Oplopanax elatus (Nakai) Nakai: chemistry, traditional use and pharmacology

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[ABSTRACT] Oplopanax elatus (Nakai) Nakai, a member of the ancient angiosperm plant family Araliaceae, is used for the treatment of different disorders in the medicine systems of China, Russia, and Korea, and was designated in Russia as a classical adaptogen. Despite extensive studies of classical adaptogens, there are comparatively few reports concerning the chemical composition and pharmacological effects of O. elatus in English. The plant is a potential source of saponins, flavonoids, anthraquinones, terpenes, and other active compounds. Experimental studies and clinical applications have indicated that O. elatus possesses a number of pharmacological activities, including adaptogenic, anti-convulsant, anti-diabetic, anti-fungal, anti-inflammatory, anti-oxidant, blood pressure modulating, and reproductive function effects. In this review, the chemistry, safety, and therapeutic potential of O. elatus are summarized and highlighted to encourage the further development of this plant.

[KEY WORDS] Oplopanax elatus; Chemistry; Safety; Adaptogen; Asthenia; Diabetes; Physical and mental fatigue

[CLC Number] R28

Introduction

The genus Oplopanax (Torr. & A. Gray) Miq. is a member of the ancient angiosperm plant family Araliaceae, and consists of three species: Oplopanax horridus (Sm.) Miq., Oplopanax japonicus Nakai, and Oplopanax elatus (Nakai) Nakai. O. horridus is distributed throughout the Pacific Northwest of North America [1], while O. japonicus is endemic to Japan [2].

Oplopanax elatus (syn. Echinopanax elatus Nakai) is commonly known in Russia as Zamanikha (Заманиха) and as Ci shen (刺参) in China. It is mainly distributed in Russia, in the south of Primorye, while outside of Russia it grows in the northern part of the Korean Peninsula, and in the temperate regions of Northern China [2-4]. It is a deciduous shrub with a spiny stem of about 1 m (rarely to 2–3 m) height, with large palmately compound leaves, and a long creeping rhizome.

Inflorescence axillary 7–18 cm long, peduncles 2.5–6 cm, densely covered with long rust-colored hairs and prickles; umbels small, 9–13 mm across, in oblong raceme or a slightly branching panicle at tips of main and lateral axes; fruit yellow-red, 7–12 mm long [5-6]. The plant is endangered in Russia due to intense uncontrolled harvesting, and is included in the Red Book of the Russian Federation [7]. The roots are collected in September-October after ripening of the fruits [8].

Compared with the extensive research on other familiar adaptogenic plants of the Araliaceae, such as Ginseng, Eleutherococcus and Aralia, there is comparatively little known about the chemical composition and pharmacological effects of O. elatus in English. The plant has been well-studied in Russia and China. However, many of the scientific articles were never translated into English, and as a result a significant amount of information obtained and collected by scientists was not available to the international community.

In this review, the chemistry, safety, and therapeutic potential of O. elatus are highlighted with the aim for the further development of plant-based medicines. The information regarding the chemistry, safety, effectiveness, and pharmacological effects of O. elatus was systematically
collected from the scientific literature through library catalogs, the online service E-library.ru, and, in addition, Medline/Pubmed, Scopus, CNKI (www.cnki.net), Wanfang Med Online (www.WanFangData.com), VIP (www.vipdatabase.com), Web of Science, www.fips.ru, and the Espacenet patent databases.

**Chemical Constituents**

**Essential oils**

Essential oils are the major anti-fungal ingredients of *O. elatus*. Wu et al. [9] used supercritical fluid extraction (SFE) and gas chromatography-mass spectrometry (GC-MS) analysis to study the chemical composition of the essential oils in the roots and rhizomes of *O. elatus*. A total of nineteen, volatile ingredients were characterized. They also found a significant difference in the essential oils extracted by SFE and steam distillation. SFE was capable of extracting abundant enols, aldehydes, and olefinic aldehydes, whereas a high abundance of aldehydes, terpenes, and esters were obtained by the traditional steam distillation method. Zhang et al. [16] studied the composition of the volatile oils in the stems of *O. elatus* by steam-distillation extraction and GC-MS and GC-IR analyses. The stem contained 3.1% of the oil, and thirty-two compounds were identified, including twenty-five first reported from this plant. Of these, α-pinene, octanal, 6, 6-dimethyl-2-methylene-norpinane, and 5-methyl hexanal were the four most abundant volatile ingredients. The essential oils were reported to contain quite different chemical ingredients depending on the parts of *O. elatus* that were analyzed. The growing environment was another crucial factor that led to the variable content of the essential oils of *O. elatus* [10].

