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REVIEW

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Effect of Herbal Medicine on Fertility Potential in Experimental Animals - an Update Review

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ABSTRACT

Introduction: Sexual function greatly affects the quality of life. Any problem which affects satisfaction is considered sexual dysfunction. **Aim:** The aim of this study was to investigate how recently used of complementary and alternative medicines has increased in treating infertility. **Methods:** Study has descriptive character based on searched and analyzed facts from the published articles in scientific journals. **Results:** The majority of the studies done for the detection of the efficacy of medicinal plants in treating male infertility were done on experimental animals with few clinical studies. However, there is still a need for more studies to have certain results, as conflicting results were noted in different studies done on the effect of the same medicinal plant on spermatogenesis. It might be referred to the absence of standardization among research models, the difference in extracts, administration route, doses and how long did the experiment last added to differences in the part of the plant used and plant collection. This review summarized the finding of many studies that studied the effect of different medicinal herbs on the testes, epididymis, sperm and prostate parameters, testosterone level and steroidogenesis, erection/ejaculation function and libido. **Conclusion:** The protective effect might be due to OLE competence to antagonize the oxidative stress and LPO. *Londium suffruticosum* I. *suffruticosum* leaf extract was administered to sub-fertile male rats, subfertility was induced by carbendazim, it resulted in increased spermatogenesis, increased sperm counts, lessened sperm agglutination by preserving normal pH in testicular microenvironment, increasing the testicular oxidative biomarkers, SOD, and CAT. It was found that the main active components of the extract are alkaloids, steroidal lactones and flavonoids.

Keywords: Fertility-plants-herbs-testes-testosterone-epididymis-sperms.

1. INTRODUCTION

Sexual function greatly affects individual's quality of life, the normal male sexual response cycle consists of five phases: libido, erection, ejaculation, orgasm and detumescence subsequently. Any problem which affects satisfaction is considered sexual dysfunction (1). Male sexual dysfunction is growing world widely. Sexual dysfunction has many etiological factors including various physical and psychological conditions (2).

The male accounts for 30%–50% of entire infertility causes (3), 25% of them are unknown causes, without knowing the exact etiology, targeted management is not applicable, rising the use of empiric treatment in present conventional medicine without sufficient scientific evidence (3).

Recently the use of complementary and alternative medicines (CAMs) has increased in treating infertility (4). 29% of sub fertile couples in the United States were detected in a prospective cohort study using CAM with 17% of them using herbal medicine (5). The use of herbal medicine among infertile couples was detected in Jordan and Lebanon as well with prevalence 21% respectively (6) and 12.2% (7). Surprisingly only 1% of available medicinal plants have been explored, although most of them are still used depending on their initial use in literature, it is limited to certain areas of the world because of shortage of scientific research on their benefits (8). The interest in using herbal medicine in spite of the presence of synthetic treatments may be accounted for the belief that natural aphrodisiacs have less or no side effects, have systemic effect as providing nutrition and are cheaper (3).

The majority of the studies done for the de-

tection of the efficacy of medicinal plants in treating male infertility were done on experimental animals with few clinical studies (1). Generally, the results of these studies are encouraging (9). However, there is still a need for more studies to have certain results, as conflicting results were noted in different studies done on the effect of the same medicinal plant on spermatogenesis. It might be referred to the absence of standardization among research models, the difference in extracts, administration route, doses and how long did the experiment last added to differences in the part of the plant used and plant collection (1). As within the same plant there are various phytochemicals that may work together to produce certain effect with isolation of a certain compound the efficacy may decrease, another important role is studying the toxicology of these medicinal plants and detection of the upper limits of doses that can be used (1).

2. EFFECT OF MEDICINAL HERBS ON TESTIS

Many studies showed the effect of different medicinal herbs on the testes of experimental animals from these herbs *Asparagus adscendens* Roxb (Liliaceae) known as shweta musali or satavar bhed as well, it is claimed to be used in the treatment of seminal weakness (10), others use its stem as aphrodisiac (11). A study showed that *A. adscendens* root extract “200 and 300 mg/kg doses orally for 30 days” significantly increased testes weight and testicular tubular diameter (12). *Chlorophytum borivilianum* family Liliaceae, also known as “Safed musli” is a widely used Indian plant that is considered herbal Viagra (13). A study was done using the extract of its root against subfertile male albino rats -induced by cyproterone acetate. Evaluation of apoptosis profile was done using TUNEL assay, Western blot study, and DNA fragmentation study of testicular tissues; it revealed an increase in male reproductive ability by the increase of oxidative defense and maintained homeostasis in the process of testicular apoptosis (14).

Garcinia kola Heckel (Family Clusiaceae) also known as Guttiferae seeds “bitter kola”. It is claimed to be aphrodisiac in the African traditional medicine. The testicular histology of adult male albino rats were studied after giving 70% ethanolic extract of *G. kola* at “100, 200 and 400 mg/kg” daily for 56 days, this study confirmed the claim of its aphrodisiac activity and revealed increase in testicular weight (15).

Kaempferia parviflora Wall. ex. Baker (Family Zingiberaceae) Thai traditional medicine primarily use it for male impotence (16). *Lecaniodiscus cupanioides* Planch. Ex Bth. (Family Sapindaceae) it is present in Africa and Asia broadly (17). It was found to have positive effect on testicular function by studying the effect of its aqueous root extract on infertile male rats induced by paroxetine, it revealed restoration of the activity of acid and alkaline phosphatases, gamma-glutamyl transferase, lactate dehydrogenase and testosterone level in the testes (18). On studying the effect of hydroethanolic extract *M. oleifera* effect on the histomorphology of the testes of male rats, a rise in the number of interstitial Leydig cells was found, the author concluded that this effect may be because of the antioxidant action of the extract (19).

A study on male rats confirmed the effect of its root's aqueous extract on stimulating normal testicular function as there was significant increase in testes-body weight ratio and the concentration of testicular testosterone (20). *Phoenix dactylifera* Linn (Family Areaceae) the effect of *P. dactylifera* pollen on testes was studied revealing an increase in the testicular weight (21). *Punica granatum* (Pomegranate) The effect of *P. granatum* fruit rind extract on mouse testis was studied, it revealed a radio protective role (22). The beneficial effect of pomegranate on fertility is attributed to its antioxidant activity (9).

