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An Overview on Chemical Constituents, Medicinal Applications, Pharmacological Activity, Toxicology, Metabolism and Pharmacokinetics of *Strobilus lupuli*

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Abstract: *Strobilus lupuli* is the dried strobiles (inflorescences) of *Humulus lupulus* L. (Cannabaceae). Other names of *Strobilus lupuli* include European hops, hoblon, hop vine, hopfen, and hops. *Humulus lupulus* L. is an important plant that contains metabolites used in the brewing and pharmaceutical fields. *Strobilus lupuli* is cultivated in Europe, Asia, and North America, occurring in the world's temperate areas. The analysis of *Strobilus lupuli* through chromatography analysis showed the presence of bitter substances and xanthohumol. The bitter substances in the resins are the major constituents of *Strobilus lupuli*, where these substances represent 15-25% of *Strobilus lupuli* constituents. *Strobilus lupuli* is applied as a sedative agent for the treatment of nervous tension and insomnia. *Strobilus lupuli* is applied in the treatment of dyspepsia and lack of appetite. *Strobilus lupuli* is applied to treat anemia, bacterial infections, abdominal cramps, dysmenorrhoea, leukorrhoea, dermatitis, diarrhea, migraine, and edema. The pharmacology activity of *Strobilus lupuli* includes experimental and clinical pharmacology. Experimental pharmacology includes antimicrobial, anti-inflammatory, antioxidant, central nervous system depressant, estrogenic and miscellaneous activities. The oral median lethal dose of ethanol extract of *Strobilus lupuli* in mice was found to be 500 mg/kg, while the oral median lethal dose of *Strobilus lupuli* in rats was 2700 mg/kg. No information is available on general precautions or on precautions concerning drug and laboratory test interactions. There is no teratogenic effect in pregnancy, or nursing mothers, or pediatric use of *Strobilus lupuli*. *Strobilus lupuli* powder dose = one dose of 0.5 g. Infusion or decoction dose = 0.5 g/ 150 ml water. *Strobilus lupuli* extract dose = 0.06-0.08g.

Keywords: *Strobilus lupuli*; *Humulus lupulus*; Cannabaceae; Medicine; Toxicology; Dose.

1. Introduction

The dried strobiles (inforescences) of *Humulus lupulus* are called Strobiles lupuli. *Humulus lupulus* belong to the family Cannabaceae [1,2]. European hops, hachichet addinar, hoblon, hombrecillo, hop vine, hopfen, hops, houblon, houblon grimpant, houblon vulgaire, humulus, lupio, luppulo, lupol, lupulin, lupulo, pijiuha, razak, vidarria, and xianshema are different names of Strobiles lupuli [3-5]. Europe, Asia, and North America are the principal cultivated regions of Strobiles lupuli, which occurred mainly in temperate regions of the world [5,6]. Important secondary metabolites are derived from Strobiles lupuli, and these metabolites are used in the brewing and pharmaceutical fields [7]. *Strobilus lupuli* is a perennial, twining herb (up to 6 m high), and the aerial parts have many long, angular, rough-hairy, entwining