**Saponins**

The roots and rhizomes of *O. elatus* contained 6.9% of crude steroid saponins, which were separated into six components using silica gel thin-layer chromatography, however, no references on the isolation of saponins from the roots were reported [15].

Saponins, also known as cirenshenosides or cirenensosides, are a large category of plant secondary metabolites in *O. elatus*. Wang and co-workers have performed systematic studies focusing on the saponins occurring in the leaves of *O. elatus*. The total saponin content in the leaves was 3.32% based on a developed colorimetric method [15]. Twenty-one cirenshenosides (Fig. 1), comprising the newly-reported glycosides A-D, cirenshenosides I-V, and three known saponins, were isolated from *O. elatus* leaves by Wang et al. [13-21]. Interestingly, the structures of the saponins isolated from the leaves of *O. elatus* are: i) pentacyclic triterpene glycosides involving an oleanane or lupane skeleton; ii) different orientations of the 3-OH on the oleanane and lupane skeletons; iii) a tri-saccharide glycosyl portion Glc(6,1)Glc(4,1)Rha, glycosylated at C-28 through an ester bond (except for cirenshenoside P); and iv) variation of the oxidation level of C-23 as CH2, CH2OH, CHO, and COOH. It is noted that cirenensoside S reported in the literature by Wang et al. [16] has the same structure as cirenshenoside U reported by Wang and Xu [17]. The structure elucidation of these new saponins was mainly based on NMR analysis and selective hydrolysis reactions.

**Flavonoids**

Flavonoids are also known to be present in *O. elatus*, and Soviet scholars reported that the flavonoids occupy 0.9% of the roots of *O. elatus* [11]. Wang and Xu [21] first isolated two flavonol O-glycosides from the leaves, and they were identified as the 3-O-biosides of kaempferol and quercetin, respectively (Fig. 1).

**Anthraquinones**

The stems and roots of *O. elatus* were reported to contain anthraquinones (Fig. 1). Xu and Liang [22] isolated four anthraquinone derivatives, identified as chrysophanol, physcion, emodin, and aloe-emodin based on NMR analysis. These anthraquinones were obtained from *O. elatus* for the first time, and also for the first time in a species of the Araliaceae. In addition, Wang et al. [23] obtained rhein from the stems of *O. elatus*.

**Other metabolites**

Other constituents, such as phenolic acids, organic acids, oligosaccharides, sterols and their glycosides, polyacetylenes, and trace elements, have also been reported from *O. elatus*. As part of a continuing study, Xu and Liang [24] isolated syringin, β-sitosterol, stigmasterol, stigmasterol-3-O-β-D-glucopyranoside VI, sitosterol-3-O-β-D-glucopyranoside, behenic acid, and tetracosanoic acid from the stems of *O. elatus*. Wang et al. [23] recently isolated another two phenolic acids (3-O-caffeoyl quinic acid and 1-O-caffeoyl quinic acid), as well as sucrose and glucose, from the stems. Liu and Wu [25] performed a phytochemical study on the roots of *O. elatus*, which yielded L-rhamnose, together with sucrose, syringin, β-sitosterol, daucosterol, and n-heptacosanol.

Two new polyacetylenes, oploxynes A (9, 10-epoxyheptadeca-4, 6-diyne-3, 8-diol) and B (10-methoxyheptadeca-4, 6-diyne-3, 8, 9-triol), as well as the known olopandiol and falcarindiol were isolated by Yang et al. from the stem of *O. elatus* [26]. Olopandiol and falcarindiol, together with (Z, E)-nerolidol were identified by on-line solid-phase extraction coupled with HPLC in the root bark of *O. elatus* [27].

Dou et al. [28] conducted a phytochemical study on the roots and stems of *O. elatus* which resulted in the isolation of seven compounds, comprising four lignans and three phenylpropanoids. Of these, two new lignans were elucidated as 3, 3′-dimethoxy-4, 9, 9′-trihydroxy-4′, 7′-epoxy-5′-8-lignan-4, 9-bis-(O-β-D-glucopyranoside and 5-methoxylariciresinol-4-O-β-D-glucopyranoside. These compounds were isolated from a 60% EtOH extract.

