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Herbal Nanoparticles as Novel Agents for Fertility Regulation in Animals: A Systematic Review

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Running title: Herbal contraceptives and its role in fertility regulations

Abstract

One of the major issues world is facing today is overpopulation, which has a significant impact on social, economic and natural resources. Today, both developed and emerging nations are very concerned about the ongoing population growth. The present need is to explore medications with antifertility activity which have less side effects. Ancient Indian physicians were well aware of the use of herbs as a contraceptive agents. In both male and female animal models, the antifertility properties of several medicinal plant extracts have been investigated. Nanoparticles are minuscule structures with distinct physical and chemical characteristics that range in size from 1 to 100 nanometers. Herbal nanoparticles of silver, gold, nickel etc are used for fertility regulation. This review's objective is to present information regarding herbal nanoparticles and medicinal plants that have antifertility effects in model animals.

Keywords: Population; Antifertility; Medicinal plants; Herbal nanoparticles

1. Introduction

Continuously growing population is a major concern all over the world, It is expected that the world population will reach more than 11 billion by 2050 (Census of India, 2011). The current average population rise is approximately 81 million people per year, and the present world population is 8 billion (World population clock, 2022) [1]. The word "contraception" is frequently used to refer to both contraception and contragestion in everyday speech. A common component of family planning is the use of birth control [2]. Oral contraceptives, commonly known as antifertility medicines, are medications that regulate fertility. These medications have an impact on and are involved in female ovulation and the menstrual cycle. When an antifertility drug stops ovulation, implantation, fertilization, zygote destruction, or abortion in females, it is considered active. It inhibits testosterone, stops spermatogenesis in

men, and has an impact on organ gonadotrophin or sperm mortality [3]. Birth control is a method of purposefully preventing or lowering the risk of pregnancy or childbirth by using one or more devices or drugs. There are a number of synthetic contraceptives on the market, using them is linked to serious side effects like weight gain, hypertension, hormone imbalances, and an increased risk of cancer [4]. To avoid these side effects individuals are eager to resume the use of herbal remedies, which have few adverse effects [5]. Medicinal herbs there have been examined for potential contraceptive benefits and antifertility effects, the present need is to explore medications with antifertility activity and plant extracts have long been studied for their ability to reduce fertility in animals [6].

Effects of herbal plants and their products on fertility

These days, natural plant products are frequently used because the number of ailments (illness) has increased. Plant extracts with antifertility qualities are now frequently employed due to their biodegradability, ease of extraction, nontoxicity, affordability and intrinsic environmental friendliness [7]. Numerous plant extracts have the ability to decrease both male and female reproduction, making them useful as contraceptives [8]. Animal reproductive capabilities have been changed through the widespread use of bioactive chemicals found in plants. Many distinct bioactive compounds included in plant extracts have been employed in human health related pharmacological studies. Plant extracts contain potent natural antioxidants [9].

Many mechanisms of action have been reported for medicinal plants antifertility effects. One of these mechanisms is their influence on sex hormones, which is particularly useful for suppressing fertility [10]. The uterus, fallopian tubes, ovaries, vagina, and external genitalia make up the female reproductive system, which is essential to both population balance and women's quality of life [11].

Traditional Chinese medicinal plants like *Celosia cristata* (Jiguanhua) belongs to Amaranthaceae family, *Catharanthus roseus* (Changchunhua) belongs to Apocynaceae family and many more plants which have fertility regulation properties and have pharmaceutical uses [12].

Allium cepa is also known as onion and belongs to the Amaryllidaceae family. It contains a variety of chemical components, including myristic acid, ferulic acid, β-sitosterol and kaempferol. It is observed that ethanolic extract of *Allium cepa* plant has antifertility properties, it inhibits implantation in female Rats [13].

