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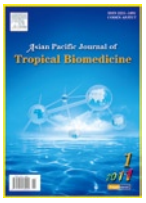

Document heading

Pharmacologically screened aphrodisiac plant-A review of current scientific literature

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ABSTRACT

Substances which are used to treat sexual dysfunction or to improve sexual behavior and satisfaction in humans and animals are called 'aphrodisiac'. Uses of plant material to treat sexual disorder is a long back history in the different system of medicine and it was practiced by different type of vaidyas and traditional healer in almost all the countries in the world, like China, India, Egypt, Rome and Greek. Even though there was an unavailability of the scientific data, these substances have been used as aphrodisiac. During the historic times *Lytta vesicatoria, Tribulus terrestris, Ptychopetalum olacoides, Crocus sativus, Bufo marinus, Myristica fragrans, Theobroma cocao* and other plants have been investigated for its aphrodisiac activity by *in vivo* and *in vitro* model. Even though the study showed positive response to a particular substance, there is always a need to run the clinical trial before administering the tested drug in human being. The present review article summarizes the plant material which has been tested for its aphrodisiac activity in different experimental model (*in vitro*, *in vivo* on animal models, or in human clinical trials) and comply its claim in the different system of medicine. A brief overview about the data of percentage study in the last eighteen years duration on aphrodisiac activity of plant material was done on the basis of the CAB abstract database.

1. Introduction

Sexual dysfunction is an inability to achieve a normal sexual intercourse including premature ejaculation, retrograded, retarded or inhibited ejaculation, erectile dysfunction, arousal difficulties (reduced libido), compulsive sexual behaviour, orgasmic disorder and failure of detumescence. It is increasing world wide due to etiological factors and aging. Several type of treatment is claimed in the modern medicine but due to serious side effects and higher cost, search of natural supplement from medicinal plants as an aphrodisiac substance is significantly increased[1]. The term aphrodisiac originated from the Greek word 'Aphrodite' which is related to love and romance, but in modern time substances which are used to treat sexual dysfunction or having sexual activity enhancing power called aphrodisiac[2]. Sexual desire is controlled and regulated by the central nervous system which integrates tactile, olfactory, auditory, and mental stimuli. The aphrodisiac drugs act by altering the level of specific neurotransmitters or specific sex hormone into the body. Mostly act through alteration in testosterone concentration in the body but other effective in both sexes[3,4].

Erectile dysfunction (ED) is an inability to attain or maintain penile erection sufficiently while engaging in sexual intercourse[5]. Androgens are sex hormones that play an essential role in male reproductive function. It is known to act both centrally and peripherally for the initiation and maintenance of sexual functions. Various stimuli such as anabolic steroids (testosterone) are known to either upregulate or downregulate androgen response[6]. Sexual dysfunction is a serious medical and social symptom that occurs in 10%-52% of men and 25%-63% of women. Of men aged 40-70 years, an estimated 34.8% have moderate to complete erectile dysfunction. Treatment of ED usually involves a psychotherapeutic approach; on the other hand, pharmacotherapy involves drugs such as papaverin, alprostadil, sildenafil, vardenafil, tadalafil, central stimulants like apomorphine and herbal drugs with aphrodisiac activity are also used for the treatment of ED. A variety of botanicals such as *Tribulus terrestris* (*T. terrestris*), *Aframomum melegueta, Eurycoma longifolia* (*E. longifolia*), *Cnidium monnieri, Ferula harmonis, Mucuna pruriens* (*M. pruriens*), *Lepidium meyenii* (*L. meyenii*), *Passiflora incarnate* and some compounds like yohimbine were reported to have

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a potential effect on the sexual functions, supporting older claims and offering new hope[7]. This review mainly focuses on the plants which were scientifically tested and validated, either *in vitro*, *in vivo* on animal models, or in human clinical trials, and proved as a potential aphrodisiac agents. A brief calculation about the percentage of the study in the last eighteen year duration on aphrodisiac activity of the plant material was done on the basis of CAB database (Figure 1). Moreover botanical name, family and uses or application of some plant which have been tested for aphrodisiac activity is shown in the Table 1.

