Phytotherapy for Osteoporosis: An Evidence-Based Report on Herbal Interventions

Abstract

Osteoporosis is a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration, leading to increased fracture risk, particularly among the elderly and postmenopausal women. While conventional pharmacotherapies are effective, concerns regarding side effects and long-term adherence have fueled interest in phytotherapy as a complementary approach. This report provides a comprehensive review of numerous herbs and traditional formulas investigated for their potential in managing osteoporosis. It details the primary mechanisms of action, including phytoestrogenic activity, regulation of the OPG/RANKL signaling pathway, stimulation of osteoblast-promoting pathways, and anti-inflammatory and antioxidant effects. Detailed profiles are provided for over 30 therapeutic herbs and two key traditional formulas, summarizing their traditional uses, pharmacological actions, preclinical and clinical evidence, and crucial safety information, including contraindications and drug interactions. The evidence indicates that while many herbs show significant promise in preclinical models, high-quality human clinical trial data is limited. Herbs such as *Epimedium* spp., Resveratrol, and *Rhizoma Drynariae* possess the strongest human evidence for improving bone mineral density. The report concludes that while herbal interventions can be

valuable adjuncts to conventional care, they must be integrated under the supervision of a qualified healthcare professional due to potential toxicity and drug interactions.

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1. Introduction

1.1 The Clinical Challenge of Osteoporosis

Osteoporosis represents a significant and growing global health issue. Often termed the "silent disease," it progresses without symptoms until a fracture occurs.[1] It is a systemic skeletal disorder defined by low bone mass and the deterioration of the bone's microarchitecture, which results in increased bone fragility and a high susceptibility to fractures, especially of the hip, spine, and wrist.[1] The socioeconomic burden of osteoporosis is immense, disproportionately affecting the aging population and postmenopausal women.[1]

1.2 The Role of Phytotherapy in Osteoporosis Management

Conventional treatments, including bisphosphonates and hormone replacement therapy, are the mainstays of osteoporosis management. However, these treatments are not without challenges, including patient side effects and concerns about long-term efficacy and adherence.[1] Consequently, many individuals are exploring phytotherapy, or herbal medicine, as a complementary or alternative

strategy. This report aims to provide a critical, evidence-based examination of these traditional remedies, distinguishing scientifically plausible interventions from anecdotal claims. The herbs and formulas discussed herein are considered potential *adjuncts* to a comprehensive care plan, not standalone cures.

2. Core Mechanisms of Herbal Interventions in Bone Health

The pathology of osteoporosis is fundamentally an imbalance in bone remodeling, where the activity of bone-resorbing osteoclasts outpaces that of bone-forming osteoblasts.[1] Many herbal interventions target the key molecular pathways that govern this delicate balance.

2.1 Regulation of the OPG/RANKL/RANK Axis

The OPG/RANKL/RANK axis is the master regulator of osteoclast formation. Osteoblasts secrete RANKL (Receptor Activator of Nuclear Factor-κB Ligand), which binds to the RANK receptor on osteoclast precursors, signaling them to mature and resorb bone. To counter this, osteoblasts also secrete Osteoprotegerin (OPG), a decoy receptor that binds to RANKL and prevents it from activating RANK. A healthy OPG-to-RANKL ratio is essential for maintaining bone homeostasis. Many promising herbs appear to exert their effects by increasing OPG and/or decreasing RANKL expression, thereby inhibiting osteoclast formation.[1]

2.2 Stimulation of Osteoblast-Promoting Pathways

Certain herbs directly stimulate pathways that promote the formation and function of osteoblasts. The Wnt/β-catenin and Bone Morphogenetic Protein (BMP) signaling pathways are critical for directing stem cells to differentiate into bone-forming osteoblasts and for supporting their subsequent function and survival.[1]

2.3 Phytoestrogenic Activity

Postmenopausal osteoporosis is primarily driven by estrogen deficiency, which leads to a surge in osteoclast activity.[7] Many plants contain phytoestrogens—compounds that can bind to estrogen receptors and weakly mimic estrogen's natural bone-protective effects. This is a vital mechanism for many herbs traditionally used to treat menopausal symptoms.[7]

2.4 Anti-inflammatory and Antioxidant Effects

There is a growing understanding that chronic, low-grade inflammation and oxidative stress are significant contributors to bone loss. These processes create a microenvironment within the bone that favors osteoclast activity while hindering osteoblasts. Therefore, herbs with potent anti-inflammatory and antioxidant properties are of great interest, as they can help restore a more

favorable environment for balanced bone remodeling.[7]

3. A Critical Note on Safety and Evidence

3.1 Navigating the Evidence Hierarchy

It is crucial to understand the hierarchy of evidence when evaluating herbal remedies. Much of the available data comes from *in vitro* (cell culture) studies, which are useful for identifying potential mechanisms but do not prove efficacy in humans. The next level of evidence comes from preclinical animal models, such as ovariectomized rats, which mimic postmenopausal bone loss.[9] While these studies provide a strong rationale for an herb's potential, the gold standard remains the human randomized controlled trial (RCT), which directly compares an intervention against a placebo or standard of care.[4] For many herbs, the evidence is promising but still preliminary.

3.2 General Safety Considerations

The term "natural" is not synonymous with "safe," particularly for the elderly, who often manage multiple health conditions and take numerous medications. Key safety concerns include:

- **Direct Toxicity:** Some herbs, such as *Psoralea corylifolia*, carry a known risk of hepatotoxicity (liver damage).[19]

- **Contamination:** Unregulated supplements pose a risk of contamination. For example, raw Shilajit has been found to contain heavy metals like lead and arsenic.[21]
- **Drug-Herb Interactions:** The potential for interactions is significant. Many herbs can affect blood clotting, blood sugar, and blood pressure, leading to dangerous interactions with common medications like anticoagulants, antidiabetics, and antihypertensives.[22]

3.3 The Importance of Professional Supervision

Given the complexities of efficacy, safety, and potential interactions, a critical recommendation must be emphasized: **No herb or supplement should be used to treat osteoporosis without the direct supervision of a qualified healthcare professional.**[26] An expert can assess an individual's health status, review their medications, and ensure the use of high-quality, standardized products.

