unwanted or unintended effects, because the safety provided by natural synergy in the plant is gone.

In addition to medicine, plants and mushrooms (which often get lumped together when we discuss medicinal herbs) provide delicious flavors that enhance our food and drinks, pigments to dye fiber, and fragrances and other qualities that give us pleasure. Many of the preparations we make with herbs involve extracting the flavors, chemistry, and essence of plants into liquids such as water, alcohol, vinegar, and oil. (Table A.1, "Preparation Methods for Common Medicinal Herbs" on page 273 summarizes the ways that common medicinal herbs, from ashwagandha to yarrow, can be prepared.)

I am often asked whether an herb can be tinctured or whether it is useful to extract an herb in dried form versus fresh. While herbalists certainly have preferences based on their experience, in general both are viable methods—we just need some understanding of the plant and its medicinal actions in order to prepare a useful remedy. Most plant constituents can be extracted into most liquids. There are, however, situations where no extraction will take place. For example, a lump of pine resin will not extract into water because there are no water-soluble constituents in pine resin. To start with, we must ask: What are we trying to create, or what are we trying to extract? Flavor, medicinal constituents, nutrients, magical essence, pigment—any or all of these may be relevant to the herbal remedy, culinary recipe, or craft project that we have in mind. More information about herbal actions and formulations is available in chapter 10, and chapter 11 provides observations about dosage and administration, that together will help you clarify what medicine will fit your needs.

I recommend that you document all your experiments in a medicine-making journal, whether it's a physical notebook or electronic file. That way, you will have the information needed to replicate a successful remedy or troubleshoot a problem. Ultimately, journal entries become batch records, which are important for both practitioners and entrepreneurs to keep.

Science of Extraction

Whether we're preparing teas, oxymels, tinctures, or plant dye baths for fiber, we must consider several key factors in the process of diffusing plant constituents into liquids. These factors include the amount of surface area of the plant matter, the amount or kind of energy applied to the process, the optimal amount of time for extraction to take place, the proportion of herb to liquid, and the chemical compatibility of the constituents and the liquid. Paying attention to these factors facilitates the extraction process, which includes ensuring the plant material is broken down enough to release its constituents and taking steps to facilitate the mingling of herb and liquid. These factors become variables or decision points in creating the extract we desire.

To begin with, let's consider what diffusion is and what it has to do with herbal medicine. The word *diffusion* comes to us from the Latin word "to spread out," and it refers to the general tendency of things to move from a concentrated environment to an area of less concentration. In terms of herb leaves, stems, roots, or other plant parts immersed in liquids, constituents (molecules of flavor, medicine, and so forth) move out of the plant tissue and into the liquid. At first, the solvent seeps into the plant matrix. (Alcohol and hot liquids have the greatest ability to penetrate plant cell walls and tissues.) The plant constituents then diffuse into the solvent and out of the plant matrix (the physical structure of the plant). At this stage, it is an *extract*, with all the soluble constituents diffused into the liquid.[1] *Solvent* may sound like some kind of toxic industrial substance, but for our purposes it is simply the liquid into which we extract herbs. The word *menstruum* is typically used to describe the solvent liquid (combination of water and alcohol) that tinctures are made with.

Surface Area

The structure of animal cells and plant cells are both similar and different. Animal cells are like water balloons suspended on a tree-like skeleton, whereas plant cells are like water balloons inside cardboard boxes. The membrane of a plant cell is encased in a fibrous cell wall made of cellulose, strengthened with lignan. I tend to describe a plant stem like a group of tall piles of cardboard boxes reinforced with cable-like fibers. You can see the fibers when you peel stalks of plants such as broccoli or burdock. Those cell walls tend to hold in a plant's juice, flavor, and constituents, and our aim when making herbal extractions is to draw those juices and constituents out of the plant matrix and into the menstruum. A key way to do that is to increase the amount of surface area exposed to the solvent. And a common way to increase surface area of plant material is by chopping it up.

Some herbalists never chop up the herbs when they make tinctures or infusions. (I myself prefer not to chop up rose petals because they are so lovely.) The choice depends on what you are trying to extract! If your aim is to capture a subtle or magical essence, like a flower essence, you may choose not to cut up your herb at all. An example is a whole ginseng root in a bottle of moonshine.

However, if you want to extract as much of the flavor and medicine from the plant as possible, breaking down those cell walls really does help. When leaves and flowers are dried and rehydrated, as when brewing a tea, the cell walls break naturally. But with fresh plants and woody plant parts—roots, barks, and seeds—preparing the material is important. You can test the effectiveness of increasing surface area by preparing two batches of extract using the same amounts of herbs and the same solvent liquid. Chop one batch of the herbs, but *don't chop* the other. Allow both batches to sit for the same amount of time in the same conditions. Press or strain out the herbs the same way. Then evaluate the finished extracts. I predict that the extract from herbs you chopped up will be more potent, because they have extracted more of the plants' gifts.