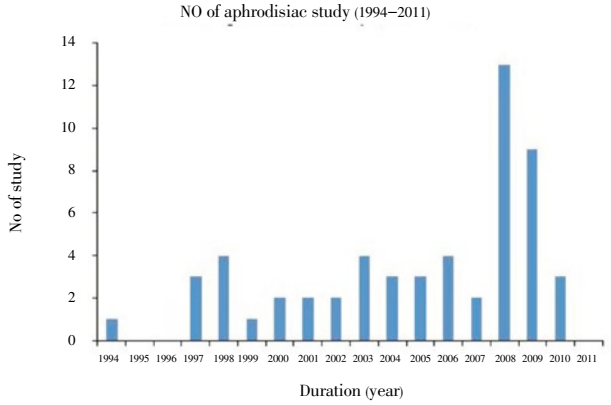

Figure 1. The number of aphrodisiac study verses year of the study.

2. Parameter used in assessing aphrodisiac properties

For the determination of the aphrodisiac activity many *in vivo* or *in vitro* model have been used. Methods that are used in aphrodisiac study can be categorized into physical methods including mating behaviour test [mount latency (ML), intromission latency (IL), ejaculation latency (EL), mounting frequency (MF), intromission frequency (IF), ejaculation frequency (EF), post-ejaculatory interval, index of libido, computed male sexual behaviour parameters], test for libido, test for potency, penile microcirculation study, intracavernous pressure (ICP) study, and biochemical methods including determination of testicular and serum cholesterol, hormonal determination, assay for neuronal nitric oxide synthase and androgen receptor protein. MF is defined as the climbing of one animal by another usually from the posterior end with the intention of introducing one organ into another. IF is the introduction of one organ or parts into another. ML is defined as the time interval between the introduction of the female and the first mount by the male. IL is the time interval from the time of introduction of the female to the first intromission by the male. EL is defined as the time interval between the first intromission and ejaculation and ejaculation frequency[1].

3. Medicinal plant having aphrodisiac properties

Medicinal plants can be used in different therapeutic purposes or used as precursors for synthesis of useful drugs containing different type of phytochemicals. Plants are extensively used to treat sexual dysfunction. For example Ginseng (*Panax ginsengs*) is an essential constituent in traditional Chinese medicine, and at least 6 million Americans use the root of this plant. Maca (*L. meyenii*), has traditionally been used by Peruvian inhabitants as a nutrient, energizer, aphrodisiac and fertility-enhancing agent[1]. *Fadogia agrestis* (*F. agrestis*)stem is another example. Botanical name, family and uses/application of the herbs having aphrodisiac activity have been shown in Table 1.

4. Pharmacologically active aphrodisiac plants in experimental models

In our country with the advent of the Ayurvedists some of the medicinal plants have proven to possess a traditional as well as scientifically-proven aphrodisiac that can enhance passion, increase libido, enhance sexual performance, and help to increase the intensity of lovemaking. A brief summary of the plants have been tested for aphrodisiac activity are documented.

4.1. Allium sativum (Alliaceae)

Aphrodisiac effect of *Allium sativum* (*A. sativum*) extracts at 0.57, 1.13 and 2.25 mL/kg, *p.o.* for 28 days on male mice was investigated and it was found that it increased sexual behaviour in dose dependent manner[8].

4.2. Allium tuberosum (Alliaceae)

The aphrodisiac activity of n-butanol extract of *Allium tuberosum* (*A. tuberosum*) seeds was investigated in male rats at 500 mg/kg, *p.o.* for 40 days, and it was found that the extract significantly reduced ML, IL, EL and increased MF, IF, EF[9].

4.3. Alpinia calcarata (Zingiberaceae)

Hot water extract of *Alpinia calcarata* (*A. calcarata*) at 150, 250 and 500 mg/kg, *p.o.* in rats was found to prolong the EL. Moreover, the EL and IL were reduced, indicating a strong aphrodisiac action. At 500 mg/kg, *p.o.*, it elevates the serum testosterone level and was found nontoxic[10].