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4. Detailed Profiles of Therapeutic Herbs for Osteoporosis

4.1 *Epimedium* spp. (Horny Goat Weed / Yin Yang Huo)

- **Traditional Use:** A cornerstone of Traditional Chinese Medicine (TCM), *Epimedium* has been used for centuries to "nourish the kidney and reinforce the Yang," a concept directly related to

strengthening bones and treating menopausal symptoms.[5] It is a key ingredient in major anti-osteoporosis formulas like *Xian-Ling-Gu-Bao* and *Er-Xian Decoction*.[30]

- **Mechanism:** Its primary bioactive compound, icariin, exerts a potent phytoestrogenic effect, mimicking estrogen to stimulate osteoblast (bone-forming) activity and inhibit osteoclast (bone-resorbing) activity.[5]
- **Evidence:** The human trial data is among the strongest in this category. A 2022 meta-analysis of multiple RCTs concluded that *Epimedium* significantly improved Bone Mineral Density (BMD), reduced pain, and increased the overall clinical effective rate.[5] A landmark 2007 RCT found that an *Epimedium*-based formula successfully maintained BMD in postmenopausal women over two years.[33]
- **Other Uses:** It is widely known as an aphrodisiac and for its potential anti-aging, anti-inflammatory, and neuroprotective effects.[5]
- **Safety:** While used safely in studies for up to two years, high doses can cause dizziness and breathing problems.[34] Due to its estrogen-like activity, it is **contraindicated in individuals with hormone-sensitive cancers** (e.g., breast, uterine) and those with bleeding disorders.[34] It has significant potential interactions with **anticoagulants, antihypertensives, and estrogen therapy**.[34]

4.2 Resveratrol

- **Traditional Use:** A naturally occurring polyphenol found in foods like red grapes and berries, Resveratrol is known for its

anti-aging and cardiovascular benefits.[6]

- **Mechanism:** It is a potent antioxidant and anti-inflammatory agent that also acts as a phytoestrogen.[6] It enhances osteoblast function via the SIRT1 and AMPK pathways while inhibiting the RANKL pathway to reduce bone resorption.[6]
- **Evidence:** The human evidence is strong. The 24-month RESHAW trial, a large RCT, found that 75 mg of resveratrol twice daily significantly increased BMD in the lumbar spine and femoral neck of postmenopausal women and reduced a key marker of bone resorption.[35]
- **Other Uses:** It is researched for improving cardiovascular function, cognitive function, and metabolic health.[6]
- **Safety:** Resveratrol is considered very safe, even at high doses, though it may cause mild stomach upset.[36] Caution is advised for those with
  bleeding disorders or **hormone-sensitive conditions**.[36] Its main drug interaction concern is with
  anticoagulant/antiplatelet drugs.[36]

4.3 *Salvia miltiorrhiza* (Danshen / Red Sage)

- **Traditional Use:** Famous in TCM for "invigorating blood," Danshen is traditionally used for cardiovascular and circulatory issues, which translates to improving nutrient delivery to bone.[22]
- **Mechanism:** Its bioactive compounds, tanshinones and salvianolic acids, provide a multi-pronged effect. Tanshinones potently inhibit osteoclast formation by interfering with the RANKL pathway and selectively blocking the collagen-degrading activity of the enzyme Cathepsin K.[7] Salvianolic acids promote

osteoblast activity via the Wnt/β-catenin pathway and provide powerful antioxidant effects.[7]

- **Evidence:** The human clinical data is extensive, though primarily from formula-based trials in China. A 2024 review of 38 such trials reported consistently high efficacy rates (77-97%).[37] Animal studies are also strong, showing a 35% increase in BMD in mice.[7]
- **Other Uses:** It is used for angina, high cholesterol, and stroke recovery.[22]
- **Safety:** Significant caution is required due to its potent circulatory effects. It is **contraindicated in people with bleeding disorders or low blood pressure** and must be stopped two weeks before surgery.[22] It has major interactions with
  anticoagulants (warfarin) and **antihypertensive medications**.[22]

4.4 *Curcuma longa* (Turmeric)

- **Traditional Use:** A staple in both kitchens and Ayurvedic medicine, Turmeric (and its active compound, curcumin) is renowned for its powerful anti-inflammatory properties.[17]
- **Mechanism:** Curcumin directly targets the chronic inflammation and oxidative stress that drive osteoporosis. It inhibits pro-inflammatory factors like TNF-α and IL-6 and favorably regulates the OPG/RANKL axis to suppress bone resorption while promoting bone formation.[17]
- **Evidence:** While large-scale human trials for osteoporosis are still needed, a 2025 meta-analysis of animal studies found that curcumin significantly increased BMD and improved bone

microarchitecture.[17]

- **Other Uses:** It is used for nearly any condition with an inflammatory component, from arthritis to metabolic syndrome.[17]
- **Safety:** Turmeric has an excellent safety profile and is very well-tolerated.[46] Side effects are rare and mild. Its interaction profile is minimal, making it one of the safest options for a dietary approach to bone health.

4.5 *Rhizoma Drynariae* (Gu Sui Bu)

- **Traditional Use:** The TCM name translates to "mender of shattered bones," reflecting its centuries-long use for healing fractures and treating osteoporosis.[4]
- **Mechanism:** Its active components, the Total Flavonoids from *Rhizoma Drynariae* (TFRD), have been developed into a licensed medicine in China.[4] TFRD provides a dual action, simultaneously stimulating bone formation (via Wnt/β-catenin and BMP pathways) and inhibiting bone resorption (via the OPG/RANKL system).[4]
- **Evidence:** The human clinical data is impressive. A 2017 meta-analysis of six RCTs involving 846 patients found that TFRD, alone or with conventional treatments, was significantly better at improving BMD than conventional treatments alone.[4]
- **Other Uses:** It is also used for toothaches and tinnitus.[47]
- **Safety:** It is well-tolerated, with only mild gastrointestinal symptoms reported as the most common adverse effect in clinical trials.[4] There are no well-documented drug interactions, giving it a favorable safety profile.[47]

4.6 *Zingiber officinale* (Ginger)

- **Traditional Use:** A globally recognized spice, Ginger is used in traditional medicine for its pain-relieving and anti-inflammatory properties, including for joint pain.[26]
- **Mechanism:** Its active compounds, gingerols and shogaols, are potent antioxidants and anti-inflammatories that suppress the inflammatory factors driving bone loss.[48]
- **Evidence:** While large-scale human trials are still emerging, one recent RCT found benefit from ginger and curcumin co-supplementation in postmenopausal women with osteoporosis.[48]
- **Other Uses:** It is famously used for nausea, indigestion, and arthritis.[26]
- **Safety:** Ginger has an excellent safety profile. It is widely consumed as food and is very safe as a supplement, with only mild stomach discomfort at very high doses.

4.7 *Panax notoginseng* (San Qi / Tianqi)

- **Traditional Use:** A valued TCM herb, San Qi is traditionally used to stop bleeding and "move blood," making it a primary remedy for traumatic injuries and fractures.[11]
- **Mechanism:** Its saponins, flavonoids, and polysaccharides improve bone quality through anti-inflammatory, antioxidant, and estrogenic effects. It also promotes angiogenesis (new blood vessel formation), which is critical for bone healing.[11]

- **Evidence:** A 2025 review identified eight clinical trials where San Qi was used (mostly in formulas) for osteoporotic fractures with good results.[11] A recent RCT on a related ginseng extract showed an increase in the bone formation marker osteocalcin.[50]
- **Other Uses:** It is used for angina, stroke recovery, and high cholesterol.[51]
- **Safety:** It is generally well-tolerated for short-term use. However, long-term use has been associated with potential **liver and kidney toxicity**.[11] It is **contraindicated in hormone-sensitive conditions**.[51] It has a major interaction with the blood thinner **warfarin**.[51]

4.8 *Boswellia serrata* (Frankincense / Shallaki)