Biosynthesis and mode of action of silver nanoparticles

Nowadays, "green technologies" are becoming more and more popular because they are eco-friendly, effective and nontoxic. Producing basic silver nanoparticles (AgNPs) for application in a variety of human endeavors, chiefly in medicine, is one of the avenues of green synthesis [14]. Despite the fact that several papers explain how different groups of organisms, including fungus, lichens, algae, higher plants, and bacteria, synthesize silver nanoparticles, the mechanism behind this process is still entirely unknown [15].

AgNP creation can take place both inside and outside of cells, as shown by the findings of AgNP synthesis using a range of microbes. Ag+ is converted to Ag0 through extracellular synthesis, which is facilitated by proteins—enzymes found on bacterial cell walls and secreted proteins. It was demonstrated that the extracellular synthesis of AgNP is common for both Gram-negative bacteria like *Klebsiella pneumonia* and Gram-positive bacteria like *Bacillus* [16].

However, several investigations have demonstrated that the nanoparticles produced by microbes are intracellular. Gram negative bacteria are an example of this mechanism, which is linked to the membrane protein that carries the silver ions into the cell. For instance, El-Baghdady demonstrated that the creation of silver nanoparticles for *Enterobacter cloacae* is intracellular [17]. This mechanism was also shown for Gram-positive bacteria *Corynebacterium* [18].

Enzymes are the key component in AgNP production, whether it occurs extracellularly or intracellularly. The majority of scientists concur that it plays a key role in the AgNP formation of NADH-dependent nitrate reductase, which functions as an electron shuttle, removing electrons from the nitrate molecule and moving them to the metal ion to form nanoparticles, as is evident for *P. aeruginosa*, *F. oxysporum*, and other bacteria [19,20,21,]. The precise way that silver nanoparticles work on cells is known, but a lot of information has been gathered in this field, particularly from working with different plant extracts, showing that AgNPs can physically interact with the cell surfaces of different bacteria. The AgNP effect on the cell can be attributed to a number of factors, including adhesion on the bacterial cell wall and membrane surface, penetration into the cell and disruption of intracellular organelles and biomolecules, induction of oxidative stress, and modification of the signal transduction pathway [22].

AgNPs were particularly seen to adhere to and accumulate on the cell surface of Gram negative bacteria. AgNPs can enter bacterial cells by way of porins, which are water-filled

passageways found in the bacteria's outer membrane. Since silver ions are more likely to penetrate the cytoplasm of Gram positive bacteria due to their thicker cell walls, the impact of AgNPs is more noticeable in Gram negative bacteria than in Gram positive bacteria [23]. Additionally, the presence of lipopolysaccharides may help maintain the structural integrity of the cell wall of Gram negative bacteria, increasing their sensitivity to silver nanoparticles because the negative charge of the polysaccharides facilitates the adhesion of AgNPs [24]. It has been proposed that cell membrane disintegration is the main mechanism of silver nanoparticles [25]. Furthermore, when silver nanoparticles dissolve, antimicrobial silver ions are released. These ions can interact with cell wall proteins that contain thiols and affect how those proteins function. When silver nanoparticles interact with the outer membrane, they can attach to proteins and form complexes with electronic donors that contain atoms of sulfur, nitrogen, phosphorus, or oxygen. Consequently, by their interaction with disulfide bonds and active site blockage, silver nanoparticles cause membrane-bound enzymes and proteins to become inactive [26].

According to reports, AgNPs may increase the trans/cis ratio of unsaturated membrane fatty acids, changing the lipid bilayer's composition and membrane fluidity. It may result in structural alterations to the membrane that impair its ability to function, increasing permeability and compromising its integrity [27]. By interfering with the bacterial actin cytoskeletal network, it is showed that the silver nanoparticles might induce bacterial cell death. The outcome demonstrates how the nanoparticles impacted the actin cytoskeleton MreB, changing the bacterial shape and increasing the membrane's fluidity, which in turn caused the cells to break [28].

AgNPs that build up on the cell membrane cause the bilayer to split and appear to be broken however, AgNPs that enter the cell directly and interact with essential biomolecules eventually cause cell death [29].