Moringa has the capability to inhibit damage of the testis. As testicular toxicity induced by mercury on male rat could be prevented by administration of 2 mL/kg-1 body weight of moringa oil orally (23). It also have positive result on testicular weight, proved by using *Moringa* leaf extract at “500 mg/kg-1 orally for 60 days” (24). *Lycium barbarum* is a Chinese plant known as “Red Diamonds”. It has earned reputation all over Asia. A study was done on the effect of *L. barbarum* polysaccharides on artificially damaged rat testis causing DNA damage. *Mucuna pruriens* and *Withania somnifera* both showed to have positive effect on increasing testicular weight (8, 25).

Thymoquinone the main active component of *Nigella Sativa* has antioxidant effect. This effect was studied against the toxic effect of morphine on male mice. The study showed that morphine had negative effect on testicular size. It appears that this is due to production of free radicals and ROS these have adverse lethal effect on the testis sensitive cells (26). Thymoquinone as antioxidant showed protective effect against the damage of free radicals, it also have increasing effect on LH and FSH which have constructive effect on testis structure consequently its weight (27). Olive leaves extract (OLE) showed to have protective effect on testicular tissue of diabetic male rats. Diabetes have deleterious effect on male reproductive organs, OLE restored the weights of reproductive organs towards control level by its antioxidant activity, this was approved by the histopathology of testicular tissues of treated animals (28). *L. suffruticosum* leaf extract affect the testis as it increase the testicular weight, it also maintain normal pH in testicular microenvironment, it also increase the testicular oxidative biomarkers, SOD and CAT so lessen sperm agglutination (29).

3. EFFECT OF MEDICINAL HERBS ON EPIDIDYMIS

Phoenix dactylifera Linn (Family Areaceae) increased the weight of the epididymis (2). *Salvia haematodes* roots showed dose-dependent improvement in epididymal sperm counts in male rats (12). *Phoenix dactylifera* showed increase in the weight of adult male rats epididymis (21). *Nigella sativa* (Ranunculaceae) the use of plant seeds aqueous extract on male albino rats with “300 mg/kg/b.wt. dose for 60 days” revealed marked rise in reproductive organs' weight and cauda epididymis' sperm count (30). *Lycium barbarum* caused increase in weight of epididymis of male rats (8).

Mondia whitei family Periplocaceae its aqueous extract at “400 mg/kg BW/day dose for 8 days” showed to increase

sperm density in cauda epididymis in rats (8). Saffron showed significant improve in the epididymal sperm parameters that are exposed to cadmium (31). *I. suffruticosum* leaf extract caused marked increase in cauda epididymal sperm count in sub-fertile male rats. Sub-fertility was induced by carbendazim, the increase in cauda epididymal sperm counts is due to increased activity of acid and alkaline phosphatases and LDH of cauda epididymis, increased spermatogenesis by avoiding the sloughing off germ cells and by stimulating testosterone secretion. It also caused slight sperm agglutination due to the *I. suffruticosum* healing property on the epididymal epithelium, and regulation of epididymal cell protein secretion (29).

4. EFFECT OF MEDICINAL HERBS ON LIBIDO

A correlation between testosterone level and libido was assumed, though some plants showed to increase libido without change in the testosterone level so further studies are suggested to explore their mechanism of action (1). *Chlorophytum borivilianum* L. its dried roots' aqueous extract showed aphrodisiac activity in male rats. It presented significant aphrodisiac activity and enhanced libido, sexual vigour and sexual arousal at 125 mg/kg. Although, all parameters of sexual behavior increased at the higher dose (250 mg/kg), there was saturation after 14 days (2). *Cydonia oblonga* Miller (quince) (Family Rosaceae) present in South Africa, Central Europe and Middle East (32). The effect its fruits' hydroalcoholic extract on Wistar rats was studied to confirm its aphrodisiac activity. It was administered at doses of "500 and 800 mg/ kg body weight per day" as a single dose for 28 days, it revealed marked increase in the mounting frequency, mating performance and attraction to females compared to control rats (33).

Dracaena arborea Wild (Family Dracaenaceae) is a Cameroonian plant known to have aphrodisiac activity in traditional medicine (34). A study lasted for 4 weeks was done on the effect of the aqueous and ethanolic (100 and 500 mg/kg respectively) extracts of dried root barks of *D. arborea* on sexual functions of type 1 diabetic rats, diabetes was induced by streptozotocin, its aphrodisiac activity was confirmed (35).

Garcinia kola Heckel a study on the effect of its 70% ethanolic extract of *G. kola* in adult male Wistar rats revealed marked increase in libido confirming that *G. kola* seed extract has potent aphrodisiac activity (15). *Montanoa grandiflora* DC and *Montanoa frutescens* Mairet ex DC (Family Asteraceae) Comparative study was done by giving the aqueous crude extracts of *Montanoa* to the fictive ejaculation model in spinal male rats showed enhanced aphrodisiac activity comparable to *M. tomentosa* (36). *Mucuna pruriens* showed to cause marked improvement in sexual behaviour, libido and potency of when used on diabetic male rats (37). Long Jack its dry extract administration at "200 to 400 mg/d for one to six months" can enhance libido (38). *Anacyclus pyrethrum* (Compositae) its aqueous root extract of *A. pyrethrum* was administered to male albino rats at "50 and 100 mg/kg/b.wt.", it showed aphrodisiac potential (39).

Withania somnifera (Solanaceae) its root's methanolic extract was given to male rats "3000 mg/ kg/day" for 7 days, it showed improvement in significantly impaired li-

bido (39). *Butea frondosa* the aqueous extract of *B. frondosa* bark was given orally at "400 mg/kg BW/day for 28 days", it caused marked improvement in mounting frequency, intromission frequency and ejaculatory frequency besides marked reduction of mounting latency, intromission latency, ejaculatory latency and post ejaculatory interval in a dose dependently (21).

Eurycoma longifolia belongs to family Simaroubaceae. On sexually experienced male rats, different fractions of *E. longifolia* were tested, it showed activating orientation effects towards receptive females (25, 39). *Ferula hermonis* belongs to family Apiaceae. The use of its methanol extract showed remarkable stimulation of sexual functions and libido in male rats, on the other hand its water extract showed a relatively low effect (39). *Microdesmis keayana* belongs to family Pandaceae. The effect of its aqueous extract and alkaloids was observed on male rats sexual function, better sex stimulating action was noted (40). *Turnera diffusa* belongs to family Turneraceae, Its aqueous extract was used on sexually exhausted rats revealing effective recovery of sexual desire/motivation, the exact mechanism of action is still unknown, but may be due to flavonoid content which has effect on central nervous systems (39).