- **Traditional Use:** An Ayurvedic gum resin, Boswellia is a classic treatment for chronic inflammatory diseases, especially arthritis.[15]
- **Mechanism:** Its active constituents, boswellic acids (especially AKBA), are potent anti-inflammatories. They inhibit TNF-α, a key cytokine that promotes the RANKL signal for bone resorption.[15]
- **Evidence:** The human clinical data for osteoarthritis is very strong, with multiple RCTs demonstrating significant reductions in pain and improvements in mobility.[53] While direct osteoporosis trials are needed, the anti-inflammatory mechanism is directly relevant.
- **Other Uses:** It is used for rheumatoid arthritis, asthma, and inflammatory bowel disease.[56]
- **Safety:** It is generally considered safe and well-tolerated.[54] It

may interact with **immunosuppressant medications** and drugs metabolized by the liver.[56]

4.9 *Psoralea corylifolia* (Bu Gu Zhi)

- **Traditional Use:** One of the most common and potent TCM herbs for osteoporosis, its name means "to mend bone." It is a key ingredient in the *Xian-Ling-Gu-Bao* formula.[31]
- **Mechanism:** It is a powerful regulator of the OPG/RANKL pathway, strongly inhibiting osteoclast activity.[8] Its compound Corylin has been shown to inhibit osteoclast formation.[60]
- **Evidence:** Despite strong preclinical data, there is a lack of high-quality standalone human trials. Its efficacy is inferred from its use in clinically studied formulas.[59]
- **Other Uses:** It is used for skin conditions like vitiligo.[20]
- **Safety:** This herb carries a significant and well-documented risk of **hepatotoxicity (liver damage)**.[19] This risk is so pronounced that it is almost always used in complex formulas where other herbs are thought to mitigate its toxicity. Its use requires expert supervision.

4.10 *Ligustrum lucidum* (Glossy Privet / Nu Zhen Zi)

- **Traditional Use:** A gentle, nourishing tonic in TCM used for over a millennium to "tonify Liver and Kidney Yin," addressing symptoms of aging like dizziness and back soreness.[27]
- **Mechanism:** It improves calcium balance by increasing intestinal

absorption and reducing urinary excretion.[61] It also helps regulate calciotropic hormones and inhibits osteoclast formation.[61]
- **Evidence:** Despite a strong preclinical rationale, there is a **lack of high-quality human clinical trials** for osteoporosis.[63]
- **Other Uses:** It is used to support the immune system and protect the liver.[27]
- **Safety:** The processed, dried fruit has a very high margin of safety and is well-tolerated.[61] However, the **raw, unprocessed berries and leaves are toxic** if ingested.[66]

4.11 *Angelica sinensis* (Dong Quai / Dang Gui)

- **Traditional Use:** Known as "female ginseng," Dong Quai is the quintessential TCM herb for "nourishing the blood" and is used for a vast range of gynecological and menopausal symptoms.[68]
- **Mechanism:** Recently discovered compounds (falcarinphthalides) have shown potent osteoclast inhibitory activity in cellular tests.[69] It is also a key part of formulas that promote osteoblast differentiation.[73]
- **Evidence:** Direct human trials for osteoporosis are sparse. Its efficacy is primarily evaluated within formulas.
- **Other Uses:** It is used for nearly all female reproductive health concerns.[71]
- **Safety:** It can cause **photosensitivity**.[71] It is **contraindicated during pregnancy** and in those with **bleeding disorders** or **hormone-sensitive cancers**.[71] It has a significant interaction with **anticoagulants** like warfarin.[71]

4.12 *Cissus quadrangularis* (Hadjod / Veldt Grape)

- **Traditional Use:** An Ayurvedic herb whose name means "bone setter," it has been used for centuries to heal fractures and treat joint pain.[74]
- **Mechanism:** It contains anabolic steroidal substances and antioxidants that aid bone repair. It decreases osteoclast activity and modulates the immune system to favor bone health.[74]
- **Evidence:** Human clinical data is promising, particularly for fracture healing, where it has been shown to increase levels of healing proteins.[75] In a study on postmenopausal women with osteopenia, it
  delayed bone loss, though it did not significantly improve BMD.[75]
- **Other Uses:** It is used for weight loss and diabetes management.[75]
- **Safety:** It is generally considered safe, with only mild side effects reported. It has no well-documented major drug interactions, giving it a favorable safety profile.[75]

4.13 *Rehmannia glutinosa* (Shu Di Huang / Chinese Foxglove)

- **Traditional Use:** A fundamental "kidney tonifying" herb in TCM, it is the lead herb in the famous Liuwei Dihuang Pill (LWDHP) used for many age-related conditions.[18]
- **Mechanism:** It promotes bone formation by enhancing osteoblast proliferation and differentiation, while inhibiting bone resorption by inhibiting RANKL-induced osteoclast formation.[18]

- **Evidence:** Human evidence is primarily derived from studies on the LWDHP formula, which has been shown to increase BMD in postmenopausal women.[18]
- **Other Uses:** The LWDHP formula is used for diabetes and cancer support.[18]
- **Safety:** It is considered possibly safe for short-term use. It may lower blood sugar and blood pressure, requiring caution with **antidiabetes** and **antihypertensive medications**.[78]

4.14 *Thymus vulgaris* (Thyme)

- **Traditional Use:** A common culinary herb with known therapeutic properties.[14]
- **Mechanism:** Its benefits are linked to potent antioxidant and anti-inflammatory effects from compounds like thymol and carvacrol.[14] Animal studies show it inhibits bone loss and improves BMD.[14]
- **Evidence:** Thyme has emerged with direct human clinical evidence. Trials in postmenopausal women found that thyme supplementation (500 mg twice daily) led to a **significant increase in BMD and T-score**, and showed a powerful synergistic effect when added to the conventional drug alendronate.[81]
- **Other Uses:** It is used for respiratory conditions like coughs.[82]
- **Safety:** It has an excellent safety profile. Caution is advised for those with **hormone-sensitive conditions** or on **anticoagulant drugs**.[82]

4.15 *Cornus officinalis* (Shan Zhu Yu / Japanese Cornel)

- **Traditional Use:** A key "kidney-tonifying" herb in TCM, used in major formulas like LWDHP to treat age-related weakness and lower back pain.[1]
- **Mechanism:** It has multi-target effects, promoting osteoblast formation, inhibiting osteoclast activity, improving the bone's vascular system, and providing immunomodulatory benefits.[1]
- **Evidence:** Human evidence is inferred from its role in clinically studied formulas. Standalone trials are lacking.[1]
- **Other Uses:** It is used to support liver and reproductive health.[28]
- **Safety:** It is generally well-tolerated, but safety data is limited. Caution is advised with **blood-thinning medications**.[28]

4.16 *Rosmarinus officinalis* (Rosemary)

- **Traditional Use:** A culinary herb known for supporting memory and cognition.[79]
- **Mechanism:** It is rich in bone-healthy minerals and powerful anti-inflammatory and antioxidant compounds like carnosic acid.[79] Animal studies show it can significantly increase BMD.[83]
- **Evidence:** There are no direct human clinical trials for osteoporosis. Evidence is based on strong preclinical data.[83]
- **Other Uses:** It is used to improve memory, aid digestion, and topically for hair loss.[79]
- **Safety:** It is very safe in culinary amounts. Very large medicinal doses can cause side effects. It should be **avoided in medicinal doses during pregnancy**.[84]