4.4. Anacyclus pyrethrum (Compositae)

Effect of petroleum ether extract of *Anacyclus pyrethrum* (*A. pyrethrum*) at dose of 50 mg/kg and 100 mg/kg, *p.o.* in male rats showed more receptive and oriented towards female rats and increased precopulatory activities like licking and sniffing of female anogenitals. The penile erection index was significantly increased with reduction in ML and IL period[11].

4.5. Asparagus racemosus (Liliaceae)

Aqueous root extract of *Asparagus racemosus* (*A. racemosus*) treatment had showed enhancement of body weight and

Table 1
Pharmacologically active aphrodisiac plant.

Botanical name	Family	Uses/activity
A. tuberosum	Alliaceae	Impotence, nocturnal emissions, food
A. calcarata	Zingiberaceae	Antibacterial, antifungal, anthelmintic, antinociceptive, antioxidant
A. pyrethrum	Compositae	Tonic, rejuvenator, aphrodisiac, sexual stimulant
A. racemosus	Asparagaceae	Dyspepsia, lactogogue, antidiarrhoeal, antiseptic, diuretic, nutritive tonic, demulcent, aphrodiasic, antispasmodic, liver and kidney diseases
B. edulis	Acanthaceae	Wounds, ulcers, hemorrhages, asthma, throat inflammation, purgative, liver and spleen disorders, diuretic, urinary discharges, dysmenorrhoea, diuretic, aphrodisiac, expectorant, deobstruent, conjunctivitis
Butea frondonsa	Papillionaceae	Antistress, hepatoprotective, antiestrogenic, ocular anti-inflammatory, antihelminthic
C. benthamiana	Fabaceae	Erectile dysfunction, antibacterial
C. sinensis	Theaceae	Diuretic, urinary inconsistency, common cold, anxiety, skin problem
C. edulis	celastraceae	Stimulant, sympathomimetic
C. borivilianum	Liliaceae	Immunomodulatory, adaptogenic, impotency, sterility, potency, alertness, mental ability
C. sativus	Iridaceae	Anticonvulsant, antidepressant, antiinflammatory, antinociceptive, antitumor activities
C. orchioides	Hypoxidaceae	Tonic, demulcent, diuretic, piles, asthma, jaundice, diarrhoea, colic, gonorrhea
Derris scandens	Leguminosae	Expectorant, antitussive, diuretic, antidysentery muscle aches, antimicrobial, immunostimulating activities
D. zibethinus	Bombacaceae	Fertility enhancing activity
E. longifolia	Simaroubaceae	Fevers, aches, sexual insuficiency, hypertensive, tuberculosis, vermifuge, health supplement
H. zeylanica	Ophioglossaceae	Aperiant, febrifuge, intoxicant, anodyne, sciatica, boils, ulcers, malaria, snake bites, jaundice, aphrodisiac
H. sabdariffa	Malvaceae	Diuretics, aphrodisiac, antiseptic, astringent, digestive, tonic, sedative, laxative, antimicrobial
K. parviflora	Zingiberaceae	Inflammation, diarrhea, vertigo, heart diseases, reproductive disorder
*L. meyenii**	Brassicaceae	Improving sexuality and fertility, aphrodisiac
L. barbarum	Solanaceae	Diabetes, hyperlipidemia, cancer, hepatitis, hypo-immunity function, thrombosis, male infertility
M. acuminata	Rubiaceae	Eye drops, oral hygeine, aphrodisiac, anticancer
M. keayana	Pandaceae	erectile dysfunction, hypotensive, vasorelaxing properties,
M. whitei	Periplocacea	Aphrodisiacs, urinary tract infection, jaundice, headaches, diarrhea, treatment of impotence and fertility men
M. tomentosa	Asteraceae	Postpartum bleeding, antipregnancy, reproductive impairments, induction of labor, regulation of fertility
M. pruriens	Papilionaceae	Improving fertility, aphrodisiac agent, sexual disorder
M. fragrans	Myristicaceae	Aphrodisiac, stomachic, carminative, tonic, nervous stimulant, aromatic, narcotic, astringent, hypolipidemic, antithrombotic, antifungal, antidysentric, anti inflammatory
O. gratissimum	Labiatae	Antibacterial, antifungal, hypoglycemic, antidiarrhoeal, analgesic
P. incarnata	Passifloraceae	Anxiolytic, sedative, anti-convulsant, analgesic, adaptogenic, nervine, anti-stress, post-menopausal
Psoralea corylifolia	Leguminosae	Aphrodisiac agent, bone fracture, osteomalacia, osteoporosis
S. aromaticum	Myrtaceae	Dental disorders, respiratory disorders, headache, soar throa, antimicrobial, antifungal, antiviral, anti-inflammatory, cytotoxic, anesthetic
*T. terrestris**	Zygophyllaceae	Urinary, cardiovascular, gastrointestinal disorders
T. zeylanicus	Trichopodaceae	Hepatoprotection, anti-ulcer activity, immunomodulation
T. diffusa	Turneraceae	Muscle and nerve weakness, aphrodisiac, tonic, catarrhal and bladder inflammations
V. tessellata	Orchidaceaae	Inflammatory conditions, otitis, fever, rheumatism, nervous, problems, bronchitis, dyspepsia, fever, hiccough, piles, boils