5. EFFECT OF MEDICINAL HERBS ON ERECTION/EJACULATION FUNCTION

Erectile dysfunction is defined as a "consistent or recurrent incapability of a man to achieve and/or sustain penile erection sufficient for natural satisfactory intercourse"; it is considered the major sexual stimulation disorder in men (41). In human, HCG, FSH and GnRH are medications used for hormonal imbalance in cases with ED (39). They act by relaxing corpus cavernosum as Phosphodiesterase 5 is an enzyme exist in the smooth muscle of the corpus cavernosum in high concentrations, and it breaks down cGMP (1). Although many synthetic PDE-5 inhibitors are available. However, the existing drugs have restricted efficacy, side effects and contraindications in some conditions. Sildenafil Citrate (Viagra) for example has reported side effects such as "headache, flushing, dyspepsia and nasal congestion". That's why searching for natural aphrodisiacs is required with supposed no or less side effects (39).

From the medicinal herbs that showed beneficial effect on erection/ejaculation function: *Anacyclus pyrethrum* DC (Family Asteraceae) (Spanish chamomile) is also known as Akarkara. It is used as tonic and rejuvenator in the ayurvedic system of Indian medicine (42). Petroleum ether extract of roots of *A. pyrethrum* caused marked increase in the penile erection index (43). It could be acting through increasing testosterone level, changing neurotransmitters level and NO pathway involvement, that need more investigation.

Arctium lappa L. (Family Asteraceae) also known as burdock, it is used in Chinese societies as healthy and nutritive food (44). The aqueous extract of *A. lappa* L. roots was used in a study as oral dose of "600 and 1,200 mg/kg" in normal male rats. They observed that the MF, IF and EF ($p < .05$) and the frequencies of every component of penile reflexes were markedly increased. The ML IL and PEI were markedly reduced and EL was prolonged. The action of the

extract was concluded to be due to the existence of alkaloids, lignans, saponins, and flavonoids, acting through a multitude of central and peripheral mechanisms (JianFeng et al., 2012) (45). *Butea frondosa* Koenig ex Roxb. (Family Papilionaceae), bark methanol extract of *B. frondosa* was used on male rats caused corpus cavernosum smooth muscle relaxation up to $21.77 \pm 2.57\%$ and increased the smooth muscle to collagen level ratio in their penile tissue (46).

The aqueous extract of *C. benthamiana* was investigated for its vasorelaxing properties using isolated rat aortic rings pre-contracted by phenylephrine. This study showed that *C. benthamiana* roots have large amount of phenolic compounds as resveratrol, gallic acid and tannins in addition to marked vasorelaxing properties. *Cinnamomum cassia* (Nees & T. Nees) J. Presl (Family Lauraceae) it is commonly known as cassia. Methanol extract of *C. cassia* bark was used in a study on young male rats; it resulted in relaxation of isolated rat corpus cavernosum smooth muscle up to 43% that was pre-contracted by phenylephrine and marked increase ($p < 0.05$) in sexual function (46). *Corchorus depressus* Linn. (Family Tiliaceae) it is found in drier parts of North India. The chloroform fraction of methanolic extract was used at dose "25 mg/ml in vitro and 400 mg/kg in vivo" on normal male rats. It resulted in marked increase in erections, quick flips, long flips and total reflex (47).

Crocus sativus L. (Family Iridaceae) Saffron is the dried stigma of *Crocus sativus*. It is cultivated in some countries such as Greece, India and in Iran as well (48). Saffron contains "crocin, picrocrocin and safranal" as its main components. There is still a debate about the effectiveness of saffron in the treatment of erectile dysfunction as there was different results in different studies. Conversely, an open-label, fixed-dose randomized, and crossover study showed that no favorable effect of saffron use in men with ED (49). So, further investigations and testing of Saffron is recommended. *Garcinia kola* Heckel the use of its 70% ethanolic extract in adult male Wistar rats revealed marked enhancement of erection and ejaculation (15).

Monsonia angustifolia E. Mey. ex. A. Rich. (Family Geraniaceae) in a study the crude aqueous extracts of *M. angustifolia* was administered at different doses "3, 30 and 300 mg/kg body weight" during a 7-day experimental study on male rats. It showed that the extract at changed dose markedly increased computed indices as "erection, quick flips, long flips and total penile reflexes". The best effect was at a dose of "300 mg/kg bw" of the aqueous extract (50). *Montanoa grandiflora* DC and *Montanoa frutescens* Mairet ex DC administration of aqueous crude extracts to male rats produced marked enhancement in the ejaculatory ability (36). Oral administration of *Myristica fragrans* Houtt. (Family Myristicaceae) extract resulted in marked increase in mounting frequency with penile anaesthetization along with erections, quick flips, long flips and the cumulative of penile reflexes with penile stimulation. It was concluded that the aphrodisiac activity of nutmeg may be due to its nervous stimulating property (2).

Withania somnifera its root's methanolic extract was used on male rats resulted in significant improvement in penile erectile dysfunction (51). *Curculigo orchoides* known as "kali musli" as well, a member of family "Ama-

rylladaceae". It is well known in Ayurveda part of Indian traditional medicinal system and in Chinese medicine for its aphrodisiac action. The use of ethanolic extract of rhizome "100 mg/kg BW/day" in male rats resulted in significant enhancement in penile erection index (8). *Montanoa tomentosa* A study performed on spinal male rats revealed that *M. tomentosa* enhanced ejaculatory motor pattern besides sexual effectiveness (52).

Epimedium Herbs Icaria (ICA) has been isolated from the aerial parts of Epimedium herbs, A study revealed that oral administration of ICA in castrated male rats had the ability to increase intracavernosal pressure (ICP), percentage of corpus cavernosum smooth muscle, mRNA, and protein expression of neuronal nitric oxide synthase (nNOS) and iNOS (53). Yohimbine has been combined with other treatments as well. The oral use of yohimbine "15 mg daily" combined to trazodone "50 mg daily" revealed safety and effectiveness and can be used as a first-line management of psychogenic impotence (54).

6. EFFECT OF MEDICINAL HERBS ON TESTOSTERONE LEVEL AND STEROIDOGENESIS

The need for the presence of natural substances, as alternatives for hormone deficiency treatment has increased recently. Many herbal medicines had shown their capability to increase testosterone levels and enhance fertility (9). From these plants: *Anacyclus pyrethrum* DC a study showed that administration of alkylamide-rich ethanol solution extract of its roots extract, resulted in marked increase in serum testosterone, luteinising hormone and follicle stimulating hormone concentrations in male rats (55). *Arctium lappa* L. oral administration of *A. lappa* L. roots extract to normal male rats revealed marked rise in serum testosterone levels (45).