Further evidence that breaking up plant material is important comes from multiple studies on extraction. References such as *Remington's Practice of Pharmacy* similarly assert that the "process of *maceration* . . . consists simply in soaking the properly comminuted drug or substance in the menstruum until it is thoroughly penetrated and the soluble portions softened and dissolved."[2] *Comminuted* means "reduced to minute particles." A 2020 study from the journal *Molecules* found that "the results obtained . . . showed a higher efficiency for extraction from juniper berries in 70% ethanol if the pericarp was disrupted in comparison to that achieved with the maceration of intact berries."[3] Have I convinced you to chop up your herbs?

Some herbalists prefer to just chop herbs roughly, but my experience is that more surface area is typically a good thing. Grind, blend, or process your herbs until they are broken down to a reasonably small size. It isn't typically necessary to reduce herbs to a powder or puree to achieve good extraction. You may have a particular need for powder sometimes, for example, if you want to make an instant beverage powder that will dissolve easily into water. Surface area is worth experimenting with, and if herbs are clumping up too much or getting through your strainer and creating too much sediment, then perhaps chop or grind them less finely.

Many methods and tools work well to break the cell walls and increase the surface area of plants. For dried herbs especially, an old-fashioned mortar and pestle can be an effective tool. Stone or ceramic mortars are available in sizes ranging from very small to fairly large and heavy. Grinding herbs with a mortar and pestle takes some getting used to. It requires a bit of effort and can be slow, but the work is satisfying and rather meditative. Electric coffee grinders or spice mills work well and quickly but are often noisy. Be careful to unplug the grinder before removing the ground herb. The flavor of coffee will never go away

Figure 1.1. If you prefer not to use a food processor, you can chop fresh roots, like these dandelion roots, fairly finely with a sharp knife to expose plenty of surface area.

from a grinder, so if you've ever used your grinder for grinding coffee, you'll need a separate one for herbs only. I have one grinder that I use for both coffee beans and bitter herb roots like chicory, and a second grinder for other herbs. Larger grinders are available, which are basically blenders or food processors with dry-grind attachments. These are darn handy when making a big batch of something. You may want a machine or attachment for grinding dried foods and denser parts of herbs (seeds, roots, barks, and whole hawthorn berries), and another one for smoothies and other wet preparations that use fresh herbs.

No matter what kind of grinder you use, I encourage you to grind a small amount at a time, because a blender or grinder filled with plant material takes longer to process and thus heats up more. We want the herbs to be ground up as quickly as possible, without heating up, which could cause them to lose aromatic constituents that have medicinal qualities. A best practice is to grind multiple smaller batches quickly and thoroughly.

The simplest way to increase surface area with any fresh herb is to chop it with a sharp chef's knife on a sturdy cutting board. I encourage you to chop up fresh herbs as soon as they are clean, particularly roots. I'll discuss more about processing freshly harvested roots in "Postharvest Processing" on page 37. Even if you are going to use a food processor or blender to puree fresh herbs, do chop them up before placing them in the machine. If you don't, stems will tend to wind around the blade, or chunks of roots will not break down well. Chopping

well before blending also helps the process go faster and avoids the risk of overheating the herbs.

Many kinds of blenders and food processors are available, including combination units in a wide variety of features, prices, and so forth. Kitchen stores and online suppliers offer a variety of models, and perfectly functional older blenders with glass pitchers or cups can often be found at yard sales.

When you go out on a gathering expedition in the field, bring along a cutting board, chopping knife, and container of menstruum so you can chop gathered herbs on the spot and put them into your menstruum. Then you can puree them more when you're back at home if you choose to.

Energy

With respect to making herbal remedies, energy takes different forms, especially heat, motion (also called kinetic energy), and time. Herbalists often use energy to increase diffusion. Both warmth and agitation cause molecules to move more rapidly, knocking constituents out of the plant cells so they can diffuse more freely into a liquid. We can use energy to achieve a more complete extraction, to customize which constituents we extract according to our needs, and sometimes to help plant constituents extract into solvents they aren't exactly "like," such as comfrey into oil. Some of the recent technology used in industrial plant extractions—microwave and ultrasonic technology are examples—essentially vibrate the plant material to increase extraction.

Heat

Heat is a key variable, because the nature of heat is to alter the speed of things. In chapters of this book that cover specific extraction methods, in some cases I present both a cold/slow method and a hot/fast method. The latter speeds up extraction time and efficacy, resulting in a more complete extraction. Everything moves more slowly when it's cold, so without heat the process of diffusion happens more gradually. Since heat can change medicinal constituents, however, we may choose to use a cold method to preserve them. Consider what constituents are important to your remedy and what temperature will extract and preserve them best.