* Tested clinically in humans

reproductive organs, penile erection, mount frequency in rats, and indicates an improvement in sexual behavior[12].

4.6. Bidens frondosa (Asteraceae)

The aphrodisiac activity of *Bidens frondosa* (*B. frondosa*) bark at 400 mg/kg, *p.o.* for 28 days showed significant reduced ML, IL, EL, post ejaculatory interval (PEI) and increased MF, IF and EF[13].

4.7. Blepharis edulis (Acanthaceae)

Ethanolic extract of *Blepharis edulis* (*B. edulis*) Linn at 100, 250, and 500 mg/kg, *p.o.* in male albino mice reveals significant and sustain increase in hormonal levels of testosterone without any adverse effects and it was found to be most effective at the dose level of 500 mg/kg[14].

4.8. Caesalpinia benthamiana (Fabaceae)

Aqueous extract of *Caesalpinia benthamiana* (*C. benthamiana*) at 50 mg/kg, *p.o.* in male rats is found to have significant sex power stimulatory activity, due to its vasorelaxant properties. Further upto 2 g/kg, *p.o.* it is safe and showed no toxicity[5].

4.9. Chenopodium album (Chenopodiaceae)

Ethanolic extract of *Chenopodium album* (*C. album*) at 100, 250, and 500 mg/kg, *p.o.* in male albino mice showed significant increase in the MF, IF, IL, Erections as well as aggregate of penile reflexes and caused significant reduction

in the ML and post ejaculatory interval. Moreover 500 mg/kg, *p.o.* was found to be most active[15].

4.10. Chlorophytum borivilianum (Liliaceae)

Lyophilized aqueous root extracts of *Chlorophytum borivilianum* (*C. borivilianum*) at 200 mg/kg, *p.o.* showed significant enhancement of body weight and reproductive organs, penile erection, MF, *whereas* significant variation in reduction of ML, EL, IL, reduced hesitation time indicates an improvement in sexual behavior of extract treated animals[2].

4.11. Camellia sinensis (Theaceae)

Camellia sinensis (*C. sinensis*) tea at 84, 167 and 501 mg/mL, *p.o.* dose level in rats were found to possess marked aphrodisiac activity in terms of prolongation of latency of ejaculation shortening of ML, IL and elevation of serum testosterone level[16].

4.12. Crocus sativus (Iridaceae)

Effect of aqueous extract of *Crocus sativus* (*C. sativus*) stigma (80, 160 and 320 mg/kg, *i.p.*), crocin (100, 200 and 400 mg/kg, *i.p.*), safranal (0.1, 0.2 and 0.4 mL/kg, *i.p.*), on male rats were investigated. Crocin and extract increased MF, IF and erection frequency behaviors and reduced ML, IL and EL, *whereas* safranal did not show any aphrodisiac effects[7].

4.13. Catha edulis (Celastraceae)

Administration of leaf extract of *Catha edulis* (*C. edulis*) at dose of 1 000 and 2 000 mg/kg, *p.o.* for 6 weeks were found to increase plasma testosterone levels in more than 2 folds in the male Sprague-Dawley rats[17].