Corchorus depressus Linn. administration of chloroform fraction of methanolic extract to normal male rats revealed marked rise in serum testosterone levels (47). *Cyperus esculentus* L. (Family Cyperaceae), a study used *C. esculentus* in two groups of sexually active male rats one was highly active and the other was moderately active. The dose was "1 and 2 g kg⁻¹ day⁻¹" of *C. esculentus* to the first group and "2 g kg⁻¹ day⁻¹" to the second group for 30 days. They observed that there was marked increase in serum testosterone levels in both groups (56).

Eurycoma longifolia Jack it is found in South-East Asia (57). It is known locally as "Tongkat Ali" in Malaysia and Indonesia. It is sometimes named "Malaysian ginseng." A study stated that *E. longifolia* could be used as a supplement for treating fertility conditions caused by testosterone deficiency or excess of oestrogen, as they observed that *E. longifolia* elevates testicular functioning and inhibits the effects of an excessive oestrogenic state (58).

Screening for *F. agrestis* phytoconstituents revealed the existence of alkaloids and saponins whereas anthraquinones and flavonoids are weakly present. *Lecaniodiscus cupanioides* Planch. Ex Bth. it was administered to male rats with sexual dysfunction induced by paroxetine. *L. cupanioides* reversed the effect of paroxetine on testosterone, follicle stimulating hormone and luteinising hormone

concentrations in a dose dependent manner (59).

Monsonia angustifolia E. Mey. ex. A. Rich. the crude aqueous extracts of *M. angustifolia* was administered to male rats, it revealed that the extract different dose markedly ($p < .05$) increased serum hormone concentrations (50). *Moringa oleifera* Lam. hydroethanolic extract *M. oleifera* caused increased serum testosterone level in an experiment on male rats (19). *Musa paradisiaca* L. in a study the aqueous extract of its root was orally administered to male rats, it showed marked increase in the concentration of testicular testosterone. On the other hand, they noticed reduction in the concentrations of serum luteinizing and follicle stimulating hormones. The authors concluded that this may be due to stimulation of the normal testicular functioning of the testes and revealed androgenic and anabolic properties as well (20).

Pedalium murex Linn. (Family Pedaliaceae) It presents commonly in South India, Srilanka, Ceylon, Mexico and tropical Africa (60). *P. murex* ethanolic fruit extract was administered to male rats, resulted in marked increase in serum testosterone level ($p < .05$). There was significant effect past withdrawal of the treatment as well (61). Phytochemical investigation of *R. chalepensis* revealed the existence of several alkaloids, coumarins, flavonoids, phenols, amino acids, furocoumarins, sterols and/or triterpenes and saponins in the leaves and young stems of the plant (62).

Cinnamomum zeylanicum, its bark is commonly known as "cinnamon". The major constituent of cinnamon is "cinnamaldehyde". It enhances testosterone secretion from Leydig cells (63). *Mucuna pruriens*, the use of mucuna caused increase in serum testosterone level and it is also androgenic in hyperglycemic male rats (37). Another study revealed that it caused significant improvement in testosterone levels but showed no change in the FSH and LH levels (64). A study concluded that the increase in T might be by GnRH, LH stimulation and prolactin inhibition (65).

Cynanchum wilfordii, its oral administration at a dose of "200 mg/kg body weight/day" raised levels of LH, FSH, and T (66). *Tribulus terrestris* has the ability to enhance testosterone levels (67). A study confirmed its enhancing effect on testosterone levels but revealed that LH levels were indifferent than the control (64). *Nigella sativa* its alcoholic extract "0.5 and 1.5 g/kg" was given to male rats for a period of 53 days, it revealed a marked rise in testosterone and FSH (68). Another study revealed that *N. sativa* extract could also result in increased testosterone biosynthesis through increasing the activity of hypothalamic-pituitary-testicular axis and LH secretion as well (69). *Zingiber officinale* (Zingiberaceae) its methanolic "100 or 200 mg/kg b.wt." and watery extract "150 and 300 mg/kg" each was given orally for 65 days to male diabetic rats (induced by alloxan), both caused increase in serum testosterone level (70).

Bulbus natalensis, its aqueous extract was given to male rats; it caused marked increase in LH and testosterone levels (8) In addition, polyphenols content of OLE has antioxidant effect that can oppose free radicals. *I. suffruticosum* flavonoids and steroidal lactones of *I. suffruticosum* showed to have role in increasing production of testosterone. *Punica granatum* fruit juice, its use resulted in marked elevation of testosterone, LH and FSH, that were short by CCl₄ in-

jection (29).

7. EFFECT OF MEDICINAL HERBS ON SPERM AND PROSTATE PARAMETERS

Benign prostate diseases BPH is very common, approximately 1 of each 4 men will have BPH in their life. The use of phytotherapies in experimental models has shown promising effects in the treatment of prostate disease (66). The administration of saw palmetto for supporting prostate is debatable, while the use of "Pygeum africanum, Hook.f., *Urtica dioica* L., Rosaceae, Urticaceae, and nutraceutical agents like pollen extract, beta-sitosterols" revealed promising results (65). *Cynanchum wilfordii*: *Cynanchum wilfordii* was orally given to BPH rat model, a decrease in prostate weight was noticed, there was also a decrease in 5 α -reductase level, PSA in serum and prostate as well (66).

From the common causes of infertility in men, oligospermia is the first. According to WHO guidelines, oligospermia is defined as decreased sperm count less than 12 million/ml (39). Reactive oxygen species (ROS) production is essential for normal sexual function in men, whereas the increase of ROS may result in injury of tissue and cell death and may lead to decrease in quality of sperms and male infertility. The medicinal herbs positively affect sperm parameters by many mechanisms include "antioxidant, anti-inflammatory, anti-oedematous and venotonic activity". In addition, they may contain precursors for generation of sperm and increase the level of serum testosterone (9).

Butea frondosa Koenig ex Roxb. A study revealed that giving bark methanol extract of *B. frondosa* resulted in increase in the production of sperms and decrease in the abnormal spermatozoa in male rats either young or old (46). *Chlorophytum borivilianum* L. In studies on animals, *C. borivilianum* was confirmed to have positive effect on the parameters of sperm and the quality of semen as well (71). In another study, the hydromethanolic extract of *C. borivilianum* root was given to subfertile Wistar male albino rats; subfertility was induced by cyproterone acetate. They found that giving *C. borivilianum* root extract prevented the negative deviations - that resulted from cyproterone acetate - via increasing oxidative defense and maintaining homeostasis in testicular apoptosis process (14). The free radical scavenging activity of the root extract of *C. borivilianum* may be related to the large amounts of phenolic compounds in the plant (72).