Take, for example, the medicinal herb comfrey. The mucilaginous constituents of comfrey are primarily water soluble, but herbalists like to make salves for application to skin and mucous membranes using comfrey, which involves extracting these water-soluble constituents into an oil. Warming the oil encourages the mucilage of comfrey to diffuse into the oil even though they are not chemically "like" each other. Although there can be downsides to adding heat, this is a case where adding heat is necessary. Overheating, however, can increase dispersal of small aromatic molecules such as terpenes so they fly away in steam or vapors rather than stay in your herbal product. Too much heat can overcook the herbs, changing their flavor and possibly the chemical nature of their constituents. And beware! Heating alcohol is dangerous because it's flammable and explosive.

Kinetic Energy

Shaking or stirring the liquid solvent into which we are extracting herbs introduces kinetic energy. This is another handy way to use energy to improve the potency of remedies. I love the phrase "shake and pray, every day," shared at a workshop years ago, because it's a good reminder to attend on a daily basis to both our macerations (herbs steeping in various liquids) and our good intentions for the recipients of those medicines. When we steep herbs, the maceration process will progress faster if we wiggle the teabag, upend the jar, give the container a thorough shake, or stir up any herbs that have settled to the bottom so they are dispersed into the liquid again. The beneficial effect of kinetic energy is why some commercial herbal product makers put their batch containers on a roller or other device that agitates the contents. It results in a more concentrated extraction.

In most cases, when we macerate herbs, the liquid should cover the plant material so that it doesn't mold, oxidize, dry out, or otherwise go bad. If we commit to shake or stir every single day, or better yet more than once daily, we can maximize the quantity of herbal constituents that will "fit" into the liquid.

Time

How can time be a form of energy? Because it allows constituents greater opportunity to complete the journey out of plant structures into the menstruum. Some plant constituents are small molecules that can diffuse or extract quickly. Thus, we can steep an aromatic herb like chamomile for just 5 minutes and end up with a useful cup of tea for soothing a bellyache. Other constituents, such as immune-supportive polysaccharides or tannins, take longer because they are much larger molecules that exit plant or mushroom cells more slowly. Generally speaking, longer time will facilitate more extraction taking place, but only to a point. In other words, a mushroom decoction simmered for 6 hours will likely be more potent than one simmered only 1 hour, but a tincture macerated for 1 year *won't* be more potent than one steeped for 1 month.

Resources on herbal medicine making vary in their recommendations for how long to macerate various types of extracts, from 2 weeks to 6 weeks or more, with a general guideline being a month or moon cycle. It's a broad guideline, and it's helpful to remember that you can intentionally speed up the rate of extraction by employing the principles of increasing surface area and adding energy. When we employ these principles, extractions in alcohol, in particular, happen rapidly, and tinctures need only 2 weeks of maceration.

To extract herbs into viscous liquids such as glycerin or honey, or a menstruum such as vinegar that has somewhat less extracting power, without adding heat, we may need to macerate the extract for a longer period of time, even up to 8 weeks. Everything moves more slowly at a cold temperature, but we can still employ surface area and agitation to help the diffusion process.

Proportion

It's wise to consider what quantity of herb you will need to extract into a given amount of liquid to produce the desired remedy. Particularly with tinctures, the proportion of herbs to menstruum is known as the weight-to-volume ratio, which has gotten a reputation for being complicated and scary to figure out. No need to be intimidated by it—we simply need to pin down the proportion of herb to liquid so that we can measure both with confidence and therefore make more consistent and predictable batches of extract. It's fine to work with whatever units of measure that are familiar and comfortable when you weigh herbs and measure the volume of liquids, whether that's grams and milliliters or ounces, cups, or parts (technically volume to volume). Using the weight-to-volume ratio with herbal extracts of all kinds allows us to calculate the desired batch size as well as the safe and effective dose.

Some variables to think through as you decide on the ideal proportion of herbs to liquid for a given remedy follow:

- How fresh is the herb you have on hand? (Has it come directly from the garden or has it been in a jar in a spice rack for years?)
- Who are you making the remedy for and how sensitive is this person?
- Are you administering this remedy topically or orally?
- Is this a potent, low-dose herbal remedy or a food?
- Will this remedy be consumed as it is, like a cup of tea, or will it be used in a formula that also contains other ingredients?

In practice, it is necessary for the liquid to cover the herb, but this still gives us a wide range of possibilities. The basic rule is that using a greater proportion

of herbs to liquid gives us a more concentrated extraction (makes a stronger medicine), and a smaller proportion results in a weaker, more dilute extraction (a gentler remedy). If the herbs are old or inferior, you may need to use a lot because there isn't much flavor or medicinal constituent left in the plant material. Conversely, you can use small doses or proportions of very concentrated or potent remedies. (I discuss this principle in more detail in chapter 11.)

