ME-04 Harvest, drying and storage: keeping the medicine chest alive for years

HEALING after the FALL, research library, ME-04

Researched 10 October 2026 by Claude Opus agent for THRIVING after the FALL, Book Four. Library document, unverified.

Findings

1. Three calendars, and which one the record supports

Three things travel under the name "harvest calendar". The **folk calendar** sets gathering by moon, saint's day or hour. Its best-documented modern form is Maria Thun's biodynamic sowing calendar, begun in the 1950s, whose results appear in her own publications rather than in replicated trials, and a review of lunar rhythms in agriculture concedes that few studies on planting by moon rhythms are reported under field conditions (Panneerselvam and others, undated). The one properly designed test I could reach is negative: a 1958 Argentine trial of ten crops, in randomised blocks with four replications and the four lunar phases as treatments, found no difference in production related to moon phase and attributed the yield differences it saw to temperature and photoperiod (Universidad Nacional de Cuyo repository, summary only) [VERIFY]. A 1971 onion study from the same institution reported a lunar effect on anticipated flowering, which is one outcome and not yield. Moon-phase harvesting has one negative replicated-design trial against it and no positive trial for it. A village that keeps the practice should keep it as ceremony and not as pharmacy.

The **record** is the pharmacopoeial collection instruction, specific and quantified. The British Pharmaceutical Codex of 1911 directs that digitalis leaves "should be collected when the plant is in full flower, and dried immediately after collection", states that digitoxin averages 0.28 per cent in August and September, "after which the quantity rapidly diminishes", and adds that leaves merely air-dried "rapidly become less efficacious" (BPC 1911, *Digitalis Folia*). Withering reached the same conclusion in 1785 without any chemistry (THRIVING library, ME-02). That is the model: a named part, a named stage, an immediate drying step, a number.

The **inference** is the generalisation the modern herbal prints as if it were the record: roots in autumn, leaves before flowering, flowers at opening, bark in spring, seed when ripe. The measurements below show two of those wrong for the plants most often named. Scale matters as well. ME-02 ranks species and genotype first among the causes of potency variation, with willow varying over a hundredfold between species (THRIVING library, ME-02), while harvest timing moves potency 1.3-fold to 5-fold, drying temperature up to sevenfold, and storage up to fivefold over two years. Identify to species first, time the harvest second, and spend most attention on the forty-eight hours after cutting.

2. Harvest timing, part by part

Leaves. Peppermint contradicts the rule of cutting before flowering. A 2024 trial reported oil yield per unit dry matter at full flowering 1.8 times that at 50 per cent flowering and 4.6 times that at pre-flowering, with menthol at

42.39 per cent (search extract, primary publication not reached) [VERIFY], and earlier work agrees that full flowering gave the greatest biomass, oil and menthol, with the unwanted menthofuran rising as the plant matures. An Iranian trial found menthol nearly flat at 27 to 28 per cent across stages, so the stage changes the minor components more than the main one. Cut mint at full flower, not before.

Digitalis is the case that kills. The BPC figure means leaf gathered in October is a weaker drug than leaf gathered in August, dosed against the same spoon (BPC 1911). The same Codex records the Brussels Conference ruling that only second-year leaf be used, then states that there is no reliable way to tell first-year from second-year leaves and that "the separation is, however, not material", which shows that a rule can outlive its evidence. Belladonna leaf gives maximal alkaloid at early night and early morning, and in *Datura* the scopolamine to atropine ratio is about 3:1 in young plants and reverses after flowering, so the same plant gathered at two dates yields two different drugs (THRIVING library, ME-02).

Flowers. "At opening" depends on which compound you want. In *Arnica chamissonis*, flowers harvested at four stages gave the highest luteolin and apigenin at stage 1, the opening bud, while total phenols peaked later and sesquiterpene lactone content rose systematically from yellow bud to the end of flowering (search extracts) [VERIFY]. Note this is *A. chamissonis*, not *A. montana*. For *Matricaria chamomilla* the recommendation is full bloom in the early morning, and both time of day and flower stage significantly change alpha-bisabolol oxide A, chamazulene and trans-beta-farnesene. For calendula I found only secondary advice, so "full bloom" rests on tradition [VERIFY].

Roots. Here the folk calendar fails hardest. A five-year Dutch and German series on *Valeriana officinalis* found essential oil peaking in September at 1.2 to 2.1 per cent v/w dry weight, and valerenic acid and derivatives peaking in February and March at 0.7 to 0.9 per cent (Bos and others 1998, abstract and secondary summaries only). If valerenic acid is the marker, the right harvest is late winter, and digging in the autumn of the second year is advice about root mass and workable soil. A survey of wild-simulated Korean ginseng from eleven plantations found total saponin in spring 4.5 to 6.5 times higher than in autumn regardless of cultivation period (abstract only) [VERIFY]. Echinacea splits: three-year *E. angustifolia* roots harvested in autumn had more polysaccharides and slightly fewer total alkylamides than spring and summer roots (Saskatchewan 2000, repository record) [VERIFY]. Autumn is right for yield, storability and digging, right for some markers and wrong for others, so a village dependent on one root must test its own calendar against a sealed reference sample of a batch that worked (THRIVING library, ME-02).

Bark. Spring is a rule about peeling, not chemistry. The Lithuanian willow survey found two-year bark cut in autumn about 25 per cent richer in salicylic derivatives than one-year or spring-cut material (Jurkstiene and others 2009, via ME-02), and oak bark runs 8 to 20 per cent tannins depending on time of harvest, age of branches and assay method (THRIVING library, ME-01, citing EMA). Peel in spring if you must, cut in autumn if you want the drug, and in both cases take from one side of a trunk or from cut branches, never ringing a tree (Heron 2010).

Seed, and the weather rules. Seed is gathered ripe, which is also what lets the stand regenerate: FAO directs that where regeneration is in doubt no more than 70 per cent of any population be taken (Heron 2010). Overharvest belongs to OR-02, which the library does not yet hold. The weather rules are worth more than the calendar. Harvest in dry weather, not in rain, not early when there is dew, and not green leafy herbs in the hottest part of the day. Keep cut material in shade, never in a closed sack where heat builds, never on the ground, and never in sacks that have held agrochemicals (Heron 2010). These are about water and heat in the first hour, and they set the microbial load that ME-01 found the kettle cannot remove.

3. Drying: the largest loss a village controls

Why speed. A cut plant is still metabolically alive, and water lets its enzymes work. In *Digitalis purpurea* the primary glycosides purpurea glycoside A and B are hydrolysed by the leaf's own enzyme, named digipuridase in the older literature, and residual moisture above roughly 5 per cent keeps that reaction running (pharmacognosy teaching sources, low authority) [VERIFY]. The pharmacopoeial answer is heat fast enough to kill the enzyme: the Thai

Pharmacopoeia monograph calls for fast drying after harvest not exceeding 60 degrees. The brief's 60 degrees for digitalis is real but is not a drying rule. It is an enzyme-killing rule for one drug and a few like it. The brief's lead on Bourquelot and Perrot stabilising digitalis leaf with alcohol vapour could not be confirmed in any source I reached and should not be quoted [VERIFY].