ZnO Nanoparticles - The ability of zinc oxide (ZnO) nanoparticles to suppress and inactivate cell development in *Campylobacter jejuni* was studied. The findings demonstrated that *C. jejuni* was highly responsive to ZnO nanoparticle therapy. ZnO nanoparticles were found to have a bactericidal effect on *C. jejuni* [30]. ZnO's antibacterial qualities have led to its incorporation into food can linings for meat, fish, maize, and pea packages in order to maintain colors and stop spoiling. ZnO nanoparticles exhibit stronger antibacterial properties than big particles because of their small size (less than 100 nm) and high surface to volume ratio, which improves their ability to interact with bacteria [31]. Numerous antibacterial properties of ZnO nanoparticles against both Gram positive and Gram negative bacteria have

been demonstrated [32]. ZnO nanoparticles caused membrane blebbing and uneven cell surfaces, as well as an increase in membrane permeability. When cells were exposed to ZnO nanoparticles, this caused membrane leakage was also often seen in E. coli [33]. In *C. jejuni* ZnO nanoparticles caused notable morphological alterations, detectable membrane leakage, and substantial elevations in the expression of genes linked to oxidative stress. he direct interaction between ZnO nanoparticles and cell surfaces, which alters the permeability of membranes where nanoparticles enter and causes oxidative stress in bacterial cells, is a plausible mechanism of ZnO inactivation of bacteria based on these phenomena and cell responses. This ultimately leads to the inhibition of cell growth and, cell death [30].

Effects of Nanoparticles on Fertility

Nanoparticles are natural, organic or manufactured material containing particles, in an unbound state [34]. Exploring the properties and uses of materials at the nanoscale (0.1–100 nm) is the field of nanotechnology. Nanomaterials may offer solutions to environmental and technological problems in the fields of medicine, water treatment, solar energy conversion, and catalysis [35].

Another potential source of nanoparticles exposure is the quickly evolving field of nanotechnology, which is producing materials with size-dependent characteristics. New materials include distinct physico-chemical features that make them advantageous for a variety of commercial applications. These properties include enhanced strength, reactivity, and conductivity. The kind of material utilized, as well as dimensions, shape, composition, homogeneity, agglomeration and origin method, are used to categorize nanoparticles. Au, Ag, Cu, Fe, Zn are metallic nanoparticles, FeO, VO, AlO, ZnO nanoparticles are metal and non-metal oxides, ZnS, CdSe, ZnSe, CdS are semiconductor nanoparticles and carbon-based nanoparticles are the four groups into which nanoparticles can be classified based on the type of material employed [36]. Silver nanoparticles, are widely used antimicrobial compounds that can be incorporated into textiles, plastics, and other materials. They are one of the most commonly utilized nanoparticles in consumer items [34]. Plant-mediated silver nanoparticles have several biological characteristics, including antibacterial, anti-inflammatory and antifertility effects [37]. Particles as tiny as nanoparticles have the ability to pass through biological membranes and reach even the body's tiniest capillaries, including the blood-brain and blood-testes [38].

Many different nanostructures have been used to create nanoparticles. Because of their special qualities, metal oxide nanoparticles, such as ZnO nanoparticles have attracted

increasing attention lately. They are being applied in a variety of fields, including biomedicine, manufacturing, and agriculture. Because of its special physical and chemical characteristics, zinc oxide can be thought of as a substance with multiple uses. It is significant to remember that the most vital microelement present in every bodily tissue is zinc ions [39].