4.14. Casimiroa edulis (Rutaceae)

Aqueous extract of the seeds of *Casimiroa edulis* (*C. edulis*) at 250 mg/kg, *p.o.* on male rats for seven days exhibited a significant increase in MF, IF, and first and second EL, whereas ML, IL and the post ejaculatory interval showed a significant reduction when compare to control group[18].

4.15. Curculigo orchioides (Hypoxidaceae)

Ethanolic extract of rhizomes of *Curculigo orchioides* (*C. orchioides*) at 100 mg/kg, *p.o.* in rats was found to be change significantly the sexual behaviour such as penile erection, mating performance, MF, ML, and increase of penile erection index and weight of reproductive organs[19].

4.16. Durio zibethinus

Aphrodisiac activity of petroleum ether extract and isolated compound 3- beta -hydroxy-21-normethyl-19-vinylidenylursane of *Durio zibethinus* (*D. zibenthinus*) were screened for different dose level and it was found that 400 mg/kg, *p.o.* was most active in the mice and have better aphrodisiac activity than all other treated dose[20].

4.17. Diodia scandens (Fabaceae)

Ethanol extract of *Diodia scandens* (*D. scandens*) on pregnant guinea-pig uterus was investigated and found to induce concentration-dependent increase in the force of contraction and tonus. *D. scandens* was shown to acting via muscarinic receptors. Acetylcholine (ACh) was 2.5 × 10(5) times more potent. It also induced vasodilatation in the rat hindquarters and depressed the blood pressure in the anaesthetized cat[21].

4.18. Eurycoma longifolia (Simaroubaceae)

Root extracts of *Eurycoma longifolia* (*E. longifolia*) at repeated does of 0.5 g/kg, *p.o.* in sexually sluggish old adult male rats showed that *E. longifolia* exerted stimulation of copulatory behaviour in non-copulator male rats with high level of maintenance of both intromissions and ejaculations[22]. Chloroform, methanol, water or n-butanol fractions from *E. longifolia* at 500 mg/kg, *p.o.* on sexually naive male mice showed aphrodisiac properties as indicated by the slow and transient reduction in hesitation time[23]. Butanol, methanol, aqueous and chloroform root extracts of *E. longifolia* at 200, 400 and 800 mg/kg, *p.o.* produced a dose-dependent, recurrent and significant increase in the episodes of penile reflexes, as shown by increases in quick flips, long flips and erection of the treated mice[24]. Effect of *E. longifolia* on sexual behavior of sexually sluggish and impotent male rats at 250, 500 and 1 000 mg/kg, *p.o.* were investigated in different model and found that it significantly reduced ejaculation latencies and increased the percentage of mounting and ejaculating of animals. Testosterone serum levels were also increased[25]. Various fractions of *E. longifolia* roots, on the sexual qualities of middle-aged male rats at 0.5 g/kg, *p.o.* were found to enhance the sexual qualities by decreasing their hesitation time[26]. Effects of 200, 400 and 800 mg/kg, *p.o.* of butanol, methanol, water and chloroform fractions of *E. longifolia* Jack were studied on the levator ani muscle in both uncastrated and testosterone-stimulated castrated intact male rats. 800 mg/kg of butanol, methanol, water and chloroform fractions of *E. longifolia* Jack significantly increases the levator ani muscle and body weight[27]. The effects of root extracts of *E. longifolia* at 200, 400 and 800 mg/kg, *p.o.* on the orientation activities of sexually experienced male rats showed significantly more frequent and vigorous mounting, licking and anogenital sniffing towards the receptive females, increased grooming of the genitals compared with the controls[28]. Different fractions of *E. longifolia* roots (chloroform, methanol, water or butanol) were screened for aphrodisiac properties in sexually naive male mice using dose of 0.5 g/kg, *p.o.* daily and it resulted in an enhancement of the sexual motivation of animals after 3 days. The effect was more prominent after 8 days[29].

4.19. Helminthostachys zeylanica (Ophioglossaceae)

Methanol extract of *Helminthostachys zeylanica* (*H. zeylanica*) rhizome to male mice significantly stimulates the

sexual behaviour as evidenced by increase in the number of mounts, mating and reproductive performance. The pups fathered mice by the drug-treated were normal, with reference to fetal growth, litter size and sex ratio[30].