Temperature, with numbers. FAO gives a maximum of 45 to 50 degrees for most herbs, raised by 10 degrees if the air is very humid, and 30 degrees ideally and not more than 35 for aromatic herbs containing volatile oils (Heron 2010). Shohet and Wills measured the valerian trade-off exactly: raising drying temperature from 15 to 70 degrees cut drying time by 176 hours, but valerenic acids fell about 23 per cent between 15 and 40 degrees and a further 36 per cent between 40 and 50, with no further significant loss above 50. Washing, soaking or cutting roots made no significant difference to valerenic acid, though cutting markedly shortened drying, and they concluded to dry at the lowest feasible temperature (Shohet and Wills 2006). Read against the brief's "35 to 45 for most", this says 40 degrees has already cost a quarter of the marker.

Peppermint's cliff is steeper. Blanco and colleagues found oil falling from 1.0 per cent at 40 degrees to 0.14 at 60 and 0.12 at 80, a sevenfold loss between 40 and 60 (Blanco and others 2002, repository record). A 2016 study comparing constant 35 degrees with constant 55 found about 2.3 per cent oil loss against about 22 per cent, and several Turkish and Iranian trials found shade drying gave the highest oil, one reporting 3.68 per cent against 2.78 from sun.

Not every plant wants the lowest temperature. *Hypericum perforatum* dried at 50 degrees maintained its hypericin compared with fresh material while 25 degrees lowered most metabolites (search extract) [VERIFY], and in belladonna total alkaloid was lowest in sun-dried and highest in shade-dried leaf, with drying method and storage time both significantly changing total alkaloid, atropine and scopolamine (Amiri 2023). The divergence follows the mechanism the digitalis monograph states: where the enemy is an enzyme, heat helps, and where it is volatility or oxidation, heat harms. The default that does least damage across the set is 35 to 45 degrees in moving air out of sunlight, dropping to 30 to 35 for anything strongly scented, rising only where the record says so.

Airflow, and how long. FAO's rules cost nothing: build the drying system before the harvest, dry as soon as possible after cutting, raise material off the ground, create airflow over it, lay it in thin layers, and protect from insects, dust, animals, birds and rain. Material laid too thick starts to decompose, producing fungal growth and discoloured leaves, and drying on the ground is a last resort, covered or taken in at night to stop re-absorption (Heron 2010). The only clean measured curve I found for a medicinal root is Zlatanović and colleagues on valerian in forced-convection air at 1 metre per second. Whole roots, quarters and 2 mm slices were dried at 40 and 50 degrees, initial moisture was 51.2 plus or minus 0.3 per cent, and roots were taken as dry at 68 per cent fresh-weight loss and 10 per cent moisture. The longest run took about 650 minutes and the shortest about 200, a whole root took twice as long as quartered root at either temperature, and most moisture left in the first 100 minutes (Zlatanović and others 2017). So cut the root: cutting halves the drying time or better at no cost in marker content. I found no published drying curves by part and climate for leaves and flowers at village scale, the thin-layer literature reporting diffusivities rather than hours, so the hours a reader needs must come from the snap test [VERIFY].

The endpoint. The brief's 10 to 12 per cent is right as a band. The European Pharmacopoeia sets loss on drying monograph by monograph, with examples from 10.0 to 12.0 per cent, and requires the test unless otherwise justified, with water determination used instead for drugs high in essential oil (EDQM guide). Digitalis is the exception at not more than 5 per cent [VERIFY], and a UNIDO-linked cinchona report warns that bark stored above 12 per cent moisture deteriorates, the same threshold from the other direction. Without a balance and oven the endpoint is the snap test: leaves crumble rather than fold, stalks snap rather than bend, roots break with a sharp crack rather than a tough fibrous tear, flowers shatter at a touch, seeds rattle. The free confirmation is the jar test. Seal a sample in clear glass overnight and look for condensation in the morning. Any mist and it goes back on the rack.

4. Fresh to dry, and what a harvest weighs

A Russian review gives weight losses on drying by part: buds 65 to 70 per cent, flowers 70 to 80, leaves 55 to 90, herbs 65 to 90, roots and rhizomes 60 to 80, bark 50 to 70, fruits 30 to 60, seeds 20 to 40 (secondary compilation) [VERIFY]. As fresh-to-dry ratios that is roughly 3.3:1 to 5:1 for flowers, 2.2:1 to 10:1 for leaves, 2.5:1 to 5:1 for roots, 2:1 to 3.3:1 for bark and 1.25:1 to 1.7:1 for seed. The one measured case agrees: valerian at 51.2 per cent initial moisture lost 68 per cent of fresh weight, about 3.1:1 (Zlatanović and others 2017).

The kitchen rule of 3:1 is a substitution rule for flavour, not a yield rule, and popular sources also give 4:1 and 6:1, so a healer swapping fresh for dried on a narrow-margin plant is guessing at a factor that may be 2 or may be 6 (THRIVING library, ME-02). Never convert fresh to dried by a published ratio for a narrow-margin plant. Weigh the fresh batch, dry it, weigh it again, write that plant's own ratio on the page. One season, then permanent for that plant in that climate.

5. Storage: four enemies and what each costs per year

Heat. The best dataset here is Simonnet and colleagues on *Artemisia annua*, presented to the WHO and Medicines for Malaria Venture meeting in Mumbai in September 2009. Leaves and powder below 0.5 mm were stored at constant 20, 30, 40, 50 and 70 degrees, at relative humidity below 30 per cent for 13 months and about 85 per cent for 7 months, sampled every 2 to 40 days with four replications. Their conclusions carry whole: the raw material has to be well dried before storage, never store raw material after crushing, the higher the humidity the greater the loss at high temperature, storage at 20 degrees is acceptable even at high humidity, storage at 40 degrees even at low humidity gives up to 30 per cent loss after one year, and high temperatures even for a few days can cause important loss (Simonnet and others 2009). The only long-run rate I found is lavender: Dušková and colleagues stored dried flowers for eight years and reported essential oil falling at about 0.007 per cent per day, about 2.56 per cent per year, with linalool and alpha-terpineol rising as other compounds degraded, attributed to residual moisture plus room temperature alone (repository record and secondary summary) [VERIFY].

Water. Below about 0.81 water activity *Aspergillus flavus* did not grow in any of ten medicinal herbs tested at 25, 30 and 40 degrees, and in seed substrates neither *A. flavus* nor *A. parasiticus* grew at 0.82 at 20, 27 or 35 degrees, while in sorghum the minimum for mycelial growth was 0.91. Toxin can appear where growth is marginal, with high aflatoxin B1 at 0.90 in one seed study (search extracts) [VERIFY]. For a village this is one instruction: dry to the snap, keep dry, and the mould problem solves itself.

Oxygen and light. In a dried total extract of *Hypericum perforatum*, decay was lowest at minus 20 degrees and highest at 40 degrees with 75 per cent humidity, and light protection reduced breakdown of all constituents except hyperforin within four months, with the advantage gone by six (search extracts) [VERIFY]. That is awkward for the amber-jar rule: light protection bought four months and then stopped mattering. I found no controlled trial of amber glass on dried herbs at all, so opaque storage is cheap and mechanistically sound and nobody has measured what it is worth [VERIFY].