There have been reports of spermatogenesis arrest following exposure to high ZnO nanoparticle concentration [40, 41, 42]. The development of immature germinal cells in the epididymis, together with spermatocytes and sperm cells that have deteriorated and desquamated in the lumen and epididymis of seminiferous tubules [42]. Additionally, Wistar Han rats' seminiferous tubules were almost entirely absent of spermatids and spermatozoa after being exposed to ZnO NPs, which also reduced the amount of germinative cells. In addition, the quantity of Leydig cells (a crucial cell involved in the synthesis of testosterone) decreased in the animals treated. These outcomes are in line with evidence from an in vitro investigation employing a Leydig cell line, which shows that exposure to ZnO nanoparticles in vitro causes a decrease in the viability of Leydig cells and an increase in apoptosis [43]. Due to the betterment of nanotechnology the use of nanoparticles applications shows marvelous increase for industries, cosmetics and drug delivery system. Titanium dioxide nanoparticles are produced in large quantities globally for a variety of applications, including paints, rubber, plastics, food coloring, pharmaceuticals, and household necessities. It is studied that TiO_2 nanoparticles IP injection changed the testicular oxidant/antioxidant status and mRNA expression of steroid-related genes, reduced the percentage of motile sperm in the sperm count, decreased sex hormone levels, and caused architectural changes in the tissues of the testicles, epididymal, and prostate glands. The quantity and quality of spermatozoa, appropriate Leydig cell activity, and optimal hormonal balance are the main factors that influence male fertility [44].

The antifertility effects of several plant species have been investigated with varying results. For instance, in male Wistar rats, the hydroethanolic extract of *Cordia dichotoma* decreased both sperm motility and total sperm count [45]. Studies have shown that oral administration of *Hibiscus rosa-sinensis* phytosomes reduces the average concentration of sperm in the epididymis, increases the percentage of anaplastic sperms in the caudal epididymis, and decreases the percentage of motile sperm, the degree of sperm activity, and the percentage of live sperm and when the aqueous extract of *Hibiscus rosa sinensis* flowers given orally to the male mice it decrease the concentration of sperm in the testes and epididymis as well as the decreased fertility percentage significantly [8].

Medicinal Plants which have Antifertility Properties

1. *Adiantum lunulatum*

Adiantum lunulatum commonly known as Hanspadi. It is a fern constituting phytoconstituents such as terpeoids, flavonoids, steroids. It was observed that after oral administration of crude extract of both alcoholic and decoction of whole plant of *Adiantum lunulatum*, deformation in the germ cells of testis Leydig's cells were atrophied. Seminiferous tubules were filled either with edematous fluid and no spermatozoa could be seen in seminiferous tubules [46].

2. *Ailanthus excella*

The researcher discovered that in female rats, hydroalcoholic extract of *Ailanthus excella* (stem bark) dramatically decreased implantation and led to abortion. In rats with immature ovariectomies, it considerably increased the uterine weight. Significant anti-estrogenic effect was demonstrated when the extract and ethinyl estradiol were administered together. However, based on the aforementioned data, the hydroalcoholic extract of *Ailanthus excella* was found to have an antifertility effect [47].

3. ***Cordia dichotoma***

A hydroalcoholic extract of *Cordia dichotoma* leaves was utilized to induce sterility in indigenous women due to its abortificient activity. The extract has been shown to be safe when taken orally. In female rats, a good anti-implantation activity was seen, additionally the extract significantly increased the uterine weight and altered the metabolic markers in the immature rats. Significant estrogenic action was demonstrated by simultaneously administering the extract and ethinyl estradiol [48].

4. *Carica papaya*

Herbal oral contraceptive suspension with antifertility properties that contains methanol extracts of *Carica papaya* leaves with strong contraceptive properties reported in folklore and ancient Indian literature.

It was observed that, herbal oral contraceptive suspension treated rats had significantly lower weights for reproductive organs such as the testis, epididymis, and seminal vesicle and sperm concentration in the epididymis and motility declined, whereas sperm abnormalities increased and sperm motility duration decreased. Therefore, the findings suggest that both the androgenic and spermatogenic characteristics are disrupted [49].

5. *Curcuma longa*

Rats implantation and estrus cycles were used to measure the antifertility effects of curcumin. It was studied that the extract of this plant dramatically decreased the number of implants and the size of the litters in the rats. Additionally, the drastically changed the lengths of each estrus cycle phase and combined their effects to reduce the number of ovarian follicles [50].