4.17 *Eucommia ulmoides* (Du Zhong / Hardy Rubber Tree)

- **Traditional Use:** A classic TCM herb used to "tonify the liver and kidney, and strengthen bones and muscles," particularly for lower back and knee pain.[10]
- **Mechanism:** Its total flavonoids (TFEL) regulate the OPG/RANKL pathway to prevent bone resorption and have been shown to beneficially regulate gut microbiota, which is linked to bone metabolism.[10]
- **Evidence:** Human clinical evidence is still emerging. A trial on its effects on osteoarthritis has been completed, but direct osteoporosis trials are needed.[85]
- **Other Uses:** It is used for general weakness and strengthening the lower back.[49]
- **Safety:** Animal studies suggest a good safety profile with no toxic side effects, but human safety data is not well-established.[10]

4.18 *Lepidium meyenii* (Maca)

- **Traditional Use:** An Andean root vegetable used for over 2000 years to enhance energy, stamina, and fertility.[86]
- **Mechanism:** Preclinical studies show that red and black maca can protect bone architecture in animal models, importantly without showing estrogenic effects on the uterus.[86]
- **Evidence:** There is currently a **lack of human clinical trial data** for Maca in osteoporosis.[13]
- **Other Uses:** It is widely used to improve sexual function, energy,

and mood.[86]
- **Safety:** It is generally safe as a food product but can cause side effects like moodiness and insomnia. It should be avoided by individuals with **hormone-sensitive cancers**.[88]

4.19 *Cuscuta chinensis* (Tu Si Zi / Chinese Dodder Seed)

- **Traditional Use:** A widely used TCM herb to "tonify the kidney," improve sexual function, and treat osteoporosis.[9]
- **Mechanism:** In animal models of glucocorticoid-induced osteoporosis, its extract increased BMD by favorably regulating the RANKL/OPG and RunX2 pathways.[9]
- **Evidence:** There is a lack of direct human clinical trials for osteoporosis.
- **Other Uses:** It is used to improve sexual function and as a general anti-aging tonic.[9]
- **Safety:** It appears to have a good safety profile, with one human trial reporting only mild side effects and no significant impact on liver or renal function.[90]

4.20 Shilajit

- **Traditional Use:** A mineral-rich resin from the Himalayas, used in Ayurvedic medicine as a *rasayana* (rejuvenating substance) to "destroy weakness" and improve bone density.[21]
- **Mechanism:** Its primary bioactive, fulvic acid, is a potent antioxidant. Its benefits are linked to reducing oxidative stress and its rich mineral content.[21]

- **Evidence:** Human evidence is limited but promising. A 2022 study in postmenopausal women with osteopenia found that Shilajit supplementation **reduced bone loss, inflammation, and oxidative stress** compared to placebo.[93]
- **Other Uses:** It is used to enhance energy, cognitive function, and fertility.[92]
- **Safety:** This is a critical issue. While purified Shilajit is relatively safe, **raw, unprocessed products carry a high risk of contamination with toxic heavy metals** like lead and arsenic.[21] It may interact with
  blood thinners and **diabetes medications**.[92] Use requires extreme caution and high-quality sourcing.

4.21 *Achyranthes bidentata* (Niu Xi / Ox Knee)

- **Traditional Use:** A TCM herb with a strong reputation for treating bone and joint disorders, believed to strengthen the liver and kidney.[3]
- **Mechanism:** A 2024 meta-analysis of 11 animal studies concluded that its extract **effectively promotes an increase in bone mineral density**.[3]
- **Evidence:** Human data comes from RCTs on formulas containing Niu Xi, which have been shown to relieve bone pain and improve BMD.[3] Standalone trials are needed.
- **Other Uses:** It is used for musculoskeletal and gastrointestinal problems.[94]
- **Safety:** It is generally considered safe, but high doses may cause GI upset. Comprehensive safety data is lacking.[94]

4.22 *Tinospora cordifolia* (Guduchi / Amrita)

- **Traditional Use:** A highly revered Ayurvedic herb, its name "Amrita" means "nectar of the gods." It is a powerful immunomodulatory and rejuvenating herb.[96]
- **Mechanism:** Its potent anti-inflammatory and antioxidant properties can help create a more favorable environment for bone remodeling.[97]
- **Evidence:** There is a **lack of clinical trials** investigating its effects on osteoporosis in humans.[99]
- **Other Uses:** It is used for fevers, diabetes, and arthritis.[96]
- **Safety:** Its powerful immune-stimulating effects mean it should be **avoided by individuals with autoimmune diseases** (e.g., MS, lupus, RA).[100] It may interact with **antidiabetes medications** and **immunosuppressants**.[100]

4.23 *Astragalus membranaceus* (Huang Qi)

- **Traditional Use:** A fundamental "Qi tonic" in TCM, used to boost the immune system and strengthen the body.[101]
- **Mechanism:** Preclinical evidence shows it stimulates the proliferation of bone marrow stromal cells (osteoblast precursors) and is a key component of formulas shown to promote osteoblastic differentiation.[102]
- **Evidence:** There are **no high-quality human studies** demonstrating the effectiveness of standalone Astragalus for osteoporosis.[25]
- **Other Uses:** It is used for the common cold and to support

patients undergoing chemotherapy.[25]
- **Safety:** It should be **avoided by people with autoimmune diseases**.[25] It has an extensive drug interaction profile, including with
immunosuppressants, anticoagulants, and lithium.[25]

4.24 *Nigella sativa* (Black Cumin Seed)

- **Traditional Use:** A traditional medicine staple in the Middle East, often said to "cure everything but death."[104]
- **Mechanism:** Its active compound, thymoquinone (TQ), is a powerful antioxidant and anti-inflammatory that can inhibit inflammatory cytokines and the NF-κB pathway.[104]
- **Evidence:** Human clinical evidence is emerging. One trial investigated its effects on bone density in postmenopausal women, and another showed benefit when combined with curcumin.[48]
- **Other Uses:** It is used for asthma, allergies, and diabetes.[104]
- **Safety:** It has a significant potential for drug interactions. It is **contraindicated during pregnancy, before surgery, and for those on anticoagulant therapy**.[24] It interacts with medications for
diabetes and **hypertension** and inhibits key liver enzymes (CYP3A4, CYP2D6).[24]

4.25 *Cistanche deserticola* (Rou Cong Rong / "Desert Ginseng")

- **Traditional Use:** A prized TCM tonic used to treat "kidney

deficiency," impotence, and constipation.[105]

- **Mechanism:** Animal studies show it has significant anti-osteoporosis activity, improving BMD and bone structure.[106] A recent study revealed its primary mechanism is the beneficial **regulation of lipid metabolism**, which is strongly correlated with bone turnover markers.[106]
- **Evidence:** There are **no direct human clinical trials** evaluating *Cistanche* for osteoporosis.[107]
- **Other Uses:** It is used for gynecological diseases and to improve sexual function.[105]
- **Safety:** There is very limited information on its safety and drug interaction profile, which is a major limitation.[108]