Garcinia kola Heckel Giving 70% ethanolic extract to adult male Wistar rats presented significant increase in sperm count in treated rats (15). *L. meyenii* also was proved to be effective on men as there was rise in the quality of semen parameters including increase in total sperm number, sperm concentration, motile sperm count, progressive motile sperm count, semen volume and normal sperm shape (73).

Another study showed that *S. khuzestanica* has marked antioxidative potential which explained the improvement in sperm quality (74). *Cinnamomum zeylanicum* In animal models, cinnamon showed to improve sperm parameters not including decreasing sperm abnormality (75). It was also reported that it significantly antagonized the adverse effect of naloxane, carbonium tetrachloride and lead ac-

etate on the parameters of sperm (63). *Crocus sativus* the aqueous extract of *C. sativus* was reported to improve sperm parameters in rats (31). Another study was done on diabetic male rats, ethanolic extract of seeds was given at dose 200 mg/kg BW/day resulted in marked improvement spermatogenic potential (37).

Nigella sativa Administration of its seeds aqueous extract to male albino rats revealed marked rise in sperm motility and number in cauda epididymides and testicular ducts (30). In contrary, another study it revealed that no remarkable difference in sperm motility and viability, however showed marked beneficial effect on some other sperm parameters (76). In addition, the effective material of *N. sativa* thymoquinone, an antioxidant proved to have protective effects against toxic effects of morphine treated male mice, which is mainly due to oxidative stress, improving spermatogenesis, sperm motility and viability (26).

Punica granatum the fruit juice was given to male rats, it revealed a beneficial effect on sperm parameters. When the juice was consumed daily in rats, it presented less sperm cell defects resulted from testicular torsion followed by distortion and carbon tetrachloride intoxication (77). Its ethanolic extract protected against the adverse effect of lead acetate on spermatogenesis (78). On comparing Hydromethanolic extract of *P. granatum* fruit with olive oil, *N. sativa* oil and control group, the extract of *P. granatum* fruit showed better effects in sperm parameters (79). The beneficial effects of *P. granatum* was concluded to be because of the antioxidant activity of the phenols present in its components (80).

Withania somnifera Its roots were used for “3 months”, it resulted in positive effects on semen parameters (81). This improvement in semen quality was concluded to be due to the antioxidant activity of *W. somnifera* root (82). Yet, *W. somnifera* stem presented spermicidal and antifertility activity (13). From the many active components in the root, the most significant are alkaloids and flavonoids. As flavonoids have antioxidant activity and some alkaloids have been proved to reactivate the main free radical scavenging enzymes (83).

Oral administration of either methanolic or watery extract of *Zingiber officinale* roots to male diabetic rats-diabetes was induced by alloxan- for 65 days, revealed favorable effects on sperm profile of diabetic rats (70). Furthermore, *Zingiber officinale* protected against the harmful effect of many toxic substances as “sodium arsenite, alloxan, cyclophosphamide, gentamicin, deltamethrin, aluminium chloride and busulphan” on sperm characters of the epididymis. The phenols present in it including “zingerone, gingerdiol, zingiberene, gingerols and shogaols” were proven to boss strong antioxidant effect (84).

Black seeds have positive effect on sperm profile. *Anacyclus pyrethrum* Its aqueous root extract was administered to male albino rats, it presented remarkable rise in the sperm count (43).

Passiflora incarnate Benzoflavone (BZF) moiety isolated from *P. incarnata* (20 mg/kg BW), was proved to be effective against Δ 9-tetrahydrocannabinol induced adverse effect on sperm count (8). Olive leaves extract (OLE) administration to diabetic male rats – diabetes induced by STZ- shown to

have protective effect on sperm parameters against the adverse effects of diabetes(decreased sperm count, motility and viability and increased sperm abnormalities). The author concluded that this protective effect might be due to OLE competence to antagonize the oxidative stress and LPO (28). *Londium suffruticosum* I. *suffruticosum* leaf extract was administered to sub-fertile male rats, subfertility was induced by carbendazim, it resulted in increased spermatogenesis, increased sperm counts, lessened sperm agglutination by preserving normal pH in testicular microenvironment, increasing the testicular oxidative biomarkers, SOD, and CAT. It was found that the main active components of the extract are alkaloids, steroidal lactones and flavonoids (29).

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REFERENCES

1. Abbas, M. Is the use of plants in Jordanian folk medicine for the treatment of male sexual dysfunction scientifically based? Review of in vitro and in vivo human and animal studies. *Andrologia*, 2016; 49(3): e12619.
2. Malviya, N., Malviya, S., Jain, S. and Vyas, S. A review of the potential of medicinal plants in the management and treatment of male sexual dysfunction. *Andrologia*. 2016; 48(8): 880-893.
3. Nejatbakhsh, F, Shirbeigi, L, Rahimi, R, Abolhassani, H. Review of local herbal compounds found in the Iranian traditional medicine known to optimise male fertility. *Andrologia*. 2016; 48(8): 850-859.
4. Weiss DA, Harris CR, Smith JF. The use of complementary and alternative fertility treatments. *Current Opinion in Obstetrics and Gynecology*. 2011; 23: 195–199.
5. Smith JF, Eisenberg ML, Millstein SG, Nachtigall RD, Shindel AW, Wing H, Katz PP. Infertility Outcomes Program ProjecGroup. The use of complementary and alternative fertility treatment in couples seeking fertility care: Data from a prospective cohort in the United States. *Fertility and Sterility*. 2010; 93: 2169-2174.
6. Bardaweel SK, Shehadeh M, Suaifan GA, Kilani MV. Complementary and alternative medicine utilization by a sample of infertile couples in Jordan for infertility treatment: Clinics-based survey. *BMC Complementary and Alternative Medicine*. 2013; 13: 35.
7. Ghazeeri GS, Awwad JT, Alameddine M, Younes ZM, Naja F. Prevalence and determinants of complementary and alternative medicine use among infertile patients in Lebanon: A cross sectional study. *BMC Complementary and Alternative Medicine*. 2012; 12: 129.
8. Rajender S, Akhand Pratap S. Potent natural aphrodisiacs for the management of erectile dysfunction and male sexual debilities. *Frontiers in Bioscience*. 2012; S4(1): 167-180.
9. Tahvilzadeh M, Hajimahmoodi M, Toliyat T, Karimi M, Rahimi R. An evidence-based approach to medicinal plants for the treatment of sperm abnormalities in traditional Persian medicine. *Andrologia*. 2015; 48(8): 860-879.
10. Panda SK, Das D, Tripathy NK. Botanical studies of plants sold in market as ‘Safed Musli’. *International Journal of Pharma Research and Development*. 2011; 3: 1-18.
11. Sharma S, Kumar A. Herbal medicinal plants of Rajasthan: Musli.