Surface area. Two independent lines agree that powdering is the worst thing you can do to stored material. Simonnet found powdered leaf lost artemisinin faster at every temperature and humidity and concluded never to store after crushing, and Heigl and Franz found values for powdered drugs under stress lower than for whole drug, attributed to larger surface and faster degradation (Heigl and Franz 2003). ME-01 reaches the same conclusion from mechanism. Store whole or coarsely cut, grind on the day of use.

Containers, and a correction to the brief. The brief's "glass, tin, paper, not plastic film" is half right, and the wrong half is the paper. In a Brazilian one-year study, oregano, parsley and yarrow were packed in glass, low-density polyethylene or paper. At one week there were no significant microbiological differences, but after one year only oregano kept acceptable microbiological characteristics, in polyethylene or glass, and for all three species the greatest

contamination occurred with paper (repository record and abstract) [VERIFY]. Heigl and Franz found aluminium-lined aroma-protecting bags protected better than paper tea bags under stress. The honest rule is not about material but about three properties: airtight, opaque, dry when filled. Glass with a tight lid is the best a village will have, tin is nearly as good and survives dropping, and a sealed plastic bag beats an open paper sack by a wide margin. Plastic's two faults are solvable: volatile oils migrate through thin polyethylene over months, and plastic traps water against herb that was not dry. Paper breathes, which is why it fails in a damp store and why it is still right for the last stage of drying.

6. Shelf life: the rule of thumb tested against the data

The brief's rule is leaves and flowers about 1 year, roots and barks 2 to 3, seeds longer, tinctures 3 to 5. Against the stability data it is wrong in both directions, and the error tracks chemistry, not plant part.

One year for leaves and flowers is too harsh for some and far too generous for others. Heigl and Franz stored typical flavonoid-containing herbal drugs, whole, cut and powdered, in paper and in aluminium-lined bags, under ICH long-term conditions of 25 degrees and 60 per cent relative humidity for 24 months, with stress testing at 40 degrees and 75 per cent for 6 months. During long-term testing no significant changes in the flavonoid pattern could be detected, with values mostly inside plus or minus 10 per cent of the initial value, and marigold flowers showed no significant change in any of nine flavonoid peaks over 27 months. Birch leaves were the exception, losing most flavonoids at elevated temperature with a corresponding rise in the aglycones (Heigl and Franz 2003). A flavonoid leaf or flower drug kept cool and dry is still in specification at two years, and the one-year rule throws away good medicine.

Volatile and labile drugs fail long before a year. A patent application reports that after one year of storing dried chamomile the essential oil fell 43.8 per cent and chamazulene within that oil fell disproportionately by 68.4 per cent [VERIFY], and a 1989 *Planta Medica* study found dried chamomile flowers losing about 70 per cent of their matricine within two years under controlled conditions while extracts of fresh material were stable in every respect [VERIFY]. Lavender loses about 2.56 per cent of its oil a year, slow, but the composition shifts as it goes. Hyperforin in stored *Hypericum* crude drug is reported completely degraded after one week, a figure quoted secondhand that I would not print without better sourcing [VERIFY].

Roots at two to three years is badly wrong for at least one common root. Perry, van Klink, Burgess and Parmenter found levels of all alkamides in *Echinacea purpurea* root fell by over 80 per cent during storage at 24 degrees for 64 weeks, under sixteen months. Chopping altered some alkamides slightly, drying had no effect at all, and alkamides also dropped significantly at minus 18 degrees (Perry and others 2000). A root losing four fifths of its characteristic constituents in sixteen months at room temperature is not a two-to-three-year drug, and the result also shows that drying is not always where the loss happens.

Barks keep, and the evidence is extraordinary. Canales, Nesbitt, Walker, Barnes and colleagues reanalysed cinchona barks from the Economic Botany Collection at Kew that John Eliot Howard and others had annotated with alkaloid contents more than 150 years earlier. Total alkaloid estimates were comparable to the historical annotations, and quinine and cinchonine amounts and the four-alkaloid total were significantly similar between historical and current analyses (Canales and others 2020, abstract and repository records). Those barks sat in a dry museum cabinet, but dry bark in a sealed container is the longest-lived plant drug a village will hold, and it is what the quinine chapter depends on.

Opium and seed. The UN *Bulletin on Narcotics* of 1958 reported that provided the drug was well dried, no appreciable decrease in morphine need be expected even after several years, with no decrease at all after four years, while recording that opinions were very much divided. The qualification matters: Dunnicliff, Ray and Singh found morphine in Indian opium held steady stored moist and without air but fell rapidly when dried at 60 degrees and kept in contact with air (*Nature* 1937, 140:92), so opium's keeping is a function of drying and sealing, not of its nature. For

seed I found no stability study of any medicinal seed drug, so "seeds longer" is inference from the low water content [VERIFY].

Tinctures, where I extend ME-01. ME-01 found a *Lychnophora passerina* tincture stable only 6 months at 25 degrees in sealed light-protected glass, and hydroalcoholic extracts of two *Mikania* species losing more than 5 per cent of their coumarin marker under every condition across a 6-month accelerated and a 12-month long-term study, so that no two-year shelf life could be assigned (THRIVING library, ME-01). I take that as correct and add an older, more alarming case. Francis Fish's 1955 Glasgow thesis found tinctures from either dried or stabilised digitalis leaf unstable on storage, losing up to 60 per cent of initial potency by the 18-hour frog assay, with intravenous assays showing 20 to 30 per cent loss over nine to twelve months. The part that should frighten the dispensary is that a chemical assay based on the Keller-Kiliani reaction showed a slight increase in strength over the same period and did not indicate the loss at all (Fish 1955). ME-13 owns assay, and this is the case that limits it: a test measuring the wrong thing will certify a weakened medicine. The other side deserves saying. Nobody has run a long-term study on a 1:5 tincture of chamomile in 40 per cent ethanol in a cool dark cellar, which is what a village will have, so the defensible statement is that a tincture is microbiologically safe for years above about 25 per cent ethanol, that its markers fall by a few per cent to a few tens of per cent in the first year, and that for a narrow-margin plant the uncertainty alone justifies remaking it every season.

The ranking the brief asked for. Fastest losers: echinacea root alkamides, over 80 per cent in 64 weeks at 24 degrees. Chamomile oil and chamazulene, 44 and 68 per cent in a year. Hyperforin, days to weeks. Artemisinin at 40 degrees, 30 per cent in a year. Garlic in any processed form, with concentrated extract at 30 degrees down to 52 per cent of its allicin in 15 days, though whole bulbs differ because enzyme and substrate stay apart. Digitalis tincture, 20 to 30 per cent in nine to twelve months. Valerian, no storage figure found beyond the drying losses. Slowest: flavonoid leaf and flower drugs unchanged at 24 to 27 months, dry bark measurable after 150 years, well-dried opium with no decrease at four years, seed inferred longest. The pattern is not leaf against root. It is volatile and oxidisable against glycosidic and alkaloidal, modified by whether the plant's own enzymes were killed during drying.