4.26 *Humulus lupulus* (Hops)

- **Traditional Use:** Known for its use in brewing, Hops is also a medicinal plant used as a sedative.[16]
- **Mechanism:** It contains one of the most potent phytoestrogens discovered, **8-prenylnaringenin**, which can mimic estrogen's bone-protective effects.[109] Animal studies show it significantly **enhanced bone mineral density** and improved bone microarchitecture.[16]
- **Evidence:** There are **no human clinical trials** for osteoporosis.[16]
- **Other Uses:** It is used for anxiety, restlessness, and insomnia.[16]
- **Safety:** It is generally safe. Due to its potent estrogenic activity, it should be used with caution or avoided by individuals with **hormone-sensitive cancers**.[110]

4.27 *Carthamus tinctorius* (Hong Hua / Safflower)

- **Traditional Use:** Used in TCM to "invigorate the blood" and in folk medicine to enhance bone formation.[2]
- **Mechanism:** Preclinical studies show its seed extract promotes osteoblast proliferation, and a diet of its buds increased BMD in animal models.[2]
- **Evidence:** There is a **lack of high-quality human clinical trials** for osteoporosis.[113]
- **Other Uses:** It is used for menstrual pain and pain from injuries.[116]
- **Safety:** It is a uterine stimulant and is **contraindicated during pregnancy**.[117] Allergic reactions are possible.[117]

4.28 *Withania somnifera* (Ashwagandha)

- **Traditional Use:** A premier adaptogen in Ayurvedic medicine, used to help the body resist stress and for conditions of debility.[119]
- **Mechanism:** As an adaptogen, it can modulate the body's stress response and cortisol levels, which can indirectly benefit bone health. Animal studies show it has the potential to improve BMD.[120]
- **Evidence:** Human clinical trial data for osteoporosis is **lacking**.[121] A pharmacokinetic study in older adults is underway to understand its metabolism in this population.[122]
- **Other Uses:** It is well-studied for reducing stress and anxiety, improving sleep, and boosting male fertility.[121]
- **Safety:** It is generally safe for short-term use but has been

linked to rare cases of **liver injury**.[121] It is **contraindicated in pregnancy, autoimmune diseases, thyroid disorders, and hormone-sensitive prostate cancer**.[121] It has a significant interaction profile with medications for **diabetes, hypertension, and immunosuppressants**.[121]

4.29 *Morindae Officinalis Radix* (Ba Ji Tian)

- **Traditional Use:** A "kidney Yang" tonic in TCM used to strengthen sinews and bones and treat lower back pain.[123]
- **Mechanism:** Preclinical studies show its extracts and polysaccharides can inhibit bone loss in animal models.[124]
- **Evidence:** There is a **lack of human clinical trials** for osteoporosis.[124]
- **Other Uses:** It is used to improve kidney function and treat erectile dysfunction.[123]
- **Safety:** Its safety profile is not well-documented. Caution is advised for those with **diabetes**.[124]

4.30 *Dioscorea opposita* (Chinese Yam / Shan Yao)

- **Traditional Use:** A gentle Qi tonic in TCM used as both food and medicine to nourish the Spleen and Kidney.[125] It is a key ingredient in the LWDHP formula.[18]
- **Mechanism:** It contains diosgenin, which has shown estrogenic effects in lab studies and may indirectly modulate hormones.[13]
- **Evidence:** Human clinical evidence for osteoporosis is **lacking** and its promotion as a "natural alternative" is not supported by

sufficient evidence.[13]

- **Other Uses:** It is used for digestive issues and diabetes management.[125]
- **Safety:** It is very safe as a food. In large supplement doses, it can cause GI upset. It should be avoided by people with **hormone-sensitive conditions**.[127]

4.31 Guggul (*Commiphora wightii*)

- **Traditional Use:** A cornerstone of Ayurvedic medicine, this gum resin is known for its "Kapha-reducing" properties, which translates to strengthening bones.[44] It is a key ingredient in the Lakshadi Guggul formula for bone problems.[129]
- **Mechanism:** Its active compounds are guggulsterones. Its bone-health effects are thought to relate to its anti-inflammatory and tissue-strengthening properties.[44]
- **Evidence:** Human evidence is limited but indicative. A phase 2 clinical study was registered in India to evaluate formulas containing Guggul for osteopenia/osteoporosis.[130] An outcomes study on osteoarthritis of the knee found it significantly improved pain and function.[132]
- **Other Uses:** It is used for high cholesterol, acne, and arthritis.[128]
- **Safety:** It can cause mild side effects like nausea and rash. There are rare but serious case reports of **liver issues**.[128] It has a significant interaction with **CYP3A4 substrate drugs**, potentially making many common medications less effective.[128]

4.32 Triphala

- **Traditional Use:** A cornerstone Ayurvedic formulation of three fruits (Amalaki, Bibhitaki, Haritaki), it is a rejuvenating tonic most famous as a gentle laxative.[26]
- **Mechanism:** Its powerful antioxidant and anti-inflammatory properties, from a rich content of tannins and vitamin C, can help combat the oxidative stress that contributes to bone loss.[26]
- **Evidence:** Human evidence is **indirect and limited**. There are no direct clinical trials for osteoporosis.[135] Clinical studies in India have explored its use in a broader therapeutic context for post-menopausal osteoporosis.[136]
- **Other Uses:** It is widely used and clinically confirmed to improve gastrointestinal health, reducing constipation and abdominal pain.[134]
- **Safety:** Triphala has an excellent safety profile and is very well-tolerated. There are no major documented safety concerns or drug interactions, making it one of the safer traditional formulations.[133]

4.33 *Acanthopanax senticosus* (Siberian Ginseng / Ci Wu Jia)

- **Traditional Use:** An adaptogenic herb used in TCM to boost energy and enhance physical performance.[38]
- **Mechanism:** Preclinical evidence suggests a direct effect on bone growth. Its active compound, Eleutheroside E, has anti-inflammatory and anti-osteoporotic actions, preventing bone loss and reducing inflammatory markers in animal models.[102]

- **Evidence:** There is a **lack of human clinical trials** evaluating Siberian Ginseng for osteoporosis.[137]
- **Other Uses:** It is used to increase energy and improve athletic performance.[137]
- **Safety:** This herb is a significant concern. It can cause side effects like nervousness, restlessness, and insomnia. It is not recommended for individuals with **high blood pressure** or certain **heart conditions**.[137] It may decrease the effectiveness of the blood-thinner **warfarin**.[140]

4.34 *Salvia officinalis* (Common Sage)