stems. The growing location of *Humulus lupulus* had a large effect on its hexyl glucoside levels constituents, while the *Humulus lupulus* genetic differences affect its levels of linalyl, raspberry ketone, and 2-phenylethyl glucoside constituents [8]. These stems have cordate, palmate, three-lobed (5-7 lobed, dark green, stipulate leaves). The flowers have 5 bracts and 5 stamens. These flowers are pale green with an entire cup-like perianth and unilocular ovary. The fruits are ovate to ovate-cylindrical strobiles with flexuous rachis. These fruits are yellowish-green to pale brown, ovate, and scaly bracts. The fruits contain brown glandular achene [6]. *Strobilus lupuli* is ovoid-cylindrical or cone-like. It is leafy (3-4 cm long and up to 3 cm wide). It contains a narrow, hairy, flexuous rachis and many imbricated, yellowish-green to dusky yellow, obliquely ovate, membranous bracts. It has orange to yellowish-orange glandular trichomes. It has light brown achene [6]. *Strobilus lupuli* odor is strong and aromatic, while its taste is aromatic and bitter [6]. *Strobilus lupuli* powder is greenish-yellow in color. [2]. There are 3 types of *Humulus lupulus* called Cascade, Chinook, and Nuggett are suitable to be cultivated in semi-arid Mediterranean environments [9]. Phytocystatin (Hop1) is extracted from *Humulus lupulus*. The expression of Hop1 in plants increases resistance to herbivory by insects and improves tolerance to both biotic and abiotic stress factors [10]. *Humulus lupulus* essential oil, as well as, *Humulus lupulus* constituents (β-myrcene, α-humulene, and β-caryophyllene) possesses control against *Sitophilus granaries* insect [11]. *Humulus lupulus* showed an increase in flavanols constituents which refers to *Humulus lupulus* role to prevent fungus from spread into the *Humulus lupulus* stem [12]. *Humulus lupulus* shoots well-maintained their nutrients than leaves, and this effect correlated with different tissue structures. Fresh *Humulus lupulus* contains high fiber constituents, which and remain after *Humulus lupulus* cooking. *Humulus lupulus* ingredients such as magnesium, potassium, sodium, and zinc declined by 50% due to cooking, while calcium, copper, iron, and manganese were more stable [13].

The aim of this review is to focus on chemical constituents, medicinal uses, pharmacological activity, metabolism, and pharmacokinetics of *Strobilus lupuli*.

2. Chemical Constituents of *Strobilus lupuli*

The analysis of *Strobilus lupuli* by chromatography analysis showed the presence of bitter substances and xanthohumol [3]. There are high quantities of β-caryophyllene, humulene, linalool, and geraniol content and low quantities of myrcene content of *Strobilus lupuli* during the period of its storage [14]. The bitter acids of *Humulus lupulus* improve beer quality. Bitter acids and xanthohumol constituents of *Humulus lupulus* have a beneficial effect on human health [15]. *Humulus lupulus* contains volatile aroma compounds, and it presents as free volatiles and bound glycosides [16]. *Humulus lupulus* contains a new polysaccharide called HLP50-1 (molecular weight = 49.13 kiloDalton), where HLP50-1 has an osteogenic effect, and it is used to treat osteoporosis [17]. *Humulus lupulus* L. has volatile compounds such as aromas constituents. There are many aromas, such as lupulone (the main component) and humulone component [18]. *Humulus lupulus* L. contains α-acids and β-acids (humulones and lupulones). Also, *Humulus lupulus* L. has volatile caryophyllene, humulene and β-myrcene constituents. These compounds were extracted by chromatography associated with spectrometry analysis. This technique increases β-acids (20%), α-acids (20%), humulene (5.6%), and caryophyllene (7.4%) [19].

3. Major Chemical Constituents of *Strobilus lupuli*

The bitter substances in the resins are the major constituents of *Strobilus lupuli*, where these substances represent 15-25% of *Strobilus lupuli* constituents. The resins are 2 forms; (1) hard (petroleum-ether insoluble) and (2) soft resins. The soft resins contain; (1) α-acids (such as α-humulene (2,6,9-humulatriene) and related humulones) and (2) β-acids (lupulones). The soft resins' major chemical constituents are humulone and lupulone and their related derivatives, 2-10%, and 2-6%, respectively. The hard resins contain δ-resin and γ-resin. The *Strobilus lupuli* contains essential oil (0.3-1.0%) such as β-caryophyllene, farnesene, humulene and β-myrcene [3, 5, 20, 21]. The essential oil has traces of 2-methylbut-3-ene-2-ol, which increases to a maximum of 0.15% after storage of *Strobilus lupuli* for 2 years (due to hydrolysis of humulones and lupulones). *Strobilus lupuli* also includes the chalcone xanthohumol, prenylflavonoids, and other flavonoids (such as kaempferol, rutin) and tannins [3, 22, 23]. *Humulus lupulus* contains many flavonoids such as robinin, nicotiflorin, astragalin, kaempferol-7-*O*-rutinoside, hyperin, rutin, quercetin-7-*O*-rutinoside, and manghaslin [24].