7. What is in the jar besides the plant

ME-01 established that dried herb is not sterile and that brewing does not make it so, with no significant reduction in *Bacillus cereus* at either 100 or 68 degrees (THRIVING library, ME-01). That load is picked up in the field and the drying yard, which makes it this report's problem.

Microbes, and the one lever. FAO names the sources: material on the ground, dirty or reused sacks, feet on the drying floor, dust on open racks, rain, birds and animals, and handling by anyone with wounds or infectious disease (Heron 2010). An Egyptian study comparing natural, solar and oven dehydration of calendula and chamomile found significant decreases in microbial counts with oven and solar against natural drying, in the order oven, then solar, then natural (search extracts) [VERIFY], and a closed solar dryer cut total bacterial and fungal counts on Siwi dates by 96 and 93 per cent against open sun. Against that, an Iranian study of peppermint reported shade drying did little to reduce microbial load, and dried purple basil carried 5.25 to 6.31 log colony-forming units per gram of aerobic mesophilic bacteria whatever the method, judged unsatisfactory by international standards [VERIFY]. The conclusion is uncomfortable: an enclosed dryer with moving warm air is the only intervention shown to lower the count, no drying method sterilises, and ME-01's rule that newborns, the famine-weakened and the post-measles patient get a full rolling boil and a fresh brew is permanent, not a stopgap.

Mould and aflatoxin. Chien and colleagues examined 1,067 samples of 24 herbal types received by a Taiwanese factory between 2005 and 2016 and found aflatoxins in 373, that is 35 per cent. *Platycladi semen* was worst, 65 per cent above the total limit and 79 per cent above the B1 limit, and aflatoxin B1 in contaminated samples ran 0.21 to 693 micrograms per kilogram against a European Pharmacopoeia limit of 4 micrograms per kilogram total and 2 for B1 (Chien and others 2018). A 2009 Seoul survey concluded that aflatoxin concentration increased during storage and drying. Seeds, nuts and starchy rhizomes are the high-risk group, and they are also the group the rule of thumb

says keeps longest. A village has no way to detect aflatoxin and brewing does not destroy it, so the only defences are moisture below the threshold, visual rejection, and never storing seed or starchy root damp.

Insects and mites. *Lasioderma serricorne*, the cigarette beetle, is described as the most destructive worldwide pest of stored herbal drugs and tolerates up to 8 per cent nicotine, and *Stegobium paniceum*, the drugstore beetle, has been recorded eating belladonna and strychnine. Both are 2 to 3 mm and reddish-brown with the head tucked under so it does not show from above, only the larvae feed, and development takes about two months at 25 degrees and 65 to 70 per cent relative humidity. An Indian market study found 30 to 60 per cent of turmeric samples infested, and 133 of 141 Turkish dried fig samples carried mites, 94.3 per cent, *Acarus siro* among the species, which also spread mycotoxin-producing fungi [VERIFY]. The village answers are sanitation, airtight containers, cold where possible and destroying infested stock, since the textbook answer of fumigation with methyl bromide is not available after the Fall.

Roadside lead, old ground and pesticides. A Southern California study of common roadside plants found metal concentrations 8 to 11 times higher close to roads than further away, and a Polish study sampling medicinal plants at 2, 10, 30 and 50 metres found cadmium falling with distance in every species, by over 61 per cent between 2 and 50 metres in greater plantain and by about 44 per cent, the smallest fall, in dandelion [VERIFY]. So do not gather within 50 metres of any road still carrying traffic, within sight of or downhill from a former works, smelter, tannery, railway yard, fuel store or shooting range, or on ground burned over with painted timber. Dandelion and plantain, the commonest roadside gathers, are among the better accumulators. Pesticides are a problem of the first decade and then a diminishing one: a Seoul survey of 213 dried fruit samples found residues in 31.0 per cent and 3.8 per cent over maximum residue limits, and an Indian study of 1,125 samples of five plants from 2017 to 2020 found 14.7 per cent of raw materials and 5.9 per cent of alcoholic extracts over the EU limit, with none in aqueous extracts. Water does not extract most residues, alcohol extracts some, and raw herb carries more than any preparation made from it.

The poisonous neighbour, after it has been cut up. PH-10 owns field identification (THRIVING library, PH-10). What this report adds is that every check PH-10 gives is destroyed by harvest and drying. Foxglove-for-comfrey is caught in the field by the bristle test, the cucumber smell, the slimy sap and the raised net of veins, and a jar of cut dried grey-green leaf has none of those. Lin, Yang, Phua, Deng and Lu reported an outbreak in which nine people drank tea from leaves picked in a Taiwanese national park a day earlier and believed to be comfrey. All nine presented with nausea, vomiting, diarrhoea and dizziness, and three went on to significant cardiotoxicity. Peak serum digoxin by immunoassay ran 4.4 to 139.5 nanograms per millilitre against a reference range of 0.8 to 1.2. Three needed temporary cardiac pacing, 40 to 80 mg of digoxin-specific antibody had no effect, and all nine recovered (Lin and others 2010). The CDC's *Morbidity and Mortality Weekly Report* of August 1977 describes an American couple who drank tea from foxglove leaves kept in the refrigerator in place of comfrey, the wife dead when paramedics arrived (CDC MMWR 1977, secondary summaries only) [VERIFY].

The substitution version is the Belgian aristolochia disaster. A Brussels slimming clinic changed its formula in 1990, and the *Stephania tetrandra* it ordered was supplied as *Aristolochia fangchi*, whose Chinese name is similar. Aristolochic acids were later found in 11 of the 12 batches delivered to Belgian pharmacies in that period, after thin-layer chromatography had initially failed to detect them. One hospital treated 105 patients for kidney damage, 43 of them for kidney failure, and in a follow-up of 39 patients who reached end-stage renal failure, 18 urothelial cancers were found (reviews read as search extracts) [VERIFY]. The lesson is procedural. Identification is an event that happens once, in the field, with the whole plant in hand, and everything afterwards is a chain of custody. If the chain breaks, the identification is gone and cannot be recovered by looking at the jar.

8. The label, the voucher and the book

The brief calls the unlabelled jar the commonest fatal error in the dispensary record. I could not find a published series ranking causes of death in dispensaries and naming it first, so the book should not make the claim in that form [VERIFY]. What the record supports is that unlabelled containers kill and that the failure is common. The Institute

for Safe Medication Practices found in a survey of about 1,600 hospitals that fewer than half always labelled syringes, basins and other solution containers, and that 18 per cent never or rarely did. At Virginia Mason Medical Center in Seattle in 2004 a patient being treated for a brain aneurysm was injected with antiseptic skin cleaner instead of marker dye, because the clear antiseptic had been put in an unlabelled cup identical to the dye cup. She suffered a leg amputation, then a stroke and multiple organ failure, and died (Seattle Times, 3 December 2004) [VERIFY]. The dispensing version is as deadly. In Felixstowe in 2017 an 86-year-old man, Douglas Lamond, received another patient's medicines in a weekly pack whose outer label carried his own name while the seven inner labels carried another patient's, and a detective said the error was very likely to have hastened his death. In Adelaide in 2020 an 82-year-old man, Pelayo Cortes, died after an accidental polypharmacy overdose from a pack showing his name on the front and another man's medication list on the back. ME-02 adds opium tincture and paregoric, a 25-fold difference between two products with overlapping synonyms, with three fatal reports to the FDA since 1997 (THRIVING library, ME-02).