The herb-to-menstruum proportion is also known as the weight-to-volume ratio. When we need to measure the dose accurately, it is important to calculate this ratio and then measure ingredients. Situations in which measuring the dose accurately include administering powerful, low-dose herbs; working in a clinical apothecary; or when selling or providing your products to others. The ability to gauge the dose accurately and consistently is important when preparing medicines for children, elders, and other sensitive people, and also when trying to follow a specific protocol. But if accuracy is not very important, we can certainly use what herbalists call the "folk method," description to follow.

Using metric units of measure makes the weight-to-volume ratio easy to calculate. In the metric system, we weigh herbs in grams (at least for a relatively small-scale batch) and measure the volume of menstruum in milliliters. For example, a 1:5 ratio could equal 500 grams of herb and 2500 milliliters of menstruum or 100 grams of herb to 500 ml of menstruum. It is also possible to figure quantities in ounces. This is the typical American system, called US customary units or avoirdupois. The units are ounces by weight for the herb to fluid ounces (a volume measure) of menstruum. In this system, if we weigh 2 ounces of herbs, we would measure out 10 fluid ounces of menstruum for a 1:5 ratio.

Weighing both herb and menstruum is also quite accurate, and easier for some people to figure out. Measuring the volume of both herb and menstruum is perhaps less accurate, and this technique is not typically used in the herb industry, but it is essentially the basis for the folk method. For example, to get a 1:5 ratio, we could combine ½ cup of herbs with 2½ cups of menstruum.

It's important to understand that a finished extract contains only the *extractives*, which are the constituents that have diffused out of the plant and into the liquid, and not all the material herb we started with. Let's look at an example of how to measure a 1:5 extract using the weight-to-volume ratio. A 1:5 extract represents 1 gram of herb extracted into 5 milliliters of liquid, or a proportion of 1 part by weight of herb to 5 parts of liquid by volume. The left-hand number of the ratio is always 1 because it represents the basic quantity we are working with. (The exception to this rule is for extracts that are so concentrated that they are solids, but that's beyond the scope of this book.) If you remember algebra from high school, you can also think of 1 as the X variable. The right-hand number in the ratio is the key variable, which determines the proportion, or amount, of liquid. The smaller the ratio, the more concentrated an extract is. For example, in a 1:4 ratio there is only four times as much liquid as solid. The larger the ratio, the less concentrated the extract is. In a 1:10 ratio there is 10 times more liquid than solid.

To calculate our batch, first we weigh the herb, which gives us our X, our basic quantity. The weight won't actually be 1, unless we specifically weigh 1 pound or 1 kilogram of herb, but the weight is represented by 1 in the proportion ratio. Then we multiply the measured weight of the herb by the right-hand number to determine the volume of solvent liquid or menstruum that we'll need, whether that liquid is alcohol, vinegar, oil, glycerin, or something else. So for a 1:5 ratio, we multiply X (the weight of the herb) by 5. For example, if X is 200 grams, we multiply 200 times 5.

200 grams × 5 = 1000 milliliters

Thus, we need to measure 1000 milliliters of liquid for the menstruum. This basic equation is useful for making all kinds of extractions.

Typically, product labels and reference books list standard weight-to-volume ratios for tinctures at 1:2 for fresh herbs and 1:5 for dried herbs. But in practice, these standards don't always work out because of variability of consistency or differences in how much space a given weight of an herb takes up (remember, the plant material needs to be fully covered by the menstruum so that the maceration process can occur). Compact or dense herbs—typically dried roots, barks, or seeds that have been ground or powdered—take up the least space per gram or ounce. Fluffy dried herbs, such as mullein, raspberry, or sage leaves, but also mushrooms, including reishi, can take up a lot of space even though they may not weigh much. In this case, following the standard ratio when you measure might result in too little menstruum to cover the herb.

Sometimes you may have only a small amount of herb, or one that is very expensive or precious, and you would get only a tiny amount of extract from it if you use a 1:5 ratio. Yes, you do still want to measure precisely for accuracy, but I am suggesting in such cases that you color outside the lines and choose whatever ratio you want for the given extract that you are making. You can create excellent extracts at 1:4 ratios for dense herbs or 1:10 for fluffy or precious ones.

With fresh herbs, the water contained in the plant material becomes part of the solvent liquid during maceration. We can plan for this by using a higher concentration of a solvent, such as alcohol or glycerin, so that the water in the plant dilutes the solvent to the ideal proportion. If we don't take the plant water into consideration, it may end up diluting the solvent liquid too much, inviting mold

Figure 1.2. Each of these tinctures was prepared with a 1:5 ratio using ground, dried herbs. Notice that each jar has a different amount of liquid above the level of the herbs. This is because each type of herb has a different consistency. From left to right: yellow dock root, uva ursi herb, yarrow herb, and calendula flower.