4.20. Hibiscus sabdariffa (Malvaceae)

Aqueous extract of *Hibiscus sabdariffa* (*H. sabdariffa*) calyx at 1.15, 2.30, 4.60 g/kg, *p.o.* for 12-week on the rat testes did not show any significant change in the absolute and relative testicular weights. However, it showed a significant decrease in the epididymal sperm counts and induced testicular toxicity in rats[31].

4.21. Kaempferia parviflora (Zingiberaceae)

The alcoholic, hexane and aqueous extracts of *Kaempferia parviflora* (*K. parviflora*) showed no effect on the weights of reproductive organ, fertility or sperm motility even in 5-week male rats. However, alcohol extract at a dose of 70 mg/kg, *p.o.* significantly decreases mount and ejaculatory latencies and increases blood flow to the testis. Whereas, hexane and water extracts had no influence on any sexual behavior parameters[32].

4.22. Lepidium meyenii (Brassicaceae)

The clinical trial of *L. meyenii* for aphrodisiac activity was done for 12 weeks in double-blind, placebo-controlled, randomized, parallel trial with 1 500 mg/kg or 3 000 mg/kg, *p.o.* doses in form of tablets on men aged between 21 and 56 years. It had no effect on serum levels of luteinizing hormone, follicle-stimulating hormone, prolactin, 17-alpha hydroxyprogesterone, testosterone and 17-beta estradiol[33].

4.23. Litsea chinensis (Lauraceae)

Ethanolic extract of the bark of *Litsea chinensis* (*L. chinensis*) on male sexual behaviour in rats at 500 mg/kg, *p.o.* produced a significant increase in penile erection index, homosexual mounting and facilitated sexual behaviour and orientational activity, as shown by increased mounting performance, anogenital sniffing, intromission and ejaculation frequencies[34].

4.24. Lycium barbarum (Solanaceae)

Effect of *Lycium barbarum* (*L. barbarum*) polysaccharides (LBP) at 10, 50, 100, and 200 mg/kg, *p.o.* per day on damaged rat testis showed that LBP provides a protective effect against the testicular tissue damage induced by heat exposure. LBP significantly increases testis, epididymis weights, superoxide dismutase activity and sexual hormone levels in the damaged rat testis. LBP had a dose-dependent protective effect against DNA oxidative damage of mouse testicular cells induced by H_2O_2[35].

4.25. Microdesmis keayana J. Le´onard (Pandaceae)

Effects of aqueous extract of *Microdesmis keayana* (*M. keayana*) root and major isolated alkaloids on sexual behavior of male rats revealed that it stimulates sexual parameters in rats, and it is safe at dose of upto 2 g/kg, *p.o.*[4].

4.26. Montanoa tomentosa (Compositae)

Aqueous extract of *Montanoa tomentosa* (*M. tomentosa*) at the dose of 38, 75 and 150 mg/kg, *p.o.* facilitates expression of sexual behaviour in sexually active male rat and significantly increases mounting behaviour in genitally anesthetized animals and induces the expression of sexual behaviour in noncopulating males. It also exerted a pro-ejaculatory effect and produced an increase in the number of discharges in the ejaculatory motor patterns in the spinal rats. The cihuapatli-induced ejaculatory motor patterns were similar to the effect that obtained after systemic oxytocin[3].

4.27. Mucuna pruriens (Fabaceae)

Ethanolic extract of *Mucuna pruriens* (*M. pruriens*) showed significantly increase in the MF, IF and EL, and decreased the mounting latency, IL, post-ejaculatory interval and inter-intromission interval at 150, 200, 250 mg/kg, *p.o.* dose in Wister albino rats[36].

4.28. Mondia whitei (Asclepiadaceae)

Effect of aqueous extract of *Mondia whitei* (*M. whitei*) on human spermatozoa *in vitro* has significantly enhanced the total motility as well as progressive motility in a time-dependent manner. This study signifies uses of *M. whitei* especially in men affected with asthenozoospermia[37].

