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RESEARCH ARTICLE

POTENTIAL ANTIFERTILITY PLANTS AND PLANT PRODUCTS

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ABSTRACT

Plants, since times immemorial, have been used virtually by all cultures as a source of medicine. The widespread use of herbal remedies for healthcare is described in ancient texts such as the Vedas and the Bible. In recent years, demand for medicinal plants is increasing in both developing and developed countries due to growing recognition of natural products, as non-narcotic, without side effects, easily available at affordable prices and sometimes the only source of health care available. The fertility control is the most important and urgent mainstay of all biomedical and biosocial problems. The need for evolving more acceptable and effective means of contraception with nil or minimal side effects is more actually felt now, than ever before, in view of the frightening rate at which population is growing. This review helps in the reinvestigation of the plants with potential antifertility activities as the rising trend towards natural contraception. But it is important to find out the mechanism of action and clinical research on few selected plants listed in this review as these plants already reported potential antifertility activities.

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INTRODUCTION

Perpetuation of one's race is the dogma of all living organisms. All living organisms strive to achieve this goal through the process of reproduction, as none of them is immortal. As per nature's rule majority of the species reproduce at a particular season of the year that is identified as the breeding season and such animals are called seasonal breeders. In one way this process restricts the growth of such species. But in a few animals as in domestic animals and human, breeding is not confined to any part of the year and they breed throughout the year. This may result in an augmentation in population. More people have been added to the Earth's population in the 20th Century than at any other time in human history. In 1900, just about 100 years ago, the world's human population was two billion. Today the total human population has grown three times, reaching over six billion, but at the same time natural resources are going down with equal speed. The rate of population growth has gone up rapidly in the past two centuries from 0.0015% before 1800 to 1.2% today. At this rate, the Earth adds one billion more people every 14 years. If this continues the world's population will double in the next century, nearing 12 billion in the year 2100 (Figure-1).Family planning could bring more benefits to more people than any other technology now available to the human race. In the last decade scientists working in India and worldwide have been trying to develop new strategies and technologies for better human reproductive health and fertility regulation. Many plants serve as natural source for antifertility substance but only a few plants were investigated.

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Successive development of research towards the use of plant/plant products for fertility regulation

The quest for a herbal contraceptive has been long and arduous and unfortunately disappointing. Textbooks of the age old systems of medicine, explorers and missionaries, present day practitioners, all point to different plants which are thought to have antifertility activity. Yet, today we are no closer to the discovery of a herbal contraceptive. The National Cancer Research Institute at the National Institute of Health, Bathesda, USA ran an extensive international screening programme in which plants collected from all over the world were tested for antifertility activity, with a view of development of an herbal contraceptive. Several other National Institutes embarked on a programme of a research on potential antifertility plants.

Medical Education and Research, Chandigarh, the Institute of

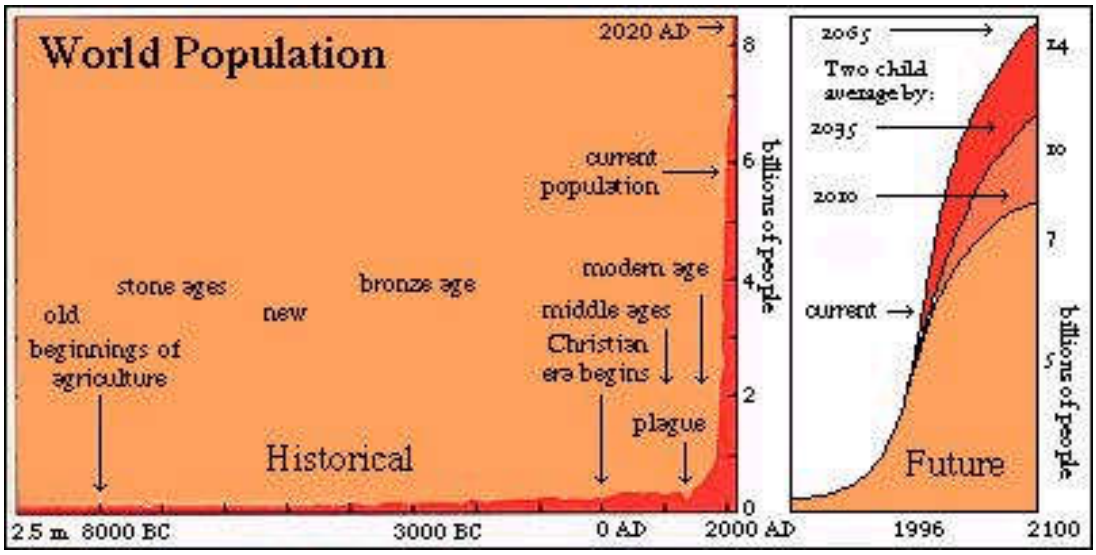

Figure 1. Historical trends and the predicted population crisis (Wallace, King)