4. *Strobilus lupuli* Medicinal Uses

Strobilus lupuli is applied as a sedative agent for the treatment of nervous tension and insomnia. *Strobilus lupuli* is applied to treat dyspepsia and lack of appetite [5, 25-27]. *Humulus lupulus* L. extract protects against bone loss and can potentially treat osteoporosis in osteoporosis mice [28]. *Humulus lupulus* showed an anti-psoriatic effect by inhibiting the expression of β-defensin 2, keratin 17, and glucose transporter 1. Also, *Humulus lupulus* has anti-proliferative and anti-inflammatory effects [29]. Xanthohumol (a prenylated flavonoid isolated from Humulus lupulus L.) attenuates cardiac dysfunction, hypertrophy, and fibrosis, therefore, has xanthohumol cardiovascular protective effect [30]. *Humulus Lupulus* L. suppressed interleukin-6 mRNA expression to 32% and to 61% at a protein level. *Humulus Lupulus* reduced cyclooxygenase-2 mRNA expression to 47% and their protein expression to 32%. *Humulus Lupulus* decreased inducible nitric oxide synthase protein expression to 2% and nitric oxide production. *Humulus Lupulus* declined nuclear factor-κB. Both mRNA and protein expression of nuclear factor-κB was decreased to 38% and 42%, respectively. Therefore *Humulus Lupulus* decreases the expression of inflammatory factors, so *Humulus Lupulus* has an anti-inflammatory effect [31]. *Humulus Lupulus* ameliorated fine dust-induced vascular dysfunction. Also, xanthohumol and isoxanthohumol constituents of *Humulus Lupulus* were found to produce the same protective effect of *Humulus Lupulus* in cardiovascular dysfunction. Therefore *Humulus Lupulus* and its active components possess therapeutic effect to prevent or treat air-pollution-associated cardiovascular diseases [32].

5. *Strobilus lupuli* in Traditional Medicine

Strobilus lupuli is applied to treat anemia, bacterial infections, abdominal cramps, dysmenorrhoea, leukorrhoea, dermatitis, diarrhea, migraine, and edema [5,6]. *In traditional medicine, humulus japonicus exhibits anti-inflammatory, antimicrobial, and anti-tumor effects used to treat hypertension, pulmonary disease, and leprosy*. It demonstrates a neuroprotective effect in animal models of neurodegenerative diseases [33]. Xanthohumol constituent of *Strobilus lupuli* is applied as an anticarcinogenic, antidiabetic, antimicrobial, and anti-inflammatory agent. Xanthohumol is used to treat autism, bone osteoporosis, skin, microbial, lipid-related diseases. Xanthohumol inhibits inflammatory mediators in cardiovascular disease,

neurodegeneration, and tumors. Xanthohumol decreases adipogenesis and controls obesity by focusing on adipocyte proteins. Xanthohumol is used as a flavoring agent in beer manufacture [34]. *Strobilus lupuli* is applied as antipyretic, analgesic, anthelmintic, aphrodisiac, carminative, depurative, digestant, diuretic, diaphoretic, and diaphoretic tonic [5,6]. *Humulus Lupulus* is used to prevent and heal several prevalent diseases such as cardiovascular disorders and many cancer types due to its antimicrobial, antioxidative, and antigenotoxic activities [35].