The label carries name to species, part, place gathered, date, preparer, and for a preparation the ratio and solvent strength (THRIVING library, ME-01). Three additions. The **voucher** is a pressed whole specimen of each species gathered, carrying the same batch number, kept flat between paper. It costs one plant and ten minutes and is the only way to check an identification after the material is cut, and it is why Howard's barks could be reanalysed 150 years later (Canales and others 2020). The **sealed reference sample**, which ME-02 proposes for potency comparison, doubles as the storage control. The **drying tag** is FAO's: a label on the dryer itself with batch number and start date, with each sack weighed and recorded as it is packed (Heron 2010), because the gap between harvest and jar is where batches merge and identities are lost.

What survives after the Fall: ink fades, paper rots, adhesive labels fall off in a damp store. A scratched or stamped tin lid, a wooden tag wired to the neck, a number scratched into glass with a hard nail, and a bound ledger kept dry are the forms that last. The jar carries the number. The ledger carries the rest.

Evidence grades

Practice or claim	Tradition says	Record shows	Grade
Dry fast, shaded, moving air, thin layers off the ground	Universal	FAO GACP, BPC 1911, consistent across drying trials	B
Endpoint 10 to 12 per cent, snap test	Rule of the art	Ph. Eur. limits 10.0 to 12.0	B
35 to 45 degrees, 30 to 35 for aromatics	Modern herbal	FAO 45 to 50 max. Valerian loses 23 per cent by 40, peppermint sevenfold 40 to 60	B
60 degrees for digitalis leaf, to stop enzymes	Pharmacopoeial	Thai Ph. requires fast drying not exceeding 60. Mechanism documented, yield data not	C
Store cool, dark, dry, airtight	Universal	Artemisinin 30 per cent loss in a year at 40 degrees, none at 20	B
Never store powdered	Pharmacognosy	Simonnet 2009 and Heigl and Franz 2003, independently	B

Practice or claim	Tradition says	Record shows	Grade
Glass or tin, not paper, not plastic film	Mixed	Paper worst of three over a year. No trial supports excluding sealed plastic	C, the plastic exclusion unsupported
Amber glass protects dried herb	Trade rule	No controlled trial. Light helped a Hypericum extract to 4 months, not 6	D
Leaves and flowers keep about 1 year	Rule of thumb	Flavonoid drugs unchanged at 24 to 27 months. Chamomile oil down 44 per cent in a year	C, wrong in both directions
Roots and barks keep 2 to 3 years	Rule of thumb	Echinacea alkamides down over 80 per cent in 64 weeks. Cinchona true after 150 years	X for echinacea root, A for dry bark
Tinctures keep 3 to 5 years	Herbal commonplace	Digitalis tincture down 20 to 30 per cent in 9 to 12 months, 60 per cent by frog assay	X as stated, B for 1 year
Roots harvested in autumn	Folk, horticultural	Valerenic acid peaks February to March, ginseng saponin 4.5 to 6.5 times higher in spring	C, wrong for at least two genera
Leaves harvested before flowering	Folk rule	Peppermint oil 4.6 times higher at full flowering. Digitalis gathered in full flower	X for peppermint and digitalis
Bark harvested in spring	Folk rule	Two-year autumn willow bark about 25 per cent richer	C for peeling, weak for potency
Moon-phase and saint's-day harvesting	Many cultures	One randomised-block trial found no effect. No positive trial found	D, X where it displaces the weather rules
Roadside and old industrial gathering	Convenience	Roadside plants 8 to 11 times higher in metals	X
Label with name, part, place, date, preparer	Apothecary rule	Fatal unlabelled-container and mislabelled-pack cases	B
A pressed voucher per batch	Herbarium practice	Howard's annotated barks confirmed after 150 years	B

Means ledger

Rung	What it can do	What changes in the outcome
Hands and knowledge alone	Gather the right species at the right stage in dry weather, carry in clean cloth, spread thin on a raised surface indoors, snap test	Removes the misidentification death and the worst field contamination. Drying stays weather-dependent, so mould in a wet autumn is near-certain. No keeping beyond a season
The hearth	A rack above the stove or in a warm loft at 30 to 45 degrees. Glass jars, tins, a cool north room, a wooden tag and a date	First control of drying speed. Material reaches the snap in a day or two rather than a week. Flavonoid leaf and flower keep a year or two. Volatiles still bleed away
Garden and still	A solar or stove dryer with airflow and a thermometer, a scale, a cellar at 10 to 15 degrees, sealed jars, a reference sample, a voucher box, a batch ledger	The thermometer is the step change: 40 against 55 degrees is 2 per cent against 22 per cent oil loss. Narrow-margin plants become dosable against the reference
Village dispensary, 300	A named drying supervisor, a hygiene rule on the drying floor, a pest-controlled raised dry dark store, a harvest calendar with actual dates, a microscope, condemned stock recorded	Reproducibility across seasons and preparers, and traceability from jar to patient. The rung at which the unlabelled jar can be made impossible, the largest single safety gain here
District infirmary, 3,000	A bulk cool dark store, blending across villages to average variation (THRIVING library, ME-02), a district reference sample, the surplus to condemn a year's stock	Blending narrows the potency range without measuring it. Destroying stock becomes affordable, which is what makes the condemnation rule real
A hospital before the Fall	Controlled-atmosphere drying, assayed batches, validated stability data, humidity-controlled warehouses, aflatoxin and pesticide screening	Potency known to a few per cent and shelf life known rather than assumed. This whole report collapses into a date stamped on a box

Harm test

By the weakened medicine. A pneumonia, malaria or heart failure treated from a jar that has lost 80 per cent of its active constituent is treated with nothing, and the healer records a failure of the remedy rather than of the store. This is how echinacea root at sixteen months, chamomile at two years and a digitalis tincture at a year kill, and it leaves no sign at the bedside. Counter with the sealed reference sample, the date on the jar and the rule to remake rather than trust.

By the strengthened medicine. A dose written against last year's weak batch, given from this year's strong one. For digitalis, with a therapeutic margin of about 2, and quinine, with a fatal dose reported as low as 1.5 g against a daily therapeutic dose near 2 g, this is lethal (THRIVING library, ME-02). Any new batch of a narrow-margin plant is titrated from a quarter dose whatever the label says.

By the wrong plant in the jar. The foxglove-for-comfrey shape: nausea, vomiting, diarrhoea and dizziness at two

to eight hours, apparent recovery, then bradycardia, heart block, ventricular arrhythmia and hyperkalaemia hours later. Nine patients in the Taiwanese outbreak, serum digoxin 4.4 to 139.5 ng/mL, three needing pacing, and a death before help arrived in the 1977 American case. Dried cut material cannot be rechecked. The dose that harms is a cup.