These included the Central Drug Research Institute (CDRI), Lucknow and the Institute of Traditional Medicine (ITM), Beijing. Although interesting antiimplantation activity was obtained with many plants, none of these could be developed as an herbal contraceptive, except gossypol, which demonstrated toxic features along with its antifertility activity (Qian *et al*., 1980). There are several excellent reviews, which summarize the results of some of this work (Choudhury, 1966; Choudhury, 1980, 1983, 1992; Garg *et al*., 1978; Kamboj, 1988 and Satyavati, 1984).The special programme for research in human reproduction of WHO did set up a task force on antifertility plants. Plants with potential antifertility action were selected and screened by means of a common protocol for oxytocic and antiimplantation activity.

The centers participating in this collaborative endeavour were-

a) Central Drug Research Institute, Lucknow, India.
b) Department of Pharmacology, Peradinya Medical School, Paradinya, Sri Lanka.
c) Chinese University, Hong Kong, China.
d) University of Seoul, Korea
e) Department of Pharmacognosy, University of Chicago, USA.

The task force functioned from 1978 till 1985. A consolidated report of the results obtained in this collaborative endeavour is now being prepared but none of the plant extracts tested reached to the stage of clinical trial.In India, the Indian Council of Medical Research, as early as in 1966, established a task force on antifertility plants. Plants were tested for contraceptive effect, both in male and in female animal models at selected laboratories. Some of the laboratories were the Central Drug Research Institute, Lucknow, Department of Pharmacology, KG Medical College, Lucknow, the Department of Pharmacology, Post-Graduate Institute of

The selection of plants for fertility regulation should follow a few criteria as suggested below.

a) Selection of plants for screening may not have been based on firm criteria. But careful selection would perhaps replace random collection.
b) The animal models should, again, be carefully selected and should be appropriate.
c) The role of animal screening for efficacy as against clinical evaluation after animal toxicity studies should be carefully looked at.
d) Standardization should be carried out on all extracts or combinations being tested as lack of such standardization may be resulted in getting results that could not be confirmed in earlier studies.
e) Before selecting a plant for screening, availability of adequate material for toxicology, pharmacology and clinical trial should be ascertained.
f) Competent clinical investigators who are willing to carry out collaborative multi-centered trials have to be readily available.
g) Centres for carrying out preclinical and toxicological studies should be made available, before starting a new programme.

It is quite possible that the next decade of research in this field could lead to the discovery of one or more herbal contraceptives. It would be interesting to go through the list of plants, which have indeed undergone clinical evaluation for antifertility activity. References have already been made to clinical trials carried out on men with gossypol. The occurrence of hypokalemia and of irreversible sterilization, has lead to a search for analogues of gossypol. The aqueous extract of the plant, *Montanoa tomentosa* have been evaluated for its luteolytic effect both in Mexico and in Sweden (Gallegos, 1983; Landgren *et al*., 1979). The first trial demonstrated a fall in progesterone levels, this could not be

the plant material from Mexico to Sweden, the dosage selected and the smaller number of women on which the plant extract was evaluated, call for a larger trial to be initiated. The red petals of plant *Hibiscus rosa sinensis* have been administered from day 7-22 of the reproductive cycle at a dose of 750mg/day (Tiwari, 1974). None of the women became pregnant. There has been no follow-up of this interesting clinical observation. The whole plant *Vicoa indica* has been administered to women during reproductive cycle and also post-partum, as it is being used in the field as a method to induce sterility. The results did not demonstrate such an effect (Dhall and Dogra, 1988). Ayurvedic medicine from the Indian sub-continent is suggesting important Leads for researchers in this field. Ancient Indian literature contains information on large number of plants reputed to have contraceptive properties. For example the use of *Hibiscus rosa sinensis* flower for fertility regulation is mentioned during 18th century itself by an Ayurvedic Scholar Bhavamishara in the 70th Chapter of his book Bhavaprakash as follows.