- International Journal of Life Science and Pharmaceutical Research. 2012; 2: 62-68.
12. Bansode FW, Arya KR, Singh RK, Narender T. Dose-dependent effects of *Asparagus ascendens* root (AARR) extract on the anabolic, reproductive, and sexual behavioral activity in rats. *Pharmaceutical Biology*. 2015; 53: 192-200.
 13. Singh D, Pokhriyal B, Joshi YM, Kadam V. Phytopharmacological aspects of *Chlorophytum borivilianum* (safed musli): A review. *International Journal of Research and Pharmaceutical Chemistry*. 2012; 2: 853- 859.
 14. Ray S, Chatterjee K, De D, Ghosh D. Bioefficacy of hydromethanolic extract of tuber of *Chlorophytum borivilianum* (Safed Musli) for the management of male infertility in cyproterone acetate-treated albino rats. *Andrologia*. 2014; 46: 659-671.
 15. Sewani-Rusike CR, Ralebona N, Nkeh-Chungag BN. Dose- and time-dependent effects of *Garcinia kola* seed extract on sexual behavior and reproductive parameters in male Wistar rats. *Andrologia*. 2015; 48: 300-307.
 16. Weerateerangkul P, Surinkaew S, Chattipakorn SC, Chattipakorn N. Effects of *Kaempferia parviflora* Wall. Ex. Baker on electrophysiology of the swine hearts. *Indian Journal of Medical Research*. 2013; 137: 156-163.
 17. Mikhail ON, Taoheed AA, Musbau AA. Phytochemical Analysis and Antimalarial Activity Aqueous Extract of *Lecaniodiscus cupanioides* Root. *Journal of Tropical Medicine*. 2013; 1-4.
 18. Nurudeen QO. Aqueous root extract of *Lecaniodiscus cupanioides* restores the alterations in testicular parameters of sexually impaired male rats. *Asian Pacific Journal of Reproduction*. 2012; 2: 120-124.
 19. Prabsattroo T, Wattanathorn J, Iamsaard S, Somsapt P, Sritragool O, Thukhummee W, Muchimapura S. *Moringa oleifera* extract enhances sexual performance in stressed rats. *Journal of Zhejiang University Science*. 2015; B, 16: 179-190.
 20. Yakubu MT, Oyeyipo TO, Quadri AL, Akanji MA. Effects of aqueous extract of *Musa paradisiaca* root on testicular function parameters of male rats. *Journal of Basic and Clinical Physiology and Pharmacology*. 2013; 24: 151-157.
 21. Bahmanpour S, Talaei T, Vojdani Z, et al. Effect of *Phoenix dactylifera* pollen on sperm parameters and reproductive system of adult male rats. *Iran J Basic Med Sci*. 2015; 31: 208-212.
 22. Mathur A, Sharma J. Radioprotective role of *Punica granatum* fruit rind extract: A biochemical study on mouse testis. *Journal of Radiation Research*. 2013; 11: 99-109.
 23. Abarikwu SO, Benjamin S, Ebah SG, Obilor G, Agbam G. Oral administration of *Moringa oleifera* oil but not coconut oil prevents mercury-induced testicular toxicity in rats. *Andrologia*. 2017; 49.
 24. Sadek KM. Chemotherapeutic efficacy of an ethanolic *Moringa oleifera* leaf extract against chromium-induced testicular toxicity in rats. *Andrologia*. 2014; 46: 1047-1054.
 25. Ho C, Tan H. Rise of Herbal and Traditional Medicine in Erectile Dysfunction Management. *Current Urology Reports*. 2011; 12(6): 470-478.
 26. Jalili C, Ahmadi S, Roshankhah S, Salahshoor M. Effect of Genistein on reproductive parameter and serum nitric oxide levels in morphine treated mice. *Int J Reprod Biomed (Yazd)*. 2016; 14: 95-102.
 27. Mabrouk A, Ben Cheikh H. Thymoquinone supplementation ameliorates lead induced testis function impairment in adult rats. *Toxicol Ind Health*. 2016; 32: 1114-1121.
 28. Soliman G, Saeedan A, Abdel-Rahman R, Ogaly H, Abd-Elsalam R, Abdel-Kader M. Olive leaves extract attenuates type II diabetes mellitus-induced testicular damage in rats: Molecular and biochemical study. *Saudi Pharmaceutical Journal*. 2019; 27(3): 326-340.
 29. Chenniappan K, Murugan K. Therapeutic and fertility restoration effects of *Ionidium suffruticosum* sub-fertile male albino Wistar rats: effects on testis and caudal spermatozoa. *Pharmaceutical Biology*. 2017; 55(1): 946-957.
 30. Mohammad MA, Mohamad MM, Dradka H. Effects of black seeds (*Nigella sativa*) on spermatogenesis & fertility of male albino rats. *Res J Med Sci*. 2009; 4: 386-390.
 31. Asadi MH, Zafari F, Sarveazad A, Abbasi M, Safa M, Koruji M. et al. Saffron improves epididymal sperm parameters in rats exposed to cadmium. *Nephrourol Mon*. 2014; 6: e12125.