By mould and its toxin. Aflatoxin B1 up to 693 micrograms per kilogram against a European limit of 2. The harm is cumulative liver injury and hepatocellular carcinoma over years, with no acute sign and no treatment. Seeds, starchy rhizomes and anything stored damp are the risk group. Any musty smell, grey or green bloom, or caking and the batch is burned, not washed, not sun-dried, not fed to animals.

By contamination from the field. Roadside lead and cadmium give colicky abdominal pain, constipation, anaemia, wrist or foot drop, and in children failure to thrive with loss of acquired skills (THRIVING library, ME-01). There is no chelation after the Fall, and the harm is in the gathering ground and cannot be removed afterwards.

By the microbes the kettle does not kill. Dried herb carries 10^3 to 10^6 colony-forming units per gram and brewing gives no significant reduction in *Bacillus cereus* (THRIVING library, ME-01). For a healthy adult this rarely matters. For a newborn, a famine-weakened patient, a post-measles child or anyone with an open gut it can be fatal, and the vomiting will be blamed on the illness.

By insects and mites. Direct harm is modest, mainly allergy and gut upset, but infested stock is moist stock and the beetles and mites carry the fungi. *Stegobium paniceum* eats belladonna and strychnine, so an infested jar of a narrow-margin plant has been eaten selectively and its strength is now unknown.

Who must never receive what. Nobody receives material from an unlabelled container under any circumstance. Infants, the pregnant, the old, the wasted and anyone with kidney or liver disease receive nothing from a narrow-margin jar more than a year old, because the direction of the potency error is unknown and their margin is smallest. No one receives a herb that smells musty, looks bloomed or has insect frass in it, including externally, because mould spores on a dressing enter a wound.

The signs in the store, and what to do. Condensation inside a jar, caking of a free-flowing herb, colour from green to brown or gold to grey, loss of smell, a musty or sour odour, visible bloom, webbing, fine dust at the bottom, reddish-brown beetles 2 to 3 mm long, or a jar gone light for its volume. Any of these condemns the batch. Burn it or bury it deep, away from water and animals, and do not compost it near the garden. Clean the container with boiling water and dry it fully. Check every other jar within arm's reach, because beetles bore through packaging and move. Record the condemnation with batch number and reason, because the pattern of failures tells you which part of the chain to fix.

Historical cases from this chapter. The Taiwanese foxglove outbreak of 2009, nine patients. The American foxglove-for-comfrey death reported by the CDC in 1977. The Belgian aristolochia substitution, 43 in kidney failure of 105 treated at one hospital and 18 urothelial cancers among 39 followed to end-stage disease. The Virginia Mason unlabelled-cup death of 2004. The Felixstowe and Adelaide dispensing deaths of 2017 and 2020.

Red flags

- **A jar that cannot be identified with certainty.** No label, a label not matching the contents, two herbs mixed, or a gatherer dead or forgetful. No test a village can run distinguishes dried comfrey from dried foxglove. Burn it. Do not taste it, do not try it on an animal, do not keep it for external use. Losing a year's stock is survivable. One foxglove tea is not.
- **Digitalis-type poisoning after any herbal tea.** Vomiting, diarrhoea and dizziness, then hours later a slow or chaotic pulse, objects looking green or yellow, and collapse. Digoxin-specific antibody does not exist after the Fall, and in the Taiwanese outbreak 40 to 80 mg of it had no effect anyway. Lay the patient flat, keep them warm and still, give nothing by mouth, and keep watch. Most of the Taiwanese nine recovered without specific treatment over days. Say honestly that the next hours decide it.

- **Progressive kidney failure in several people who took the same preparation.** Falling urine output, swelling, breathlessness, confusion. The aristolochia pattern, meaning a substituted or contaminated batch. Stop the preparation, destroy it, find every recipient from the ledger. There is no dialysis. Nurse, limit salt and protein, keep fluid gentle.
- **Jaundice, a tender enlarged liver and abdominal swelling in a regular user of one herb.** Pyrrolizidine or aflatoxin injury, both irreversible by the time they show. Stop, destroy, trace.
- **Several jars mouldy at once.** The store has failed, not the jars. Empty it, re-dry what will still pass the snap test, condemn the rest, and do not refill until the store is dry.
- **A season in which the drying failed.** Continuous rain at harvest, no fuel, no enclosed dryer. The commonest way a dispensary empties, and there is no remedy at the time. The response is the following spring: build the dryer first and plant second.
- **A narrow-margin plant with no reference sample and no date.** Treat it as unknown and titrate as ME-02 directs, from a quarter of the expected dose with written stop signs and a second person watching, or do not use it.

The case against

The losses here are second-order. ME-02 puts species and genotype first, and the arithmetic is unanswerable: willow varies a hundredfold between species and *Artemisia annua* a hundredfold across genotypes, against a drying loss of 23 per cent and a storage loss of 30 per cent a year (THRIVING library, ME-02). A village that gets the species wrong and the drying perfect has nothing. Edzard Ernst's long-standing argument that herbal preparations cannot deliver a known dose applies in full and nothing here answers it. The reply is only that drying and storage are what a village can change this year, and that they compound.

Almost none of this evidence comes from the conditions the book describes. The stability work is ICH-conditioned in a cabinet, the drying work is in forced-convection electric dryers with controlled air velocity, and the cinchona barks sat in a museum. Not one study I read tested a hut, a loft, a cellar, a clay jar or a wood stove. Applying a laboratory decay rate to a village store is an extrapolation and should be marked as one wherever the book uses a number from here.

The stability data are about markers, not medicines. Heigl and Franz measured flavonoid peak areas, Perry alkamides, Shohet and Wills valerenic acids, and in almost no case has anyone shown that a fall in the marker corresponds to a fall in clinical effect. Fish 1955 cuts both ways: the chemical assay showed a slight rise while the biological assay showed a 20 to 60 per cent fall, which means a marker can miss a real loss and equally that a falling marker may reflect nothing a patient would notice. The pharmacopoeial authors themselves note that for most herbal drugs no stability data for active or marker substances exist in the monographs at all (Heigl and Franz 2003).

The weak counter: the old ways worked. Dispensaries kept stock for centuries without thermometers or monographs and people were treated from those jars. True, and not evidence: nobody counted how many of those treatments failed for want of potency, because a failure was read as a failure of the remedy or the patient. The romance of the hospital should be resisted equally. The modern answer is an expiry date printed by a company that ran a stability study, and after the Fall there is no company, no study and no date. The snap test, the sealed reference, the nose and the ledger are enough to keep flavonoid and bark drugs potent for two to three years. They are not enough to keep an echinacea root or a chamomile flower potent for one, and the book should say so rather than print a comforting table.

10-line summary of robust findings

1. Harvest timing moves potency roughly 1.3-fold to 5-fold, drying temperature up to sevenfold, and storage up to fivefold over two years, all smaller than the swing between species that ME-02 ranks first.