6. Pharmacology Activity of *Strobilus lupuli*

6.1. Experimental pharmacology.

6.1.1. Antimicrobial activity.

Humulus lupulus extract (5 mg/L) possesses antimicrobial activity [36]. *Humulus lupulus* extract has an antibacterial effect in Gram-positive bacteria strains [37]. *Humulus lupulus* extract showed a good antimicrobial action [38]. *Strobilus lupuli* (2.5 µl/disc) inhibited the growth of *Bacillus subtilis, Trichophyton interdigitale, Staphylococcus aureus, Candida albicans,* and *Escherichia coli* [39]. *Strobilus lupuli* possessed antimicrobial effects against Gram-positive bacteria (*Bacillus subtilis and Staphylococcus aureus*) and *Trichophyton mentagrophytes* var. *interdigitale* but no activity against a Gram-negative bacterium (*Escherichia coli*) or the yeast *Candida albicans* [40]. *Strobilus lupuli* declined the growth of *Helicobacter pylori*, and the effective dose = 63-130 µg/ml [41]. *Strobilus lupuli* and its lupulone constituent inhibited the growth of *Mycobacterium tuberculosis*, and the effective dose = 1-10 µg/ml for lupulone and 7.5 µg/ml for the decoction [42]. The antibacterial effect of *Strobilus lupuli* is inversely related to pH of the medium. Where *Strobilus lupuli* against *Lactobacillus brevis* IFO 3960 at a pH = 4-7 declined the bacterial growth [43].

6.1.2. Anti-inflammatory activity.

Strobilus lupuli applied to mouse ears (2 mg/ear) stopped 12-*O*-tetradecanoylphorbol-13-acetate-induced inflammation by 90% [44]. Humulone constituent of *Strobilus lupuli* (1 mg/animal) declined ear inflammation caused by 12-*O*-tetradecanoylphorbol-13-acetate and ear edema caused by arachidonic acid in mice [45]. β-acids or lupulones constituent of *Humulus lupulus* possesses anti-inflammatory as well as anti-cancer, antioxidative, and antimicrobial activity [46]. *Humulus lupulus* extract anti-inflammatory as well as antioxidant and antibacterial effects; therefore, *Humulus lupulus* is used to treat acne-prone skin [47].

6.1.3. Antioxidant activity.

Strobilus lupuli had antioxidant and radical scavenging activities *in vitro* [48, 49]. *Humulus lupulus* has higher quantities of α-bitter acids and β-bitter acids (522.8 and 345.0 mg/g extract, respectively) and volatiles such as β-humulene, β-myrcene, β-pinene, α-humulene, α-selinene, and methyl-4-decenoate, which have antioxidant activities [50]. *Humulus lupulus* has bitter acids, oils, and flavonoids (antioxidants and immunity stimulators [51]. *Humulus lupulus* contains many compounds with antioxidant effects such as phenolic, polyphenolic, α-acids, and β-acids constituents [52]. *Humulus lupulus* ethanol extract showed higher antioxidative activities than *Humulus lupulus* water extract [53]. Xanthohumol is the main constituent of *Humulus lupulus*, and these constituents have antioxidant, anti-inflammatory, immunity oppressive, and chemoprotective properties. The concentrations of

xanthohumol of *Humulus lupulus* in flowers and food complements ranged between 0.106 and 12.7 mg/g [54].