 32. Minaiyam M, Ghannadi A, Etamad M, Mahzouni P. A study of the effects of *Cydonia oblonga* Miller (Quince) on TNBS-induced ulcerative colitis in rats. *Research in Pharmaceutical Sciences*. 2012; 7: 103-110.
 33. Aslam M, Sial AA. Effect of hydroalcoholic extract of *Cydonia oblonga* Miller (Quince) on sexual behaviour of Wistar rats. *Advances in Pharmacological Sciences*. 2014: 1-6.
 34. Watcho P, Modeste WN, Albert K, Carro-Juarez M. *Dracaena arborea* extracts delay the pro-ejaculatory effect of dopamine and oxytocin in spinal male rats. *International Journal of Impotence Research*. 2014; 26: 213-217.
 35. Wankeu-Nya M, Watcho P, Nguuelefack T, Carro-Juarez M, Tapondjou L, Kamanyi A. Effects of *Dracaena arborea* (Dracaenaceae) on sexual dysfunction in 4 weeks hyperglycemic male rats. *Asian Pacific Journal of Tropical Medicine*. 2014; 7: 609-619.
 36. Carro-Juárez M, Franco MÁ, Rodríguez-Peña Mde L. Increase of the ejaculatory potency by the systemic administration of aqueous crude extracts of *ihuapatli* (*Montanoa* genus) plants in spinal male rats. *Journal of Evidence-Based Complementary & Alternative Medicine*. 2014; 19: 43-50.
 37. Suresh S, Prithiviraj E, Lakshmi NV, Ganesh MK, Ganesh L, Prakash S. Effect of *Mucuna pruriens* (Linn.) on mitochondrial dysfunction and DNA damage in epididymal sperm of streptozotocin induced diabetic rat. *J Ethnopharmacol*. 2013; 145: 32-41.
 38. Thu HE, Mohamed IN, Hussain Z, Jayusman PA, Shuid AN. *Eurycoma longifolia* as a potential adoptogen of male sexual health: a systematic review on clinical studies. *Chin J Nat Med*. 2017; 15: 71-80.
 39. Sharma M, Arya D, Bhagour K, Gupta R. Natural aphrodisiac and fertility enhancement measures in males: A review. *Current Medicine Research and Practice*. 2017; 7(2): 51-58.
 40. Alhassan A, Mabrouk M, Idris R, Salawu E, Oyerinde A, Bauchi Z. Aqueous extract of *Juglans nigra* prevents lead induced testicular toxicity in rats. *Maced J Med Sci*. 2010; 3: 289-294.
 41. Lewis RW, Fugl-Meyer KS, Corona G, Hayes RD, Laumann EO, Moreira ED, Seagraves T. Definitions/epidemiology/risk factors for sexual dysfunction. *The Journal of Sexual Medicine*. 2010; 7: 1598-1607.
 42. Rani S, Kaushik V, Saini V, Nain P, Rani D. Biological studies of *Anacyclus pyrethrum*. *IAJPR*. 2013; 3: 4590-4596.
 43. Sharma V, Thakur M, Chauhan NS, Dixit VK. Effects of petroleum ether extract of *Anacyclus pyrethrum* DC. on sexual behavior in male rats. *Zhong Xi Yi Jie He Xue Bao*. 2010; 8: 767-773.
 44. Chan YS, Cheng LN, Wu JH, Chan E, Kwan YW, Lee SM, Chan SW. A review of the pharmacological effects of *Arctium lappa* (burdock). *Inflammopharmacology*. 2011; 19: 245-254.
 45. JianFeng C, PengYing Z, ChengWei X, TaoTao H, YunGui B, KaoShan C. Effect of aqueous extract of *Arctium lappa* L. (burdock) roots on the sexual behavior of male rats. *BMC Complementary and Alternative Medicine*. 2012; 12: 8.
 46. Goswami SK, Inamdar MN, Jamwal R, Dethle S. Effect of *Cinnamomum cassia* methanol extract and sildenafil on arginase and sexual function of young male Wistar rats. *The Journal of Sexual Medicine*. 2014; 11: 1475-1483.
 47. Kataria S, Rao SK, Bhandari A, Kaur D. Pharmacognostical standardization of *Corchorus depressus* (L.) Stocks (Tiliaceae) - A promising ethnomedicinal plant. *Indian Journal of Traditional Knowledge*. 2013; 12: 489-497.
 48. Malathi M, Ramya Devi D, Vedha Hari BN. *Crocus sativus* Linn - A potential source for diverse therapeutic applications. *International Journal of Pharma Research*. 2014; 26: 299-305.
 49. Safarinejad MR, Shafiei N, Safarinejad S. An open label, randomized, fixed-dose, crossover study comparing efficacy and safety of sildenafil citrate and saffron (*Crocus sativus* Linn.) for treating erectile dysfunction in men naïve to treatment. *International Journal of Impotence Research*. 2010; 22: 240-250.
 50. Fouche G, Afolayan AJ, Wintola OA, Khorombi TE, Senabe J. Effect of the aqueous extract of the aerial parts of *Monsonia angustifolia* E.