2. Drying temperature is the biggest loss a village controls: valerian lost 23 per cent of its valerenic acids by 40 degrees and a further 36 per cent between 40 and 50, and peppermint fell from 1.0 to 0.14 per cent oil between 40 and 60.
3. The default is 35 to 45 degrees in moving air out of sunlight, 30 to 35 for anything aromatic, and 60 only where the record names it, as for digitalis leaf, where the purpose is killing the plant's own enzyme and not drying.
4. The endpoint is 10 to 12 per cent moisture, read by a village as the snap test plus an overnight sealed jar with no condensation.
5. Cutting a root halves its drying time or better at no cost in marker content, while powdering anything accelerates every later loss, so cut for drying, store whole or coarse, grind on the day.
6. Storage at 20 degrees is safe even at high humidity, 40 degrees costs up to 30 per cent of artemisinin in a year even dry, and a few hot days can cost more than a cool year.
7. The shelf-life rule tracks chemistry and not plant part: flavonoid leaves and flowers were unchanged at 24 to 27 months, echinacea root lost over 80 per cent of its alkamides in 64 weeks, cinchona bark assayed true after 150 years.
8. Tinctures do not keep for years. A digitalis tincture lost 20 to 30 per cent of its potency in nine to twelve months by biological assay while a chemical assay showed a slight rise, confirming ME-01 and warning that the wrong test certifies a weak medicine.
9. The microbial load ME-01 found the kettle cannot remove is set in the field and the drying yard, and the only measure shown to lower it is an enclosed dryer with moving warm air, which still does not sterilise.
10. Identification happens once, with the whole plant in hand, and every check in PH-10 is destroyed by cutting and drying, which is why the label, the voucher and the ledger are the only surviving evidence of what is in the jar.

Open questions

- No published per-year rate of alkaloid loss in storage exists for any medicinal alkaloid, which ME-02 flagged and which I confirm. The belladonna work runs to 60 days, the opium work to four years with no measured rate, and the cinchona work compares two points 150 years apart. Nobody has drawn the curve.
- No drying curves by plant part and climate for leaves and flowers at village scale. The thin-layer literature reports model coefficients, not hours, and the only clean hours are for valerian root in a forced-convection dryer.
- No controlled trial of any storage container on dried medicinal herb, and nothing behind the amber-glass rule. The Brazilian packaging study is closest and it tested microbiology, not potency.
- No head-to-head trial of sun against shade drying reporting total aerobic counts, so the microbial case for shade drying rests on inference.
- Whether a fall in a chemical marker corresponds to a fall in clinical effect has been tested almost nowhere. Fish 1955 is the one case where both assays were run on the same ageing material, and they disagreed.
- The claim that the unlabelled jar is the commonest fatal error in the dispensary record could not be sourced to any published series.
- Bourquelot and Perrot on stabilisation of digitalis leaf could not be confirmed, and the FAO 1985 drying manual could not be retrieved.
- The WHO 2003 GACP guidelines could not be read, every WHO-hosted copy redirecting or erroring, so all GACP material here comes from the FAO 2010 derivative booklet, which states that it simplifies them. Trease and Evans, the American Herbal Pharmacopoeia monographs, the Commission E storage notes and Hirt and M'Pia were also unreachable, and nothing here rests on them.
- Whether the one-in-a-village rule can hold across a harvest, when fifteen people gather at once in a short season, is a social question the record does not answer.

Sources to read in full

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At the bedside after the Fall

For a household. The minimum is a dry, airy, shaded place to spread plants off the ground, a knife, clean cloth, a dozen glass jars with tight lids, and something to write with that is still legible in three years. It needs a dozen species it can identify with certainty in the field, a gathering ground away from roads and old works, and the discipline to spread the harvest within an hour of cutting. It gets one year's potent leaf and flower, two or three years of bark, and no reliable way to tell when something has faded. The first failure to expect is the wet autumn, when the mint comes off the rack grey and musty and the family dries it harder and uses it anyway. The second is the jar filled with two herbs because there were not enough jars.

For a village of 300. Add a built dryer, the highest-value construction in this chapter: an enclosed box or shed with a dark-painted solar collector, vents top and bottom, raised mesh trays and a thermometer, sized to take one day's harvest in a thin layer. Add a cool dark store, raised and rodent-proof. Add one named drying supervisor, one harvest ledger, a voucher box of pressed specimens and a shelf of sealed reference samples. Standing stock should be twenty to thirty labelled jars, the narrow-margin plants in a separate locked box with their own ledger, and a harvest calendar on the wall against which actual dates and weather are recorded. The first failure to expect is drift in the drying temperature when the supervisor is away. The second is the label that comes off in a damp winter, which is why the number is scratched into the glass.

For a district of 3,000. Add a bulk cool dark store, a district reference sample of each important drug against which villages compare, blending of several villages' harvests of one plant to narrow the variation without measuring it (THRIVING library, ME-02), and the authority and surplus to condemn and destroy a bad year's stock, which is what makes the condemnation rule real. Add a herbarium that outlives its keeper. The first failure to expect is that the district orders stock destroyed and the villages quietly keep it, because a condemned jar and an empty shelf feel the same to the person who has to say no to a patient.

Records at every rung: species to Latin binomial, part, place with enough detail to return to it, date gathered, who gathered it, dates drying started and finished, method and temperature, fresh and dry weight, batch number, container, date opened, and every batch condemned with its reason.

Protocols

P1. The gathering hour

1. Gather only in dry weather, after the dew has lifted and not in rain. Tolerance: if the plant is visibly wet, do not cut it.
2. Do not gather green leafy herbs in the hottest part of the day. Early morning after dew, or late afternoon.
3. Confirm identification on the whole living plant before cutting, by PH-10's three independent confirmations. Once cut and dried this is no longer possible.
4. Take one extra whole plant for the voucher. Press it flat between paper under a weight and write the batch number on it.
5. Gather at least 50 metres from any road still carrying traffic, and nowhere within sight of or downhill from a former works, smelter, tannery, railway yard, fuel store or shooting range.
6. Where regeneration is in doubt take no more than 70 per cent of any population. Take bark from one side of a trunk only, and never ring a tree.
7. Put cut material in a clean basket or cloth, never on the ground and never in a sack that has held anything else. Keep it in shade and do not pack it tight.
8. Get it to the drying rack within one hour. Two hours in a warm closed sack is enough to start the heating that blackens leaf.

P2. Drying

1. Decide the temperature before you start. Default 35 to 45 degrees, tolerance plus or minus 5. Aromatic material 30 to 35, never above 35. Digitalis leaf and the few drugs the record names, fast and up to but not above 60.
2. Prepare: leaves and flowers whole, stems cut to a hand's length, roots washed, scrubbed and cut into quarters or 5 to 10 mm slices, thick bark chopped, large fruit sliced, small berries whole. Cutting roots halves drying time at no cost in strength.
3. Lay out in a single thin layer on raised mesh, cloth or slats. If you cannot see daylight through the layer in places, it is too thick.
4. Shade everything green and everything aromatic. Bark and non-aromatic roots may go in sun if nothing else is available, under cover against dust and birds.
5. Move air across the material continuously: a draught through an open shed, a cracked window above a stove, or the chimney effect of a solar box dryer vented bottom and top.
6. Label the batch now, on the rack: species, part, place, date started, gatherer. Not after.
7. Turn once or twice a day, handling leaves and flowers as little as possible. Take the material in or cover it at night, because re-absorbed moisture restarts everything.
8. Expect leaves and flowers 1 to 3 days at 35 to 45 degrees with good airflow, longer in a damp climate. Cut roots 4 to 12 hours at 40 to 50 degrees in forced air, several days on an open rack, whole roots about twice as long as quartered. Bark several days. The test decides, not the clock.
9. Stop at the snap: leaves crumble rather than fold, stalks snap rather than bend, roots break with a sharp crack, flowers shatter at a touch, scratched bark comes off dry and not green.
10. Confirm with the jar test. Seal a sample in clear glass overnight. Any condensation in the morning and it goes back on the rack. Cool fully before packing, because warm herb sealed in a jar sweats.