- **Traditional Use:** A culinary herb traditionally used to reduce menopausal symptoms like hot flashes, pointing to hormonal activity.[12]
- **Mechanism:** Its phytoestrogen content may offer a weak estrogenic effect, helping to slow bone loss. An animal study found a sage diet helped inhibit bone breakdown.[12]
- **Evidence:** There are **no human clinical trials** evaluating Common Sage for osteoporosis.[141]
- **Other Uses:** It is used for menopausal symptoms and to improve cognitive function.
- **Safety:** While safe in culinary amounts, large medicinal doses can be toxic due to the compound **thujone**, which is neurotoxic and can cause seizures.[142]

4.35 *Prunus persica* (Peach Kernel / Tao Ren)

- **Traditional Use:** A powerful TCM herb used to "invigorate blood circulation," making it theoretically useful for fracture healing.[116]
- **Mechanism:** Scientific evidence for its effect on osteoporosis is very limited. Its potential is inferred from its traditional circulatory and healing functions.[116]
- **Evidence:** There are **no human clinical trials** evaluating Tao Ren for osteoporosis.[143]
- **Other Uses:** It is used for menstrual irregularities and constipation.[116]
- **Safety:** It is **contraindicated during pregnancy and menstruation** due to its strong blood-moving effects.[145] It should be used with caution in those on **blood-thinning medications**.[116]

5. Analysis of Key Herbal Formulas

5.1 Formula Focus #1: *Er-Xian Decoction*

Er-Xian Decoction (EXD) is a classic TCM formula developed to treat menopausal syndromes, including osteoporosis. It is composed of six herbs: *Epimedium*, *Curculigo orchioides*, *Morinda officinalis*, *Angelica sinensis*, *Phellodendron chinense*, and *Anemarrhena asphodeloides*.[30] It is designed to balance Yin and Yang through a sophisticated combination of warming and cooling herbs. Pharmacological studies show it attenuates bone loss in animal models by reducing inflammatory cytokines and preventing

osteoblast apoptosis.[30] While large-scale RCTs are needed, its components are well-studied, and its widespread clinical use provides a strong basis for its consideration.[146]

5.2 Formula Focus #2: *Xian-Ling-Gu-Bao* (XLGB) Capsules

Xian-Ling-Gu-Bao (XLGB) is a modern Chinese patent medicine specifically approved for the treatment of osteoporosis.[59] It contains six potent anti-osteoporotic herbs:

Epimedium, *Dipsacus asper*, *Salvia miltiorrhiza*, *Psoralea corylifolia*, *Rehmannia glutinosa*, and *Anemarrhena asphodeloides*.[31] The clinical evidence for XLGB is strong. A systematic review found it had a beneficial effect on quality of life and pain relief and increased BMD to a similar degree as conventional treatments.[59] Its safety profile appears good in clinical trials, with no significant increase in adverse events when added to conventional medications.[59] This is notable given its inclusion of the potentially hepatotoxic

Psoralea corylifolia, suggesting a mitigating effect from the other herbs in the formula.

6. Synthesis and Comparative Analysis

6.1 Overarching Mechanistic Themes

A review of these herbs reveals several powerful, recurring themes.

The most prominent is the convergence of many herbs on the **OPG/RANKL signaling pathway**. Potent herbs from both TCM (*Salvia miltiorrhiza*, *Psoralea corylifolia*) and Ayurveda (*Boswellia*) primarily work by inhibiting the RANKL signal that drives bone resorption. This aligns traditional use for "strengthening bone" with a specific molecular target.

A second major theme is the role of **inflammation and oxidative stress**. Common culinary spices like Turmeric, Ginger, Rosemary, and Thyme are potent anti-inflammatories. Their ability to reduce inflammatory cytokines directly impacts the OPG/RANKL axis, providing a strong scientific rationale for an anti-inflammatory diet as a foundational strategy for managing osteoporosis.

The third theme is **phytoestrogenic activity**. For postmenopausal women, herbs like *Epimedium*, Resveratrol, and Hops offer a weak estrogenic effect that can help counteract bone loss. However, this mechanism also carries a critical warning: a potential contraindication for women with a history of hormone-sensitive cancers.

6.2 The Power of Formulation: Synergy and Toxicity Mitigation

Traditional medicine emphasizes the power of the formula over the single herb, a concept often overlooked in the Western supplement model. A formula like *Er-Xian Decoction* or *Xian-Ling-Gu-Bao* can provide multi-target therapy, simultaneously inhibiting bone resorption, stimulating bone formation, reducing inflammation, and improving circulation.[30]

Furthermore, formulation is key to mitigating toxicity. The known liver toxicity risk of *Psoralea corylifolia* is a prime example. In the *Xian-Ling-Gu-Bao* formula, it is combined with herbs like *Salvia miltiorrhiza* and *Rehmannia*, which have liver-protective properties. This demonstrates a sophisticated understanding of pharmacodynamics, where "minister" herbs buffer the potentially harsh effects of the "emperor" herb.

7. Conclusion and Recommendations

7.1 Summary of Evidence Strength

While the preclinical data for many of these herbs is vast and compelling, the human clinical data remains a bottleneck.

- **Strongest Human Evidence:** *Epimedium*, Resveratrol, and *Rhizoma Drynariae* (TFRD) have the most robust human evidence for directly improving bone mineral density or fracture-related outcomes.
- **Promising Human Data:** Thyme, *Cissus quadrangularis*, and Guggul have encouraging human data for either osteoporosis or closely related conditions like osteoarthritis and fracture healing.
- **Formula-Based Evidence:** Many other herbs, such as *Salvia miltiorrhiza* and *Panax notoginseng*, derive their human evidence primarily from formula-based trials in Asia, which are encouraging but require further validation.

7.2 Practical Recommendations for Adjunctive Use

The safest and most accessible takeaway is the value of incorporating anti-inflammatory culinary herbs like **Turmeric, Ginger, Rosemary, and Thyme** into the daily diet. Their excellent safety profiles and proven mechanisms make them a low-risk, high-reward component of a holistic lifestyle approach. For more potent medicinal herbs, the use of high-quality, standardized products from reputable sources is critical to avoid the dangers of contamination.

7.3 The Imperative of a Holistic and Supervised Approach

Ultimately, these herbal interventions should be viewed as **adjuncts, not cures or replacements** for conventional care. The foundation of osteoporosis management remains a plan developed with a healthcare provider, which may include pharmacotherapy and must include adequate intake of calcium and Vitamin D, along with regular weight-bearing and muscle-strengthening exercise. Herbal supplements can be a powerful addition to this plan, but only when integrated thoughtfully and safely, in close consultation with a knowledgeable physician or qualified healthcare practitioner.