6. *Derris brevipes*

It was observed that oral administration of an alcoholic extract (ethanol) of the root of *Derris brevipes* resulted in delay in implantation. The ethanolic extract from the roots of *Derris brevipes* prevented the pregnant rats from giving birth after the complete gestation period, indicating that the extract had antiimplantation and abortifacient activity [51].

7. *Hymenocardia acida*

Female albino rats' reproductive processes are inhibited by the dilute ethanolic extract of *Hymenocardia acida* (stem bark). When the extract was taken orally between days 1 and 19 of pregnancy, the number of corpora lutea and live fetuses decreased [52].

8. *Leonotis ocymifolia*

To examine the antifertility effects of ethanol and aqueous extracts of *Leonotis ocymifolia* leaves and roots, both in vitro and in vivo studies were conducted. The number of implants decreased when aqueous root and leaf extracts were administered. However, the average number of implants in rats given ethanol leaf extract did not differ significantly from that of the control group at all. Acetylcholine-induced uterine contraction was shown to be increased by all extracts. According to the study's findings, the plant's leaves and roots might have hormonal qualities that could affect the rats' ability to reproduce [53].

9. *Madhuca latifolia*

Macbride, a tall tree of the Sapotaceae family, is also referred to as "Mahuwa." It has been shown that giving male albino rats an aqueous powdered medication is an efficient antifertility treatment. The action was verified by histological analyses, biochemical tests, and a notable drop in the number of sperm. *Madhuca latifolia* seeds, thus, may be a trustworthy herbal alternative following the required clinical investigations [54].

10. *Piper betel*

In addition to causing an irregularly prolonged estrous cycle, the ethanolic extract of *Piper betel* also decreased the number of litters born, the weight of the reproductive organ, and the amount of estrogen. All of these findings indicated that *Piper betel* ethanolic extract had

antiestrogenic and antifertility properties in female rats without having any harmful side effects [55].

11. *Sage leaf alangium, Alangium salvifolium*

It is studied that stem bark of this plant is used both as contraceptive and abortifacient. Extract of this plant possess antiprogesterogenic activity [56].

List of herbal plants which exibites antifertility in males and females mentioned below in table 1 & table 2. Table 3 repersents list of herbal nanoparticles.

Table1. List of plants which exhibits antifertility properties in females

S. No.	Plant name	Common name	Family	Part used	Activity	References
1.	*Alangium Salvifolium*	Sage-leaved alangium	Alangiaceae	Stem, Bark	Abortifacient	[57]
2.	*Adhatoda vasica*	Aedusi	Acanthaceae	Leaves	Antiimplantation	[58]
3.	*Arctium lappa*	Edible burdock	Asteraceae	Leaves, Roots	Abortifacient	[57]
4.	*Abrus precatorius*	Goonj	Fabaceae	Seed	Antiimplantation activity	[59]
5.	*Artemisia vulgaris*	Mugwort	Asteraceae	Leaves	Antiimplantation	[60]
6.	*Acalypha indica*	Indian Acalypha	Euphorbiaceae	Whole plant	Anti-estrogenic activity	[61]
7.	*Achyanthes aspera*	Chaff-flower	Amaranthaceae	Leaves, seeds.	Abortifacient	[62]
8.	*Anethum sowa*	Soya	Apiaceae	Fruit	Contraceptive activity	[63]
9.	*Barleria prionitis*	Porcupine flower	Acanthaceae	Roots, Leaves, and Stem	Reduce protine contents of testes	[64]
10.	*Barleria crista*	Jhinti	Acanthaceae	Root	Contraceptive activity	[65]
11.	*Ballota undulate*	Horehound	Labiatae	Leaves, Flowers	Antiimplantation activity	[59]