- Mey. Ex A. Rich., on the sexual behaviour of male Wistar rats. *BMC Complementary and Alternative Medicine*. 2015; 15: 343.
51. Ahmad MK, Mahdi AA, Shukla KK, et al. *Withania somnifera* improves semen quality by regulating reproductive hormone levels & oxidative stress in seminal plasma of infertile males. *Fertil Steril*. 2010; 94: 989-996.
 52. Carro-Juarez M, Lobatón I, Benítez O, Espíritu A. Pro-ejaculatory effect of the aqueous crude extract of *Cihuapatli* (*Montanoa tomentosa*) in spinal male rats. *J Ethnopharmacol*. 2006; 106(1): 111-116.
 53. Liu WJ, Xin ZC, Xin H, et al. Effects of icariin on erectile function and expression of nitric oxide synthase isoforms in castrated rats. *Asian J Androl*. 2005; 7(4): 381-388.
 54. Lebret T, Herve JM, Gorny P, et al. Efficacy and safety of a novel combination of L-arginine glutamate and yohimbine hydrochloride: a new oral therapy for erectile dysfunction. *Eur Urol*. 2002; 41: 608-613.
 55. Sharma V, Boonen J, Spiegeleer BD, Dixit VK. Androgenic and spermatogenic activity of alkylamide-rich ethanol solution extract of *Anacyclus pyrethrum* DC. *Phytotherapy Research*. 2013; 27: 99-106.
 56. Allouh MZ, Daradka HM, Ghaida JH. Influence of *Cyperus esculentus* tubers (Tiger Nut) on male rat copulatory behavior. *BMC Complementary and Alternative Medicine*. 2015; 15: 331.
 57. Bhat R, Karim AA. *Tongkat Ali* (*Eurycoma longifolia* Jack): A review on its ethnobotany and pharmacological importance. *Fitoterapia*. 2010; 81: 669-679.
 58. Wahab NA, Mokhtar NM, Halim WNHA, Das S. The effect of *Eurycoma longifolia* jack on spermatogenesis in oestrogen-treated rats. *Clinics*. 2010; 65: 93-98.
 59. Ajiboye TO, Nurudeen OO, Yakubu MT. Aphrodisiac effect of aqueous root extract of *Lecaniodiscus cupanioides* in sexually impaired rats. *Journal of Basic and Clinical Physiology and Pharmacology*. 2014; 25: 241-248.
 60. Rajashekar V, Upender Rao E, Srinivas P. Biological activities and medicinal properties of *Gokhru* (*Pedaliium murex* L.). *Asian Pacific Journal of Tropical Biomedicine*. 2012; 2: 581-585.
 61. Sharma V, Thakur M, Dixit VK. A comparative study of ethanolic extracts of *Pedaliium murex* Linn. fruits and sildenafil citrate on sexual behaviors and serum testosterone level in male rats during and after treatment. *Journal of Ethnopharmacology*. 2012; 143: 201-216.
 62. Lourdes CH, Dieter M, Marco Antonio JO, José FCPC. Effects of the chronic ingestion of an infusion of *Ruta chalepensis* on the vasomotor responses of rat aortic rings. *Bole tín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas*. 2011; 10: 414-422.
 63. Elgawish RAR, Abdelrazek HMA. Effects of lead acetate on testicular function and caspase-3 expression with respect to the protective effect of cinnamon in albino rats. *Toxicology Reports*. 2014; 1: 795-801.
 64. Sahin K, Orhan C, Akdemir F, Tuzcu M, Gencoglu H, Sahin N, Turk G, Yilmaz I, Ozercan I, Juturu V. Comparative evaluation of the sexual functions and NF- κ B and Nrf2 pathways of some aphrodisiac herbal extracts in male rats. *BMC Complementary and Alternative Medicine*. 2016; 16(1).
 65. Santos H, Howell S, Teixeira F. Beyond tribulus (*Tribulus terrestris* L.): The effects of phytotherapies on testosterone, sperm and prostate parameters. *Journal of Ethnopharmacology*. 2019; 235: 392-405.
 66. Lee SWH, Chan EMC, Lai YK. The global burden of lower urinary tract symptoms suggestive of benign prostatic hyperplasia: a systematic review and metaanalysis. *Sci Rep*. 2017; 7: 7984.
 67. Ghosian Moghaddam MH, Khalili M, Maleki M, Ahmad Abadi ME. The Effect of oral feeding of *Tribulus terrestris* L. on sex hormone and gonadotropin levels in addicted male rats. *Int J Fertil Steril*. 2013; 7: 57-62.
 68. Al-Sa'aidi JA, Al-Khuzai AL, Al-Zobaydi NF. Effect of alcoholic extract of *Nigella sativa* on fertility in male rats. *Iraqi J Vet Sci*. 2009; 2(sii): 123-128.
 69. El Khasmi M, Allah AI, Farh M, Riad F, Safwate A, El Abbadi N, et al. Effect of *Nigella sativa* fixed oil on the hormonal profile of androgens and circulating in male rats. *Phytotherapie*. 2011; 9: 338-342.
 70. Shalaby MA, Mounair SM. Effect of Zingiber officinale roots & Cinnamon zeylanicum bark on fertility of male diabetic Rats. *Glob Vet*. 2010; 5: 341-347.
 71. Thakur M, Thompson D, Connellan P, Deseo MA, Morris C, Dixit VK. Improvement of penile erection, sperm count and seminal fructose levels in vivo and nitric oxide release in vitro by ayurvedic herbs. *Andrologia*. 2011; 43: 273-277.
 72. Giribabu N, Kumar KE, Rekha SS, Muniandy S, Salleh N. Chlorophytum borivilianum (Safed Musli) root extract prevents impairment in characteristics and elevation of oxidative stress in sperm of streptozotocin-induced adult male diabetic Wistar rats. *BMC Complementary and Alternative Medicine*. 2014; 14: 291.
 73. Melnikova I, Fait T, Kolarova M, Fernandez EC, Milella L. Effect of *Lepidium meyenii* Walp. on semen parameters and serum hormone levels in healthy adult men: A double-blind, randomized, placebo-controlled pilot study. *Evidence-Based Complementary and Alternative Medicine*. 2015: 324-369.
 74. Safarnavadeh T, Rastegarpanah M. Antioxidants and infertility treatment, the role of *Satureja khuzestanica*: A mini-systematic review. *International Journal of Reproductive BioMedicine*. 2011; 9: 61-70.
 75. Khaki A. Effect of *Cinnamomum zeylanicum* on spermatogenesis. *Iran Red Crescent Medical Journal*. 2015; 17: e18668.
 76. Parandin R, Yousofvand N, Ghorbani R. The enhancing effects of alcoholic extract of *Nigella sativa* seed on fertility potential, plasma gonadotropins and testosterone in male rats. *Iranian Journal of Reproductive Medicine*. 2012; 10: 355-362.
 77. Turk G, Songul C, Sönmez M, Ciftci M, Yuce A, Guvenc M, Aksakal M. Ameliorating effect of pomegranate juice consumption on carbontetrachloride-induced sperm damages, lipid peroxidation, and testicular apoptosis. *Toxicology and Industrial Health*. 2016; 32: 126-137.
 78. Leiva KP, Rubio J, Peralta F, Gonzales GF. Effect of *Punica granatum* (pomegranate) on sperm production in male rats treated with lead acetate. *Toxicology Mechanisms and Methods*. 2011; 21: 495-502.
 79. Mansour SW, Sangi S, Harsha S, Khaleel MA, Ibrahim ARN. Sensibility of male rats fertility against olive oil, *Nigella sativa* oil and pomegranate extract. *Asian Pacific Journal of Tropical Biomedicine*. 2013; 3: 563-568.
 80. Al-Olayan EM, El-Khadragy MF, Metwally DM, Abdel Moneim AE. Protective effects of pomegranate (*Punica granatum*) juice on testes against carbontetrachloride intoxication in rats. *BMC Complementary and Alternative Medicine*. 2014; 14: 164.
 81. Ambiye VR, Langade D, Dongre S, Aptikar P, Kulkarni M, Dongre A. Clinical evaluation of the spermatogenic activity of the root extract of *Ashwagandha* (*Withania somnifera*) in oligospermic males: A pilot study. *Evidence-Based Complementary and Alternative Medicine: eCAM*. 2013; 571420.
 82. Gupta A, Mahdi AA, Ahmad MK, Shukla KK, Ahmad MK, Bansal N, Sankwar SN. Efficacy of *Withania somnifera* on seminal plasma metabolites of infertile males: A proton NMR study at 800 MHz. *Journal of Ethnopharmacology*. 2013; 149: 208-214.
 83. Mahdi AA, Shukla KK, Ahmad MK, Rajender S, Shankwar SN, Singh V, Dalela D. *Whitania somnifera* improves semen quality in stress-related male fertility. *Evidence-Based Complementary and Alternative Medicine: eCAM*. 2011: 576962.
 84. Bordbar H, Esmaeilpour T, Dehghani F, Panjehshahin MR. Stereological study of the effect of ginger's alcoholic extract on the testis in busulfan-induced infertility in rats. *Iranian Journal of Reproductive Medicine*. 2013; 11: 467-472.