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8. Appendix

Table 1: Comprehensive Summary of Herbal Interventions for Osteoporosis

Herb (Scientific, Common & TCM Name)	Key Bioactive Compound(s)	Primary Mechanism(s) of Action	Strength of Human Evidence	Summary of Key Clinical Findings	Key Safety Concerns & Contraindications	Major Drug Interactions
***Epimedium* spp.** (Horny Goat Weed, Yin Yang Huo)	Icariin, Flavonoids	Phytoestrogenic, ↑Osteoblast activity, ↓Osteoclast activity	Strong	Meta-analysis of RCTs shows ↑BMD, ↑effective rate, ↓pain.[5]	Hormone-sensitive cancers, bleeding disorders, pregnancy. High doses can cause respiratory issues.[34]	Anticoagulants, Antihypertensives, CYP450 substrates, Estrogens.[34]
Resveratrol (from *Vitis vinifera*, etc.)	Resveratrol	Phytoestrogenic, Antioxidant, Anti-infl	Strong	RCT (RESHAW trial) shows ↑BMD in lumbar	Bleeding disorders, hormone-sensit	Anticoagulants/ Antiplatelets, CYP450 substrat

		ammatory, ↑SIRT1, ↑Osteoblast activity, ↓Osteoclast activity		spine & femoral neck, ↓fracture risk in postmenopausal women.[35]	ive conditions. Generally very safe.[36]	es.[36]
Salvia miltiorrhiza (Danshen, Red Sage)	Tanshinones, Salvianolic acids	↓RANKL, Inhibits Cathepsin K, ↑Wnt/β-catenin, Improves microcirculation, Antioxidant	Moderate	38 TCM clinical trials (in formulas) show high efficacy (77-97%).[37] No standalone RCTs.	Bleeding disorders, low blood pressure. Stop 2 weeks before surgery.[22]	Anticoagulants (Warfarin), Antihypertensives (Calcium channel blockers, ACE inhibitors).[22]
Curcuma longa (Turmeric, Haridra)	Curcumin	Anti-inflammatory (↓TNF-α, ↓IL-6), Antioxidant, ↑OPG/↓RANKL,	Limited (for OP)	Preclinical meta-analysis shows significant ↑BMD and	Extremely safe. Mild GI upset at very high doses. Caution with	Minimal. Potential interaction with anticoagulants at high doses.

		↑Wnt/β-catenin		improved microarchitecture.[17] Human trials for related conditions (OA) are positive.[53]	anticoagulants.[46]	
Rhizoma Drynariae (Gu Sui Bu)	Total Flavonoids (TFRD) e.g., Naringin	↑OPG/↓RANKL, ↑Wnt/β-catenin, ↑BMP, ↑Osteoblast activity, ↓Osteoclast activity	Strong	Meta-analysis of 6 RCTs (846 patients) shows significant ↑BMD and therapeutic effect vs. conventional treatment.[4]	Generally well-tolerated. Mild GI symptoms are the most common adverse effect.[4] Contraindicated in "yin deficiency" in TCM.[47]	No known drug interactions.[47]

Zingiber officinale (Ginger)	Gingerols, Shogaols	Anti-inflammatory, Antioxidant	Limited (for OP)	Human trial shows benefit when co-supplemented with curcumin in postmenopausal women with OP.[48] Strong preclinical data.	Excellent safety profile. Mild GI upset at very high doses. Caution with anticoagulants.[26]	Minimal. Potential interaction with anticoagulants at high doses.
Panax notoginseng (San Qi, Tianqi)	Saponins (Ginsenosides)	Anti-inflammatory, Angiogenesis, Estrogenic effects, ↑Wnt/β-catenin	Moderate	8 clinical trials (in formulas) show good effects for osteoporotic fractures.[11] RCT on related	Potential liver/kidney toxicity with long-term use. Hormone-sensitive conditions, pregna	Warfarin, Aspirin, CYP1A2 substrates.[51]

				ginseng shows ↑osteocalcin.[50]	ncy.[11]	
Boswellia serrata (Frankincense, Shallaki)	Boswellic acids (AKBA)	Anti-inflammatory (↓TNF-α), ↓RANKL, ↓Osteoclast activity	Moderate (for OA)	Multiple strong RCTs show significant pain reduction and improved function in osteoarthritis.[54] No direct OP trials.	Generally very safe. Mild GI upset. Avoid in pregnancy.[56]	Immunosuppressants, drugs metabolized by liver enzymes.[56]
Psoralea corylifolia (Bu Gu Zhi)	Corylin, Psoralen	↑OPG/↓RANKL, ↓NFATc1, ↓c-fos	Limited (in formulas)	Strong preclinical data shows ↑BMD.[8] Human evidence is from its use in formula	**Significant risk of hepatotoxicity (liver damage)**.[19]	Unknown, but liver toxicity risk is the primary concern.

				s like XLGB.[59]		
Ligustrum lucidum (Nu Zhen Zi, Glossy Privet)	Oleanolic acid, Salidroside	↑Ca absorption, ↑PTH/Vit D, ↓Osteoclast activity, Phytoestrogenic	None (for OP)	Strong preclinical data.[61] No human OP trials. Raw berries/leaves are toxic.[66]	Excellent safety profile for processed fruit. Mild, transient GI upset. Raw plant is toxic.[61]	Very limited data available.
Angelica sinensis (Dong Quai, Dang Gui)	Ferulic acid, Falcarinphthalides	Phytoestrogenic, ↓Osteoclast activity, ↑Wnt/β-catenin (in formula)	Limited (in formulas)	Evidence from formulas like DBT.[73] New compounds show potent anti-osteoclast activity in vitro.[72]	Photosensitivity, pregnancy, bleeding disorders, hormone-sensitive cancers.[71]	Anticoagulants (Warfarin), Lisinopril.[71]
Cissus quadrangulari	Anabolic steroids	↓Osteoclast activity,	Moderate	Human trial shows it	Generally safe. Mild	No known major

s (Hadjod, Veldt Grape)	, Antioxidants	↑Fracture healing markers (osteopontin)		delays bone loss in osteopenia.[75] Other trials show faster fracture healing.[75]	side effects (headache, gas). Avoid in pregnancy.[75]	interactions.
Rehmannia glutinosa (Shu Di Huang)	Catalpol, Iridoids	↑Osteoblast activity, ↓Osteoclast activity, ↑OPG	Limited (in formulas)	Evidence from formulas like LWDHP shows ↑BMD in postmenopausal women.[18]	Possibly safe short-term. Caution with diabetes, hypotension. Stop 2 weeks before surgery.[78]	Antidiabetes drugs, Antihypertensives.[78]
Thymus vulgaris (Thyme)	Thymol, Carvacrol	Anti-inflammatory, Antioxidant, Phytoestrogeni	Moderate	Human trials show ↑BMD vs. baseline and	Generally very safe. Caution with hormone-sensit	Anticoagulants, Anticholinergic drugs, Estrogens.[82]

		c		standard care, and synergy with alendronate.[81]	ive conditions. Stop 2 weeks before surgery.[82]	
Cornus officinalis (Shan Zhu Yu)	Morroniside, Loganin	↑Osteoblast activity, ↓Osteoclast activity, Immunomodulatory	Limited (in formulas)	Evidence from formulas like LWDHP.[1] No standalone human OP trials.	Generally well-tolerated. Limited safety data. Caution with blood thinners.[28]	Anticoagulants (theoretical), drugs metabolized by the liver.[28]
Rosmarinus officinalis (Rosemary)	Carnosic acid	Anti-inflammatory, Antioxidant, Rich in bone minerals	None (for OP)	Strong preclinical data shows ↑BMD.[83] No human OP trials.	Safe in food amounts. High doses can cause GI/kidney issues. Avoid medicinal doses in	No known major interactions.