6.1.4. Central nervous system depressant activity.

Humulus lupulus contains neuroactive compounds that are useful in traditional medicine as a sleeping aid. Humulone (α-acid) and 6-prenylnaringenin (prenylflavonoid) are the most active neuroactive compounds of *Humulus lupulus*. Both humulone and 6-prenylnaringenin act principally on the γ-aminobutyric acid (GABA) site [55]. Neither *Humulus lupulus* extract nor its alpha-acid constituent impacts the locomotor effect. Also, *Humulus lupulus* extract or its alpha-acid constituent has an anxiolytic effect [56]. *Humulus lupulus* extract reduced immobility during the behavioral despair test when administered 3 times [56]. *Humulus lupulus* extract exerts: (a) a pentobarbital sleep-enhancing property without influencing the motor behavior of rats; (b) an antidepressant activity. The same effects were elicited by administering Humulus lupulus fraction containing α-acids, which can be considered the major responsible for the enhanced pentobarbital effect and the antidepressant effect [56]. *Humulus lupulus* (i.p., 0.80 g/kg) to mice produced narcosis for about 8 h; no abnormal behavior was observed there. This effect was related to the volatile fraction of *Humulus lupulus* [57]. The sedative effect of *Humulus lupulus* was dependent on its 2-methyl-3-butene-2-ol ingredient. There were only traces of this compound was detected in hops (their concentration increased to maximum (0.15%) after drying for 2 years at room temperature [58]. The sedative effect of *Humulus lupulus* is similar in its effect to *Cupressus sempervirens* in its effect [59]. *Strobilus lupuli* (≤2 μg/ml) bound to the γ-aminobutyric acid and the *N*-methyl-d-asparate receptors, as well as the chloride ion channel and glycine receptors *in vitro* [60]. Xanthohumol constituent of *Humulus lupulus* L. reduced the latency and increased the residence time of mice. Xanthohumol increased superoxide dismutase levels and reduced Interleukin-6 and Interleukin-1β levels both in the serum and hippocampus. Xanthohumol also activated autophagy and anti-apoptotic signals. Therefore, xanthohumol ameliorates memory impairment, and consequently, it has a neuroprotective effect [61].

6.1.5. Estrogenic activity.

Humulus lupulus L. has phytoestrogen such as 8-prenylnaringenin, 6-prenylanaringenin, 6,8-diprenylnaringenin, and 8-geranylnaringenin are fundamental for the active estrogen activity of *Humulus lupulus* L. [62]. Older women tend to take *Humulus lupulus* as natural alternatives to relieve menopausal symptoms. *Humulus lupulus* is enriched in bioactive prenylated flavonoids such as 8-prenylnaringenin, isoxanthohumol, xanthohumol, and 6-prenylnaringenin. 8-prenylnaringenin is one of the most potent phytoestrogens and is responsible for *Humulus lupulus* estrogenic activity [63]. *Humulus lupulus* contains an active estrogen compound (flavanone prenylnaringenin), and its extraction was done by thin-layer chromatography-mass spectrometry [64]. Injection of water or ethanol extract of *Strobilus lupuli* has an estrogenic effect in mice and rats [65,66]. The ethanol extract of *Strobilus lupuli* was greater than that of water extract of 17-β-estradiol equivalents (1250 μg/g compared with 30-300 μg/g) [65]. In other researches, no estrogenic effect in mice occurred after injection of *Strobilus lupuli* doses (up to 51 mg/kg) [67]. Injecting 5 mg of alcohol extract of *Strobilus lupuli* to rats had a luteal suppressant effect [68]. *Strobilus lupuli* increased alkaline phosphatase activity in human endometrial cells, Ishikawa variety I *in vitro* [69]. Methanol

extract of *Strobilus lupuli* bound to estrogen receptor-α and receptor-β from rat uteri [70]. Methanol extract of *Strobilus lupuli* also induced the expression of alkaline phosphatase activity and upregulated progesterone receptor messenger RNA [70]. *Humulus lupulus* contains active estrogenic compounds such as 6-prenylnaringenin and 8-prenylnaringenin. 8-prenylnaringenin is more bioavailable in healthy humans than its isomer 6-prenylnaringenin. 6-prenylnaringenin is similarly effective as 8-prenylnaringenin in enhancing peripheral blood viability [71]. 8-prenylnaringenin is used for the treatment of menopausal and post-menopausal symptoms in women. 8-prenylnaringenin prevents bone osteoporosis and tumor development [72].

6.1.6. Miscellaneous activity.

Injection of 3 doses of *Strobilus lupuli* (30 mg/animal) stimulated glutathione-S-transferase activity in the liver and intestine of mice [73]. The flavonoids isolated from *Strobilus lupuli* (0.1-100 μmol/l) stopped the growth of human breast cancer, colon cancer, and ovarian cancer cells *in in-vitro* studies [74]. In addition, the flavonoids isolated from *Strobilus lupuli* (isoxanthohumol, xanthohumol, and 8-prenylnaringenin) at dose = 10 μmol/L declined the 7-ethoxyresorufi n-*O*-dethylase activity of cytochrome P450 [75].