12.	*Cissampelos pareira*	Velvetleaf	Menispermaceae	Leaf extract	Altered the estrous cycle	[66]
13.	*Cuminum cyminum*	Jira	Apiaceae	Fruit	Contraceptive activity	[67]
14.	*Carica papaya*	Papaya	Caricaceae	Seed	Abortifacient	[68]
15.	*Cardiospermum Helicacabum*	Ballon vine	Spindaceae	Whole plant	Antiimplantation activity	[69]
16.	*Desmodium gangeticum*	Salparni	Fabaceae	Whole plant	Abortifacient	[70]
17.	*Dendrophthoe falcate*	Long-leaved Mistletoe	Loranthaceae	Aerial parts	Antiimplantation	[71]
18.	*Ficus religiosa*	Peepal	Moraceae	Fruit	Antiimplantation	[72]
19.	*Fevillea passiflora*	Fevillea	Cucurbitaceae	Seed	Abortifacient	[73]
20.	*Garcinia kola*	Bitter Kola/Akuinu	Guttiferaceae	Seeds	Altered the estrous cycle	[74]
21.	*Momordica charantia*	Bitter Melon/Karela	Cucurbitaceae	Seeds	Altered the estrous cycle	[75]
22.	*Michelia champaca*	Champa	Magnoliaceae	Leaf	Antiimplantation	[76]
23.	*Martynia annua*	Devils claws	Pedaliacea	Root	Antiimplantation	[77]
24.	*Pyrethrum indicum*	Guldaudi	Asteraceae	Root	Abortifacient	[67]
25.	*Plumbago rosea*	Rakta Chitrak	Plumbaginaceae	Leaf	Antiovulatory	[78]
26.	*Nelumbo nucifera*	Lotus	Nymphaeaceae	Seed	Abortifacient	[79]
27.	*Tanacetum parthenium*	Featherfew,Featherfoil	Asteraceae	Plant without Root	Abortifacient	[80]
28.	*Trianthema portulacastrum*	Lalsabuni	Aizoaceae	Root	Antiimplantation	[67]

Table 2: List of plants with potential antifertility activity in male

S.No.	Plants	Common Name	Family	Part	Activity	References
1.	*Aegle marmelos*	Bael (Golden apple)	Rutaceae	Bark	Antiandrogenic	[81]
2.	*Bambusa arundinacea*	Thorny bamboo	Graminae	Shoots, Stem	Reduced sperm motility	[82]
3.	*Balanites roxburghii*	Hingan	Zygophyllaceae	Fruit	Antispermatogenic	[83]
4.	*Caesalpinia bonducella*	Fever nut	Caesalpiniacceae	Seed	Antispermatogenic	[84]
5.	*Mentha arvensis*	Pudina	Lamiaceae	Leaves	Antiandrogenic	[85]
6.	*Nicotiana tabacum*	Tobacco	Solanaceae	Leaves	Antiandrogenic effects	[86]
7.	*Pueraria tuberose*	Kudzu	Fabaceae	Tubers	Reduce sperm mortility	[87], [88]
8.	*Withania somnifera Dunal*	Ashwagandha	Solanaceae	Fruit	Decreased Sperm motility	[89]
9.	*Trigonella foenum-graecum*	Fenugreek	Leguminosae	Seed	Antispermatogenic	[90]
10.	*Zizyphus jujube*	Jujube,Chinese date	Rhamnaceae	Bark	Reduce sperm mortility	[91]

Table 3: List of herbal nanoparticles that regulate fertility

S.No.	Plant Name	Family	Part	Nanoparticles	Activity	Reference
1.	*Carica papaya*	Caricaceae	Seed	Au	Antispermatogenic	[92]
2.	*Carica papaya*	Caricaceae	Seed extract	Solid lipid nanoparticles (PSCEN)	Reduce number of spermatozoa	[93]
3.	*Cinnamomum zeylanicum*	Laurels	Bark extract	Ag	Increase F.S.H level and Decrease Testosterone level	[94]
4.	*Fumaria officinalis*	Papaveraceae	Leaves	Ni	Antiovarian cancer	[95]
5.	*Heracleum persicum*	Apiaceae	Phenolic compound	Nanoliposome	Decrease sperm motility,viability	[96]
6.	*Hibiscus rosasinensis*	Malvaceae	Flower extract	Liposomes	Decrease sperm mortility	[8]
7.	*Laurus nobilis*	Lauraceae	Leaf	ZnO	Antibacterial	[97]
8.	*Moringa oleifera*	Moringaceae Leaf	Leaf	Ag	Anti-arthritic	[98]
9.	*Moringa oleifera*	Moringaceae	Leaves	Zno	Protective effect on LH, FSH, Testosterone	[99]
10.	*Psoraleacorylifolia*	Fabaceae	Seed	Ag	Antidiabetic	[100]