Liu et al. [29] determined the contents of eight trace elements (Cu, Fe, Zn, Mn, Cr, Sr, Al, and Ag) in *O. elatus* and *P. ginseng* by their atomic absorption spectrum. The total content of the determined elements in the stems of *O. elatus* was slightly higher than those in the roots. For these two species, Fe, Zn, and Mn occupied the largest portion, and of these, Mn was more abundant in *O. elatus*, while Zn was at a higher level in *P. ginseng*. 
Pharmacology

Ethnopharmacology

In Russian medicine and traditional Chinese medicine, *O. elatus* is regarded to possess similar actions to *Panax ginseng*. In China, Russia, and Korea it is used for the treatment of chronic fatigue syndrome [30]. In Chinese medicine, it has been used for treating neurasthenic, hypopiesis, schizophrenia, cardiovascular diseases, diabetes mellitus and rheumatism. It also possesses antifungal, fever-relieving, pain-relieving, and anti-aging activities [31]. The stem of *O. elatus* has been traditionally used in China as an analgesic medicine to treat arthritis [32].

In Korea, it has been traditionally used for treating a variety of ailments, such as asthenia, depressive states [33], diabetes, cough, rheumatism, gastro-intestinal disorders, and wounds [34].

Adaptogenic effects

The term "adaptogens" (phytoadaptogens), and the concept of these plant-derived substances as compounds that would increase "the state of non-specific resistance" under conditions of stress, was formalized in the USSR between 1950 and 1960. An adaptogen must: produce a non-specific response, i.e. increase the power of resistance against multiple (physical, chemical, or biological) stressors; have a normalizing effect, irrespective of the nature of the pathology and be non-toxic; be innocuous and not influence normal body functions more than required [35-36]. According to the
The sleeping time of animals was decreased by 35% [43]. Decreased locomotor activity. When the dose was increased to 2.76 mL·kg$^{-1}$, the rats were prostrate with drooping eyelids, but they could still respond to outside stimuli. The $O. elatus$ essential oil emulsion had a good synergistic effect on antagonism with pentobarbital, chloral hydrate, and chlorpromazine to pentetretrazole-induced and electroconvulsive convulsions [44].

**Anti-diabetic effects**

The anti-diabetic effects of a dealcoholized tincture from the roots were evaluated in mice and rats. Oral pretreatment of alloxan-induced diabetic mice with the tincture (2.5 g·kg$^{-1}$, 6 days before alloxan injection) significantly reduced the pancreatic malondialdehyde (MDA) level by 34%, and lowered the blood glucose level by 16% compared to control. Oral treatment of mice with the tincture (2.5 g·kg$^{-1}$, 6 days), starting 48 h after alloxan injection, resulted in a significant increase of glycogen in the liver by 45% compared to control, while the glucose level tended to decrease. The blood glucose level in rats with epinephrine-induced hyperglycemia was decreased by 18% after intragastric administration of a tincture at the dose of 2.5 g·kg$^{-1}$ over six days. The elevated blood glucose level in rats pretreated with the tincture (2.5 g·kg$^{-1}$, 6 days before alloxan injection) was reduced by 18%, and was accompanied by an increase of glycogen in the liver. A significant decrease in the plasma glucose level by 16%, and an increase in insulin level by 42%, were observed in alloxan-induced diabetic rats treated with the tincture (2.5 g·kg$^{-1}$) over six days after alloxan injection [45].

**Antifungal effects**

The antimycotic activity of the essential oil from $O. elatus$ was evaluated in vitro by the serial dilution method on solid nutrient medium. Fungistatic effects were shown against Microsporum gypseum, $M. lanosum$, Trichophyton gypseum, $T. purpureatum$, and Epidermophyton floccosum with MIC = 0.0625% for each species [46]. The essential oil of $O. elatus$ stem demonstrated antifungal activity against Trichophyton rubrum, $T. verrucosum$, $T. tonsurans$, $T. violaceum$, Microsporum canis, and $M. nanum$ with MIC = 0.063%–0.125%, while the minimal fungidal concentration (MFC) was in the range of 0.125%–0.25%. Linalool and p-cymene were determined to be the main active constituents of the essential oil against pathogenic dermatophytes [10].