					pregnancy.[84]	
Eucommia ulmoides (Du Zhong)	Flavonoids, Lignans	↑OPG/↓RANKL, Regulates gut microbiota	Limited	Human trial on OA completed, results pending.[85] Strong preclinical data shows ↑BMD and improved microstructure.[10]	Appears safe in animal studies with no toxic side effects.[10] Limited human data.	Limited data available.
Lepidium meyenii (Maca)	Macamides, Sterols	Hormonal modulation, Protects bone architecture (preclinical)	None (for OP)	No human OP trials.[13] Animal data shows bone protection without uterine	Generally safe. Can cause moodiness, insomnia, GI upset. Avoid with hormon	No known major interactions, but caution with hormone therapies.

				estrogenic effects.[86]	e-sensitive conditions.[88]	
Cuscuta chinensis (Tu Si Zi)	Quercetin, Hyperin	↑OPG/↓RANKL, ↑RunX2	None (for OP)	Strong preclinical data in glucocorticoid-induced OP.[9] No human OP trials.	Good safety profile. Mild side effects (gas, headache). No significant liver/kidney issues in one human trial.[90]	Limited data available.
Shilajit	Fulvic acid, Minerals	Antioxidant, Anti-inflammatory	Limited	One human trial in postmenopausal women with osteopenia showed ↓bone	High risk of heavy metal contamination in raw products. Purified form is relativel	Blood thinners, Diabetes medications.[92]

				loss and inflammation.[93]	y safe.[21]	
Achyranthes bidentata (Niu Xi)	Triterpenoids, Steroids	↑BMD (animal meta-analysis), ↑Bone formation, ↓Bone resorption	Limited (in formulas)	Animal meta-analysis shows effective ↑BMD.[3] Human evidence is from formulas.[3]	Generally safe. High doses may cause GI upset. Limited safety data.[94]	Limited data available.
Tinospora cordifolia (Guduchi, Amrita)	Alkaloids, Diterpenoids	Immunomodulatory, Anti-inflammatory, Antioxidant	None (for OP)	No human OP trials.[99]	**Contraindicated in autoimmune diseases** (MS, Lupus, RA).[100]	Antidiabetes drugs, Immunosuppressants, CYP450 substrates.[100]
Astragalus membranaceus (Huang Qi)	Polysaccharides, Flavonoids	Immunomodulatory, ↑Osteoblast proliferation	None (for OP)	No high-quality human OP trials.[25] Evidenc	**Contraindicated in autoimmune diseases.**[25]	Immunosuppressants, Anticoagulants, Lithium, Estroge

				e from formulas.[73]		n-blockers.[25]
Nigella sativa (Black Cumin Seed)	Thymoquinone (TQ)	Antioxidant, Anti-inflammatory (↓NF-κB)	Limited	Emerging human data.[48]	**Contraindicated in pregnancy, before surgery, with anticoagulant therapy**.[24]	Antidiabetes drugs, Antihypertensives, Anticoagulants, CYP3A4/2D6 substrates.[24]
Cistanche deserticola (Rou Cong Rong)	Phenylethanoid glycosides	Regulates lipid metabolism, ↑Osteoblast activity	None (for OP)	No human OP trials.[107]	Very limited safety and interaction data available.	Very limited data available.[108]
Humulus lupulus (Hops)	8-prenylnaringenin	Potent Phytoestrogenic, Antioxidant	None (for OP)	No human OP trials.[16]	Caution/avoid in hormone-sensitive cancers. Can cause drowsiness.[110]	Potential interaction with other sedatives.

Carthamus tinctorius (Hong Hua, Safflower)	Polysaccharides	↑Osteoblast proliferation, ↓Bone turnover	None (for OP)	No human OP trials.[113]	**Contraindicated in pregnancy** (uterine stimulant).[117]	Limited data available.
Withania somnifera (Ashwagandha)	Withanolides	Adaptogenic (stress reduction), Anti-inflammatory	None (for OP)	No human OP trials.[121]	Rare risk of liver injury. **Contraindicated in pregnancy, autoimmune/thyroid disorders, hormone-sensitive prostate cancer**.[121]	Diabetes/hypertension meds, Immunosuppressants, Sedatives, Thyroid meds.[121]
Morindae Officinalis	Anthraquinones, Polysac	↑Bone formation, ↓Bone	None (for OP)	No human OP trials.[124]	Limited safety data. Caution	Diabetes medications

Radix (Ba Ji Tian)	charides	resorption			with diabetes.[124]	(theoretical).[124]
Dioscorea opposita (Shan Yao, Chinese Yam)	Diosgenin	Hormonal modulation (indirect)	None (for OP)	No human OP trials.[13]	Avoid with hormone-sensitive conditions. Can cause GI upset in large doses.[127]	Estradiol.[127]
Guggul (*Commiphora wightii*)	Guggulsterones	Anti-inflammatory, Tissue-strengthening	Limited (for OA)	Human trial for OA shows improved pain/function.[132]	Rare risk of liver issues. Hypersensitivity rash.[128]	**CYP3A4 substrate drugs** (major interaction).[128]
Triphala	Tannins, Flavonoids, Vit C	Antioxidant, Anti-inflammatory, Gentle laxative	None (for OP)	No human OP trials.[135]	Excellent safety profile. Mild laxative effect.[133]	No major documented interactions.
Acanth	Eleuthe	Adapto	None	No	**Not for**	**Warfari**

opanax sentico sus (Siberia n Ginseng)	roside E	genic, Anti-infl ammato ry, ↑Bone growth (preclini cal)	(for OP)	human OP trials.[137]	**high blood pressur e/heart conditi ons**. Can cause nervous ness, insomni a.[137]	**n**, Caffein e/stimul ants.[140]
Salvia officina lis (Comm on Sage)	Flavonoi ds, Thujone	Phytoes trogeni c	None (for OP)	No human OP trials.[141]	**Thujon e can be neurot oxic in high doses**.[14 2]	Limited data availabl e.
Prunus persica (Tao Ren, Peach Kernel)	Amygda lin	Invigora tes blood circulati on	None (for OP)	No human OP trials.[143]	**Contrai ndicate d in pregna ncy and menstr uation**.[1 45]	Anticoa gulants (theoret ical).[116]
Er-Xian Decoct ion (Formul	Icariin, Berberi ne, etc.	Multi-ta rget: Phytoes trogeni	Limited (formul a)	Animal studies show it attenua	Comple x safety profile based	Comple x interacti ons

a)		c, Anti-inflammatory, Balances Yin/Yang		tes bone loss.[30]	on components. Requires expert prescription.	based on components.
Xian-Ling-Gu-Bao (Formula)	Icariin, Danshensu, etc.	Multi-target: Phytoestrogenic, ↑Blood circulation, ↑Bone formation	Moderate	Systematic review shows ↑BMD similar to conventional meds, improves QoL and pain.[59]	Good safety in trials, but contains *Psoralea* (hepatotoxic risk) and herbs with hormonal/blood-thinning effects.[59]	Complex interactions based on components.

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