Medicinal Plants which Enhance Fertility in both Male and Female Animals Model

1. ***Allium cepa***

   Mice's testicular tissue was examined in relation to the effects of oral administration of *Allium cepa* extract. The findings showed that oral delivery of raw *Allium cepa* extract influenced the shape of the seminiferous tract, accelerated the trend of spermatogenesis, and altered cell proliferation in mice's testicular tubules [101].

2. ***Apium graveolens***

Apium graveolens is commonly known as celery and member of the Apiaceae family. It was observed that after receiving *Apium graveolens* leaf extract for 30 days, the mice's testicular volume and seminiferous tubule width rose. Furthermore, an increase in spermatocytes, spermatogonia, and spermatozoa led to an improvement in spermatogenesis [102]. Additionally, giving laboratory mice oral *Apium graveolens* leaf extract enhanced spermatogenesis and raised the quantity of primary spermatocytes, Sertoli cells [103].

3. *Carthamus tinctorius*

The flower of *Carthamus tinctorius* is used medicinally in Iran. When mice were administered *Carthamus tinctorius* extract, their serum testosterone concentration rose and their physical self-control over testosterone output decreased [104].

4. *Calligonum comosum*

Calligonum comosum is commonly known as Escanbil and belongs to polygonaceae family. When administered to male mice, *calligonum comosum* increased the expression of the gene Catsper, which in turn improved sperm parameters. *Calligonum comosum* is a plant that has antioxidant properties because it contains quercetin and catechin. As a result, it may have an impact on sperm motility and viability [105].

5. *Humulus lupulus*

Through phytoestrogenic chemicals and the stimulation of LH secretion, It was studied that flower extract of *Humulus lupulus* increases the quantity of spermatocytes, spermatogonial, and spermatid cells as well as estrogen and testosterone [106].

6. *Phoenix dactylifera*

Phoenix dactylifera pollen is used to boost libido and treat infertility. For two months, sperm parameters were evaluated while the use of *Phoenix dactylifera* pollen as an oral capsule to treat infertile men was investigated. Pollen from *Phoenix dactylifera* was found to enhance sperm morphology and boost sperm motility and quantity. In order to cure male infertility, *Phoenix dactylifera* pollen can be used as a plant-based medication [107].

7. *Malva sylvestris*

Malva sylvestris is a member of the Malvaceae family and it has been utilized for thousands of years in Iranian traditional medicine. A study looked into how this plant affected sperm. The results of this investigation showed that treatment with hydroalcoholic *M. sylvestris* leaf extract considerably enhanced the number of primary spermatocytes [108].

8. *Withania somnifera*

Withania somnifera belongs to Solanaceae family. In mice with already decreased reproductive indices as a result of morphine addiction, According to one study, taking

this plant orally increased gonadotropin hormones, which in turn modulated levels of luteinizing hormone (LH) and FSH while also increasing levels of estrogen and testosterone [109].

Conclusion

Medicinal plants are used for various purpose since human civilization. Plants are used for treatment of numerous disease and they are also used for suppression of fertility by herbal contraceptives. It was evident from the research that the specific herb and nanoparticles possesses strong antifertility properties. According to this review, many plants, their products and nanoparticles have effective contraceptive properties.

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Abbreviations – FeO (Iron oxide), VO (Vanadium oxide), AlO (Aluminium oxide), ZnO (Zinc oxide), ZnS (Zinc Sulfide), CdSe (Cadmium Selenide), ZnSe (Zinc Selenide), CdS (Cadmium Sulfide), NPs (Nanoparticles), TiO_2 (Titanium dioxide)

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