**Anti-inflammatory effects**

The anti-inflammatory effects of the $O. elatus$ essential oil were studied in the acute paw edema model in rats evoked by carrageenan injection into the sub-plantar tissues of the hind paws. Intraperitoneal injection of an oil emulsion (0.09 mL volatile oil/mL emulsion) at 2.2 mL·kg$^{-1}$ significantly inhibited edema [47]. The anti-arthritic effect of EtOH (40%) extracts of the stem was evaluated in rats with formalin- and dextran-induced paw edema and cotton-pellet induced granuloma, respectively. The intragastric administration of the extract (10 g·kg$^{-1}$) resulted in a significant inhibition of both edema and granuloma. However, the extract from $O. elatus$ had no effect on the bilateral adrenalecctomized rats with the inflammation induced by dextran [32].

The polyacetylenes oploxynes A, oplopandiol, and falcarindiol, isolated from the stem, inhibited the formation of...
nitric oxide with IC\textsubscript{50} of 1.98, 2.72, and 1.28 μmol·L\textsuperscript{-1}, respectively, and inhibited prostaglandin E\textsubscript{2} with IC\textsubscript{50} of 3.08, 2.99, and 1.54 μmol·L\textsuperscript{-1}, respectively, in lipopolysaccharide (LPS)-induced murine macrophage RAW 264.7 cells\textsuperscript{[20]}.

**Anti-oxidant effects**

To determine the antioxidant activity, the chemical interaction of *O. elatus* EtOH root extract with the mediator system K\textsubscript{3}[Fe(CN)\textsubscript{6}]/K\textsubscript{4}[Fe(CN)\textsubscript{6}] leading to its redox potential shift by potentiometry, and by a chemiluminescent method in the model system of photooxidation of peptide Gly-Trp using riboflavin as a photosensitizer, were used. The antioxidant activity was 4 meq/L by potentiometry and 0.5 mg·mL\textsuperscript{-1} of rutin equivalents by chemiluminescence methods, respectively, and was equivalent to *Echinacea purpurea* juice\textsuperscript{[48]}.

**Effects on blood pressure**

The effects of a dealcoholized tincture of *O. elatus* and the purified glycosides on blood pressure were studied in cats and rabbits. Intravenous injection of the tincture to cats at the doses of 10–50 mg·kg\textsuperscript{-1} resulted in a slight increase of blood pressure, while higher doses (100–200 mg·kg\textsuperscript{-1}) induced a significant decrease in the arterial blood pressure by 20–30 mm Hg, which was evident during the first hour. The effect was accompanied with stimulation of breathing. Intravenous injection of purified glycosides (20 mg·kg\textsuperscript{-1}) induced a slight decrease of blood pressure in rabbits with a stimulation of breathing. Low doses of glycosides (10–50 mg·kg\textsuperscript{-1}) did not affect the heart rate of cats *in situ*. However, an increase in dose up to 80–100 mg·kg\textsuperscript{-1} resulted in a significant increase in amplitude of the heart contractions by 20%–30%, and a decrease of heart rate by 5–10 beats/min\textsuperscript{[40]}.

The effect of intravenous injection of ciresensoside (CRS) on blood pressure was studied in rats. The mean arterial pressure dropped slightly after injection of CRS at 10 mg·kg\textsuperscript{-1}, however, it was significantly increased after injection of CRS at higher doses of 30 mg·kg\textsuperscript{-1} and 100 mg·kg\textsuperscript{-1}. The effect on blood pressure was antagonized by tolazoline. The plasma monoamine concentration in the CRS-treated group was higher compared with the control\textsuperscript{[49]}.

**Effects on reproductive function**

To assess whether *O. elatus* root EtOH (10%) extract affected maturation of the reproductive tract in mice, the progress toward the first estrous cycle was studied. Female pre-pubertal mice were administered orally with the extract at a dose of 0.25 mg·kg\textsuperscript{-1}. As a result, progression toward the first estrus was initiated earlier in the treated mice. By day 24, nine of ten treated mice had passed through estrus, thereby completing their first estrous cycle. In contrast, 5 of 10 control mice had reached this point at day 25\textsuperscript{[39]}. These data evidenced a stimulating effect of the *O. elatus* extract on maturation of the reproductive tract of female rats.

**Toxicity**

The toxicity of *O. elatus* roots is very low. After acute administration in mice, the LD\textsubscript{50} was 14.5 g·kg\textsuperscript{-1}, and after seven days of administration of the root the LD\textsubscript{100} was 1.0 g·kg\textsuperscript{-1}\textsuperscript{[39]}.

No signs of toxicity were observed in mice after acute oral administration of EtOH (40%) extracts of stem at a dose of 50 g·kg\textsuperscript{-1}\textsuperscript{[12]}.