4.29. Massularia acuminata (Rubiaceae)

Androgenic potential of aqueous extract of *Massularia acuminata* (*M. acuminata*) stem at 250, 500 and 1 000 mg/kg, *p.o.* for 21 days in male rats was shown in significantly increase in testes-body weight ratio, testicular protein, glycogen, sialic acid, cholesterol, testosterone, luteinizing and follicle stimulating hormone concentrations throughout the period of administration[38].

4.30. Myristica fragrans (Myristicaceae)

Aphrodisiac effect of 50% ethanolic *Myristica fragrans* (*M. fragrans*) Houtt at 100, 250 and 500 mg/kg, *p.o.* for seven days in male rats was shown in significant augmentation of sexual activity in male rats. It significantly increases the MF, IF, and IL and caused significant reduction in the ML and PEI. The extract was also observed to be devoid of any adverse effects and acute toxicity[39].

4.31. Ocimum gratissimum (Lamiaceae)

Effect of ethanolic extract of leaves of *Ocimum gratissimum* (*O. gratissimum*) at 100, 250, and 500 mg/kg, *p.o.* for seven days on mice significantly increases the MF, IF, IL, erections as well as aggregate of penile reflexes and caused significant

reduction in the ML and PEI. A dose of 500 mg/kg showed maximum effect without any conspicuous gastric ulceration and adverse effects[15].

4.32. Pedalium murex (Pedaliaceae)

Aphrodisiac activity of petroleum ether extract of *Pedalium murex* (*P. murex*) plant at 200 and 400 mg/kg, *p.o.* in ethanol induced germ cell damage and infertility in male rat models depicted an increase in mating and mounting behaviour, body weight, percentage of pregnancy, litter size, sperm motility and also showed an increased levels of testosterone, germinal cells and the luminal spermatozoa in treated compared to control group[40].

4.33. Passiflora incarnata (Passifloraceae)

Effect of methanolic extract of *P. incarnata* on male mice exhibited significant aphrodisiac behaviour at 75, 100 and 150 mg/kg, *p.o.* Amongst these, the highest activity was observed with the 100 mg/kg, *p.o.* dose when the mountings were calculated about 95 min after the administration of the test extracts[41].

4.34. Peganum harmala (Nitrariaceae)

Treatment of *Peganum harmala* (*P. harmala*) seeds at 100 mg/kg, *p.o.* for 56 days in male rats was found to significantly chang gonad and accessory gland weight and function, semen quality, and histology of the organs involved in reproduction, without affecting the metabolic function[42].

4.35. Syzygium aromaticum (Myrtaceae)

Effect of hexane extract of flower buds of *Syzygium aromaticum* (*S. aromaticum*) at 15, 30, and 60 mg/kg, *p.o.* for 35 days were evaluated for a single spermatogenic cycle in Parkes (P) strain mice. Lower dose (15 mg/kg, *p.o.*) of the extract increased the activities of Delta 5 3 beta -HSD and 17 beta -HSD, and serum level of testosterone[43].

4.36. Tricholepis glaberrima (Compositae)

Treatment of methanol extract of the aerial parts of *Tricholepis glaberrima* (*T. glaberrima*) DC at dose of 200 mg/kg, *p.o.* for 28 days in sexually active male rats has significantly increased ML, IL, while with a significant reduction in MF, IF, and post-ejaculatory interval. Extract favors spermatogenesis by enhancing the proliferation of the seminiferous epithelium[44].

4.37. Tribulus terrestris (Zygophyllaceae)

Effect of *Tribulus terrestris* (*T. terrestris*) at 5 mg/kg, *p.o.* for 8 weeks in adult Sprague-Dawley rats on sexual behaviour and intracavernous pressures (ICP) showed increase in mount and intromission frequencies, decrease in mount, intromission, ejaculation latencies and PEI revealing the improvement of the sexual behaviour parameters[45]. Effect investigation of *T. terrestris* extract at 20 and 10 mg/kg for 4 weeks on androgen metabolism in young males showed no significant difference between *T. terrestris* supplemented groups and control in the serum testosterone, androstenedione or luteinizing hormone[46]. Aphrodisiac properties of the furostanol glycoside fraction of *T. terrestris* in male castrated rats were investigated at 5, 10, and 25 mg/kg, *p.o.* for 14 days and found to increase orientational activity parameters such as licking, anogenital and genital grooming and decreased climbing and nongential grooming by male rats indicating increased sexual stimulation[47]. Effect of *T. terrestris* at dose of 2.5, 5 and 10 mg/kg, *p.o.* for 8 weeks on sexual behaviour and ICP measurements in Sprague-Dawley rats reveals an increase in body weight and ICP, mount and intromission frequencies and decrease in mount latencies compared to the control group[48].