6.2. Clinical pharmacology.

Humulus lupulus L. has beneficial effects by normalizing weight, lipid, glucose, insulin, and inflammation by affecting many organs. *Humulus lupulus* exerts its role due to the bitter acid constituent of *Humulus lupulus* in preventing metabolic-related diseases such as diabetes, dyslipidemia, and inflammation [76]. *Humulus japonicas* increased the chondrocytes and growth plate height during the bone growth process [77]. Xanthohumol (a prenylated flavonoid extracted for *Humulus lupulus* L) amended clinical symptoms, lung physiology, and inflammation in pig lung tissue infected by porcine viral infection. Therefore xanthohumol is a good factor to treat porcine respiratory viral infections [78]. Xanthohumol inhibits phosphorylation of protein kinase B and nuclear factor kappa-B, decreases blood glucose, and increases body weight. Also, xanthohumol increased freezing time, synaptic plasticity, and dendritic spine density while decreasing oxidative stress in the hippocampus area of diabetic rats. Therefore, xanthohumol is a promising agent to treat diabetic encephalopathy [79].

7. Metabolism and Pharmacokinetics of *Strobilus lupuli*

Regarding metabolization of *Humulus lupulus* α- and β-acids, there are 33 compounds detected, including novel metabolites (such as 9 potential oxidized metabolites of humulones, and 10 glucuronide conjugates of α-acids, comprising 7 glucuronide derivatives of oxidized phase I metabolites) [80]. There are 14 compounds that increased or decreased in response to drought stress. A total of 10 of these compounds were identified as follows: 5 glycerolipids (glutaric acid, pheophorbide A, abscisic acid, roseoside, and dihydromyricetin). Some of the metabolite changes occur across all plants under drought conditions, while others may be specific to *Humulus lupulus* or the type of drought [81]. *Humulus lupulus*-derived compounds (*cis*-isocohumulone, *trans*-isocohumulone, *cis*-isohumulone, *trans*-isohumulone, *cis*-isoadhumulone, *trans*-isoadhumulone, humulone, cohumulone, adhumulone, and 8-prenylnaringenin) are bioactive compounds and are considered as compounds for drug discovery to treat metabolic diseases [82]. *Humulus lupulus* dietary supplement (xanthohumol

and 8-prenylnaringenin) caused no clinically relevant pharmacokinetic interactions. The serum obtained after the consumption of *Humulus lupulus* extract revealed abundant Phase II conjugates of *Humulus lupulus* prenylated phenols were observed, including monoglucuronides, monosulfates, diglucuronides, and sulfate-glucuronic acid diconjugates [83]. *Humulus lupulus* contains phytoestrogen precursors, which transform into estrogenic forms in the gut. *Humulus lupulus* extract decreased visceral lipids and liver triglyceride in ovariectomized animals [84]. *Humulus japonicus* increased the expression of brown adipose markers. It induced fatty acid oxidation and lipolysis and suppressed both lipogenic markers and lipid accumulation. *Humulus japonicus* ameliorated oxidative stress [85]. The increased fatty acid oxidation and lipolysis of *Humulus lupulus* play an important role in decreasing lipids [86] and protecting from infectious diseases [87]. *Humulus lupulus* caused increases in the pathogenic Enterobacteriaceae and *Akkermansia* of human gut bacterial communities. Thus, *Humulus lupulus* had a significant impact on bacterial consortium [88].

8. Toxicology of *Strobilus lupuli*

The median lethal dose (LD_{50}) of an oral dose of ethanol extract of *Strobilus lupuli* in mice was found to be 500 mg/kg [57]. The oral LD_{50} of *Strobilus lupuli* in rats was 2700 mg/kg [57]. The oral LD_{50} for lupulone constituent of *Strobilus lupuli* was 525 mg/kg in mice and 1800 mg/kg in rats [3]. The injection LD_{50} of an ethanol extract of *Strobilus lupuli* in mice was 175 mg/kg [27].