The safety of the 50% EtOH extract of *O. elatus* stems was examined in a 14-day repeated-dose toxicity study with Sprague-Dawley rats. The rats were treated with the extract by gavage at 0, 500, 1 000, and 2 000 mg·kg\textsuperscript{-1}. There were no significant changes in body and organ weights during the experimental period. The hematological analysis and blood chemistry data revealed no toxic effects from the *O. elatus* EtOH extracts. Pathologically, neither gross abnormalities nor histopathological changes were observed on comparison between the control and treated rats of both sexes\textsuperscript{[34]}.

**Clinical data**

The effect of an oral treatment with the EtOH (40%) tincture of *O. elatus* was studied in twenty-five patients with diabetes in an open clinical trial without a control group. All patients followed a diet with energy values of 30–40 kcal·kg\textsuperscript{-1}, which consisted of 60% carbohydrates, 24% fats, and 16% proteins. Daily glycosuria was calculated after the first four days, and the individual doses of insulin were calculated and injected into patients during ten days. On day 11, patients were injected with insulin followed with oral administration of 1.5 mL of tincture. One hour after tincture administration, a significant decrease in blood glucose level was observed in twenty-four patients, among them the blood glucose level was decreased in seven patients by 80%, and in some individuals it dropped from 350 to 200 mg·dL\textsuperscript{-1}. A decrease in cholesterol level to 160–170 mg·dL\textsuperscript{-1} was registered in four patients. More significant therapeutic effects were observed in patients after six days of treatment, including increased physical activity, improved appetite, normalization of gastrointestinal tract function, decreased thirst, diuresis, and glycosuria. In ten cases, the efficacy was so pronounced that it became possible to reduce the dose of insulin. The blood glucose level was decreased from 350 to 150–200 mg·dL\textsuperscript{-1} in fifteen patients. A significant decrease of daily glycosuria was registered in twelve patients. Arterial blood pressure was normalized in twenty-three patients and the heart rate, up to 80–90 beats/min, was increased in sixteen patients. The most pronounced effects were registered in patients with weakness\textsuperscript{[50]}.

Positive therapeutic effects of *O. elatus* on asthenic and astheno-depressive states (particularly in exogenous depression) in psychiatric diseases have been reported. A group of patients 20–60 years old was included in a clinical trial. Administration of the tincture (1.5–2.0 mL, 2–3 times per day) for seven days produced stimulation of the CNS in patients with asthenia. Subjects reported a decrease of complaints of fatigue, headaches, precordialgia, general weakness, anxiety, and normalization of the night sleep pattern. Patients became energetic and physically more active after 2–3 weeks of treatment. These results suggest that *O. elatus* acts in the long term as a stimulant of the cerebral cortex, inducing feedback inhibition of the subcortex. It was
concluded that *O. elatus* therapy can be indicated in asthenia and depressions of psychogenic etiology (so-called “exogenous” depressions), or those related to excessive fatigue, somatic, and nervous exhaustion [8]. Similar effects were observed for another classical adaptogen *Schizandra chinensis* [51].

The effect of *O. elatus* tincture was evaluated in patients suffering from sluggish schizophrenia with astheno-depressive syndrome. As a result, the patients became calmer, more sociable, and gregarious, and free of emotional tension and anxiety. They were less pronounced phenomenon mutism. A decrease in fatigue and anxiety was registered in patients with post-traumatic encephalopathy. The most effective *O. elatus* tincture application was in the recovery of patients with post-infection fatigue. However, in subjects with post-contusion asthenia, sexual neurasthenia, after suffering encephalomyelitis, weak therapeutic efficacy was observed [43].

Interesting results were reported concerning an increase of antibiotic therapy efficacy with *O. elatus* in children. A group of 258 children aged 0 to 14 years suffering from acute dysentery caused by *Shigella sonnei*, *S. flexneri*, and entero-colitis of the *Proteus* etiology were included in a clinical trial. Group 1 (157 patients) were treated with monomycin and kanamycin in combination with *O. elatus* tincture (2–3 drops per day) and Group 2 (101 patients) were treated with the antibiotics alone. The synergistic effect of *O. elatus* with antibiotics was registered after 10–14 days of treatment. Combination therapy with *O. elatus* decreased the time of disease course, reduced the frequency of complications, and promoted early normalization of lysozyme activity and lymphocyte blast transformation [32].