4.38. Trichopus zeylanicus (Trichopodaceae)

Administration of the ethanol extract of *Trichopus zeylanicus* (*T. zeylanicus*) leaves to male mice increased the number of mounts and mating performance. The pups fathered by the extract-treated mice were normal with regard to foetal growth, litter size and sex ratio. Although oral administration of a single dose (200 mg/kg, *p.o.*) was effective, daily administration of the extract for 6 days was more effective. The aqueous as well as n-hexane extracts of the leaves were found to be inactive[49].

4.39. Turnera diffusa (Turneraceae)

Effect of *Turnera diffusa* (*T. diffusa*) at 20-80 mg/kg, *p.o.* in sexually exhausted male rats significantly increased the percentage of males achieving one ejaculatory series and resuming a second one. In addition, *T. diffusa* significantly reduces the PEI[50].

4.40. Terminalia catappa (Combretaceae)

Aphrodisiac potential of *Terminalia catappa* (*T. catappa*) seeds at dose of 1 500 mg/kg or 3 000 mg/kg, *p.o.* for 7 days in rats had a marked improvement of aphrodisiac action, sexual vigour. In contrast, the higher dose (3 000 mg/kg, *p.o.*) reversibly inhibited all the parameters of sexual behaviour other than mounting-and-intromission frequency and copulatory efficiency[51].

4.41. Vanda tessellata (Orchidaceae)

Alcoholic extract of flowers of *Vanda tessellata* (*V. tessellata*) at doses of 50 and 200 mg/kg, *p.o.* were found to be increase mating performance, and tend to increase the male: female ratio of resulting offspring. This extract was devoid of general toxicity[52].

5. Conclusion

Medicinal plants are used from ancient times and only true natural medicines have been found useful in several ways. They can be used directly or in extracted forms for

the management of various ailments, due to presence of many phytochemicals. In this review we have mentioned the pharmacologically tested aphrodisiac plants which have claimed for its uses in the traditional system of medicine to treat sexual disorder. Plants like *T. catappa* seeds, *S. aromaticum* flower bud, and *F. agrestis* stem have been found to have aphrodisiac activities in male rats. The incidence of male sexual dysfunction is increasing, which need more and rapid search of the plants with aphrodisiac potentials. Chinese men have always been interested in increasing virility and sexual satisfaction to the extent of using any possible means[53]. In England, people believed that plants having phallic-like features such as asparagus, parsnips and carrots can be used as aphrodisiac agent. Ukrainians believe carrots and celery have aphrodisiac activity. In chinese culture, ginseng and rhinoceros horn is used as an aphrodisiac agent[1]. Substances which enhance sexual performance are called aphrodisiac including foods, beverages, vitamins, minerals, and other natural and synthetic chemicals[54-56].

The search for natural supplement from medicinal plants is being intensified probably because of its fewer side effects, its ready availability and less cost. All the plants in this review have exhibited significant pharmacological activity. The herbs can be effective aphrodisiacs, moreover, isolation and identification of active constituents from plants may bring a dynamic change in the modern world[57]. Many of the plant materials showed positive aphrodisiac activities in animals. For the determination of the safety and effectiveness of these substances for sexual enhancement it is necessary to test pre-clinically in animals and clinically in human being before consuming the drug. Further studies are also needed to check the mechanism that underlie behind such activity.

Demands of natural aphrodisiacs require increasing studies to understand their effects on humans and strengthen relationships to its safety. Due to unavailability of the safety data, unclear mechanisms, and lack of knowledge to support the extensive use of these substances, uses of these products can be harmful to the human being. With more clinical data, exact mechanisms of action, safety profile, and drug interaction with other uses of these aphrodisiacs plant materials, treating sexual disorder can become fruitful.

Conflict of interest statement

We declare that we have no conflict of interest.

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