9. Adverse Reactions of *Strobilus lupuli*

Contact dermatitis is an adverse effect of *Humulus lupulus* [89]. Contact urticarial is related to *Humulus lupulus*, while rhinitis, conjunctivitis, asthma are rare [90].

10. Contraindications of *Strobilus lupuli*

Strobilus lupuli is contraindicated in cases of known allergy to the plant material.

11. Precautions of *Strobilus lupuli*

11.1. Drug interactions

No drug interactions have been reported. The flavonoid constituents of *Strobilus lupuli* inhibit the activity of cytochrome P450, and concurrent administration of *Strobilus lupuli* may influence the pharmacokinetics of some drugs.

11.2. Carcinogenesis, mutagenesis, impairment of fertility.

Xanthohumol inhibits free radicals and cell proliferation while increasing apoptosis. Therefore, it is used as a chemoprotective/therapeutic agent in colorectal cancer [91]. The anti-tumor effect of *Humulus lupulus* plays an important role in colon cancer protection [92]. Injection of 20-50 mg/kg of *Strobilus lupuli* twice daily for 3 days to female rats pretreated by injection with 25 IU (international unit) of pregnant mare's serum gonadotrophin did not induce any changes in uterine weight, but ovarian weight decreased significantly [93]. Xanthohumol has a chemoprotective effect against the carcinogenic food contaminant aflatoxin B1 [94]. Xanthohumol treats microbial infection, aging, inflammation, diabetes, and cancer.

Xanthohumol has a therapeutic effect against many tumors, and it is used as an anti-cancer agent with minimal adverse effects [95].

11.3. Other precautions.

No information is available on general precautions or precautions concerning drug and laboratory test interactions. There is no teratogenic effect in pregnancy, or nursing mothers, or pediatric use.

12. Dosage of *Strobilus lupuli*

Strobilus lupuli has many forms, such as dry strobiles, dry extracts, fluidextracts, and tinctures [6, 26]. *Strobilus lupuli* must store in a container away from light and humidity. In *Strobilus lupuli* powder for decoctions, infusion, and other preparations (=one dose of 0.5 g). An infusion or decoction (=0.5 g in 150 ml of water). In fluidextract 1:1 (g/ml) =0.5 ml. In tincture 1:5 (g/ml)= 2.5 ml. In *Strobilus lupuli* extract 6-8:1 (w/w) =0.06-0.08 g [26].

13. Conclusions

Dried strobiles (inflorescences) of *Humulus lupulus* are called *Strobilus lupuli*. *Humulus lupulus* occurs in the family Cannabaceae. Europe, Asia, and North America are the principal cultivated areas of *Humulus lupulus*. The most famous names of *Strobilus lupuli* are European hops, hoblon, hop vine, hopfen, and hops. The chemical constituents of *Strobilus lupuli* are bitter substances and xanthohumol. Bitter substances are the main constituents (15-25% of *Strobilus lupuli* constituents). *Strobilus lupuli* is used as a sedative agent in folk medicine to treat both nervous disturbances and insomnia. *Strobilus lupuli* is also used to treat dyspepsia and lack of appetite. In medical applications, strobilus lupuli treats anemia, bacterial infections, abdominal cramps, dysmenorrhoea, leukorrhoea, dermatitis, diarrhea, migraine, and edema. *Strobilus lupuli* has experimental pharmacology and clinical pharmacology. *Strobilus lupuli* ethanol extracts lethal doses in mice and rats are 500 mg/kg and 2700 mg/kg, respectively. *Strobilus lupuli* occurs in many forms such as powder, infusion, decoction, and extract, and the *Strobilus lupuli* doses are one dose of 0.5g (as a powder), 0.5 g/150 ml water (as an infusion or decoction), and 0.06-0.08 g (as an extract).

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Conflicts of Interest

The author declares no conflict of interest.

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