A comparative study of the effect of *O. elatus* tincture and some other adaptogens (*Eleutherococcus*, *Aralia*, and *Schizandra*) on the functional state of helicopter crews is available. The subjects, consisting of 665 pilots, navigators, mechanics, and radio-operators, were treated with the preparations or placebo at a dose of 0.5–2.0 mL, twice a day for 10 days, and were tested before a flight and again 1–15 min later, and finally, 1 and 3 h after landing. The psycho-physiological state of each participant was evaluated through the application of seven tests, including assessment of dynamic tremometry, sensomotor response, and attention and memory functions. *O. elatus* tincture prevented, in a statistically significant manner, the decrease in attention and memory functions recorded immediately after landing. All adaptogens were effective in expediting the restoration and elevation of the basal level of the functional state [93].

A mixture of sixty-six plants, including the roots of *O. elatus*, was recommended for the treatment of patients with mastopathy, benign brain tumors, osteosarcoma, and myoma. Each herb was ground to a powder, and the powders mixed and pressed into tablets (2 g). The tablets were dipped in alcohol solution with bear bile, dried, and dipped in aqueous solution of mumie (shilajit), followed by drying. Patients were treated with tablets (1–4 per day with a glass of water) for one year [57]. The total saponins extract of *O. elatus* leaves (20% of saponins in dry extract) and a method for its preparation was proposed by Dou et al. [58], and it was recommended for anti-cancer therapy.
of scientific conferences, and patents, etc., there runs a consistent theme regarding the effectiveness of *O. elatus* as a therapeutic agent with anti-diabetic, adaptogenic, antimicrobial/antifungal, anti-cancer, and anti-inflammatory activities.

**Application in officinal medicine of Russia**

An intensive study of *O. elatus* was initiated in the All-Union Institute of Medicinal Plants (Moscow, USSR) in the early 1950s. Since 1955, the EtOH (70%) tincture from the roots and rhizome of *O. elatus* (1 : 5) has been officially approved for therapeutic use in the USSR as a tonic and an anti-diabetic in mild cases of diabetes. The effect of a tincture of the roots is, in general, similar to that of the tincture of ginseng. It is employed primarily to stimulate the central nervous system in asthenia conditions and depression. It is also useful in treating impotence, emaciation, hypotension, and physical and mental fatigue. *O. elatus* is not included in the State Pharmacopoeia of the USSR, 11th edition which follows the Russian Federation nowadays, but separate monographs for the roots and rhizome, and tincture are supplemented to the Pharmacopoeia. The tincture of *O. elatus* is recommended in Russia for internal administration at a dose of 30–40 drops, 2–3 times a day for 25–30 days as a CNS stimulant and adaptogen.

The root of *O. elatus* is a component of the plant mixture "Arphasetin", which contains 20% *Phaseolus vulgaris* L. bean pods, 20% *Vaccinium myrtillus* L. shoots, 10% *Matricaria chamomilla* L. flowers, 15% *O. elatus* root, 10% *Equisetum arvense* L. herb, 15% *Rosa* spp. L pseudo fruits, and 10% *Hypericum perforatum* L. aerial parts. "Arphasetin" is available in Russia pharmacies as an over-the-counter (OTC) product, and is recommended for internal administration at the dose of 1/2–1/3 glass of the infusion (1 : 40), 2–3 times per day as a hypoglycemic agent in complex therapy for type 2 diabetes.

**Conclusions**

In this review, the advances in phytochemistry, pharmacological activities and safety of *O. elatus* were presented and discussed. The plant belongs to the group of classical adaptogens with a broad spectrum of biological activities. Experimental studies and clinical evaluations have indicated that *O. elatus* possesses a number of pharmacological activities, including adaptogenic, anti-convulsant, anti-diabetic, anti-fungal, anti-inflammatory, anti-oxidant activities, and effects on blood pressure and reproductive function. One of the advantages of *O. elatus* treatment is the absence of side effects. Moreover, tolerance to *O. elatus* is many times greater than tolerance to synthetic stimulants, such as caffeine or phenamine, and the effect of the medication is not lowered over a prolonged period of treatment. The plant has a long history of application in traditional medicine, and some interesting clinical data are available. However, it is important to reproduce and confirm the clinical data according to Good Clinical Practices in appropriately constructed, blinded clinical trials. Publications concerning the chemistry of *O. elatus* are quite fragmentary and more research is needed. Overall, there are number avenues to be explored in further studies on this largely unexamined botanical.

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