P3. Packing and storing

1. Pack only material that has passed the snap test and the jar test, and not on a damp evening.
2. Store whole or coarsely cut. Do not powder anything you are storing. Grind on the day of use.

3. Use the best container you have, in this order: glass with a sealing lid, tin with a tight lid, a sealed thick plastic bag inside a tin, a sealed thick plastic bag alone. Avoid paper sacks and cloth bags beyond a few weeks.
4. Fill containers nearly full. A half-empty jar holds a half-jar of air.
5. Label before the jar leaves your hand, and scratch or stamp the batch number into the lid or glass so it survives a label falling off.
6. Store cool, dark and dry, at or below 20 degrees. Above 30 degrees the losses roughly triple. The coolest darkest driest corner of the house is worth more than the best jar.
7. Keep containers off the floor and away from walls, with a gap between them so you can see all round each one.
8. Set aside a sealed reference sample of each batch at the start, in the coolest place, opened only to compare.
9. Inspect every container every three months for condensation, caking, colour change, webbing, fine dust at the bottom and reddish-brown beetles 2 to 3 mm long. Smell every jar. Loss of smell is the first detectable failure.
10. Review the whole store once a year at the same point in the calendar, moving last year's stock to the front.

P4. The shelf-life and spoilage sheet

Working lives in a cool dark dry store, to be shortened wherever the store is warm or damp.

Material	Working life	What fails first	Signs
Aromatic leaf and flower (mint, chamomile, lavender, thyme)	6 to 12 months	Volatile oil, 2.5 to 44 per cent a year	Smell fades, colour greys
Flavonoid leaf and flower (elder, calendula, goldenrod, yarrow, pansy)	2 years, sometimes 3	Little, if cool and dry	Browning, dust
Bitter and tannin leaf and bark (willow, oak, gentian)	2 to 3 years	Slow	Taste flattens
Root and rhizome, general	1 to 2 years, not 3	Varies by compound	Smell, snap, colour
Echinacea root specifically	12 months, remake yearly	Alkamides, over 80 per cent in 16 months	Loss of the tongue-tingling
Dry bark, well dried and sealed	3 years and much longer	Little, if dry	Mould if ever damp
Seed and fruit	2 to 3 years	Mould and insects before potency	Caking, frass, musty smell
Powdered anything	Weeks to 3 months	Everything, faster	All of the above
Tincture at 25 per cent ethanol or more	1 year at full strength, 2 usable	Chemistry, not microbes	None visible. This is the danger
Narrow-margin plants of any kind	One season	Unknown and unmeasurable	None. Remake

Condemn and destroy on any of: musty, sour or earthy smell, visible mould or bloom, webbing or live insects, caking that will not break up, condensation inside the container, an unaccountable colour change, or a missing or illegible label.

P5. The harvest calendar template

Fill one per plant per climate over the first three years and keep it on the dispensary wall. Nothing published can replace it, because every figure in this report came from a different climate.

Column	What to write
Species, binomial	Exact, with authority if known
Part	One row per part
Stage to cut	The visible stage, not the date, for example "full flower, first flowers browning"
Local date window	The dates it actually happened, each year, with the weather
Time of day	And whether it mattered
Drying method and temperature	What was used, what was reached
Fresh weight in, dry weight out	This plant's own measured ratio, not a borrowed one
Hours to the snap	In this climate, on this rack
Working life in this store	Revised as the reference samples are compared
Notes	What went wrong, what was condemned

Climate adjustments while the table fills. In a wet or humid climate add 10 degrees or add days, dry indoors with forced airflow, and expect the store rather than the drying to be the limit. In a hot dry climate the drying is easy and the store is hard, so build a cool one and expect the brief's shelf lives to be optimistic by half. In a cold climate the drying needs the stove and the store needs nothing, so build the dryer first. In a tropical climate assume everything aromatic is a one-season crop and build the pharmacopoeia around barks, roots and tinctures.

P6. The labelling rule

1. Nothing is sealed without a label. No exceptions, including samples, including things you will use tomorrow, including things you are sure of.
2. The label carries, in order: species binomial, part, place gathered, date gathered, gatherer or preparer, batch number.
3. For a preparation add ratio, solvent, strength and date made (THRIVING library, ME-01).
4. The batch number is scratched, stamped or burned into the container itself, not only written on paper.
5. The ledger carries everything else, one line per batch, cross-referenced to the voucher specimen and the reference sample.
6. Any container that loses its label is condemned, whatever its contents look like, smell like or are believed to be.
7. Narrow-margin plants go in containers of a different shape or colour, stored separately and locked, never on the common shelf.
8. Before any batch is dispensed for the first time, read the label aloud against the ledger with a second person present.

Numbers to carry

1. **35 to 45, and 30 for the aromatics.** Drying temperature in degrees, never above 35 for anything strongly scented. Sixty only where the record names it, as for digitalis leaf, and then to kill the enzyme.
2. **23 and 36.** The percentage of valerenic acid lost between 15 and 40 degrees, and again between 40 and 50. Every 10 degrees of convenience costs a quarter to a third of the drug.
3. **10 to 12 per cent.** The moisture endpoint, read as the snap test and a sealed jar with no condensation overnight. Five per cent for digitalis.
4. **20, 30, 40.** Degrees in the store. Twenty is safe even in damp air, thirty is the ceiling for long keeping, forty costs up to a third of the drug in a year even dry, and a few hot days cost more than a cool year.
5. **3 to 1.** The rough fresh-to-dry weight ratio for leaf and root, within a true range of 2:1 to 10:1 by part, which is why every plant gets its own measured ratio.

6. **1, 2, 3.** Working years in a cool dark store: one for aromatic leaf and flower and for echinacea root, two for most leaf, flower and root, three and beyond for dry bark and seed. Tinctures one year at full strength.
7. **80 per cent in 64 weeks.** Echinacea root alkamides at room temperature, the number that breaks the two-to-three-year rule for roots.
8. **150 years.** Cinchona bark alkaloids still assaying true. Dry bark sealed is the longest-lived medicine the village will hold.
9. **50 metres.** The minimum distance from any trafficked road, with no gathering within sight of or downhill from old industrial ground.
10. **Never powder for storage, never store wet, never keep an unlabelled jar.** The third is absolute because no test distinguishes dried comfrey from dried foxglove.

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