This means "A women will never get pregnant if she consumes during her menses a preparation made from the *H. rosa sinensis* flowers and fermented rice broth along with good quality of old Jaggery". Other Scholars of Ayurveda have also mentioned several plants in their Ayurvedic treatise and a number of these preparations are still being used by Ayurvedic physicians all over India. Therefore, in recent years great attention is being given to plants with antifertility properties.
The active principles, isolated from the plants are reported to have fertility regulating activities like antiovulatory, antiimplantation, abortifacient and estrogenic/antiestrogenic in females, antispermatogenic, and androgenic/ antiandrogenic activities in males in various animal models as shown in following tables.

Plants/plant products showing antifertility activity in females

Randia dumetorum seeds (Singh *et al*., 2000) have shown antiovulatory activity in rabbits and rats. The female rabbit, a reflex ovulator showed reduction in the formation of corpora lutea, when treated with *Ricinus communis* (Castor bean) extract or / and its ricin-A-chain, for 10 consecutive days followed by human chorionic gonadotrophin treatment suggesting the antiovulatory property of castor bean (Salhab *et al*., 1999). Leaf extract of *Taxus baccata* (Choudhury *et al*., 1970) and *Vicoa indica* (Rao *et al*., 1996) and seed extract of *Vitex negundo* (Vohora *et al*., 1973) have shown potent antiovulatory activity in various animal models.

The purified fraction of rhizome of Wilbrandia species that contained two noncucurbitacin glycosides demonstrated potent antifertility effects in rats and mice. In regularly cycling mice, the treatment suppressed the incidence of estrous phase of the reproductive cycle, suggesting a possible antiovulatory effect (Almeida *et al*., 1992).

Petroleum ether and ethanol extracts of whole plant of *Acalypha indica* administered orally from day 1 to 7 of pregnancy at 600mg/kg dose level showed potent antiimplantation activity in albino rats (Hiremath *et al*., 1999). The ethanol extract of *Achrostichum aureum* and its fractions were evaluated for post–ovulatory antifertility activity in female rats (Dhar *et al*., 1992). The water soluble fraction of the ethanolic extract prevented 100% pregnancy when administered to female rats from day 1 to 7 postcoitum. The ethanolic extract of *Adhatoda vasica* leaves administered orally from day 1 to 7 of pregnancy showed 60 – 70% antiimplantation activity (Prakash *et al*., 1985). Crude alcohol extract of leaf and bark of *Ailanthus excelsa* exhibited remarkable antiimplantation activity in rats (Dhanasekharan *et al*., 1993).Ethyl acetate and petroleum ether extracts of the stem bark of *Alangium salviifolium* has shown significant antiimplantation activity in rats at the dose level of 500mg/kg body weight (Murugan *et al*., 2000).

Plants showing antiovulatory activity

Name of the plant	Part used	Animal model	References
Albezzia lebbeck	Seeds	Rabbit	Vohora and Khan, 1974
Aloe barbadensis	Leaves	Rabbit	Gupta *et al*., 1971
Hibiscus rosa sinensis	Flowers	Mouse	Murthy *et al*., 1997
Malvaviscus conzattii	Flowers	Rat	Bannerjee *et al*., 1999
Mentha arvensis	Leaves	Rabbit	Kapoor *et al*., 1974
Polygonum hydropiper	Roots	Rabbit	Kapoor *et al*., 1974
Randia dumetorum	Seeds	Rat	Singh *et al*., 2000
Ricinus communis	Seeds	Rabbit	Salhab *et al*., 1999
Taxus beccata	Leaves	Rat	Choudhury *et al*., 1970
Vicoa indica	Leaves	Bonnet monkey	Rao *et al*., 1996
Vitex negundo	Seeds	Rabbit	Vohora *et al*., 1973
Wilbrandia sps	Rhizome	Mouse, Rat	Almeida *et al*., 1992

Saponins isolated from the seeds of *Albizzia lebbeck* (Vohora and Khan, 1974) and aqueous extract of *Aloe barbadensis* leaves (Gupta *et al*., 1971) have shown potent antiovulatory activity in rabbits.Flower extract of *Hibiscus rosa sinensis* (Murthy *et al*., 1997) and *Malvaviscus conzatti* (Bannerjee *et al*., 1999) and leaf extact of *Mentha arvensis* (Kapoor *et al*., 1974), have shown antiovulatory activity in mice, rats and rabbits respectively.Petroleum ether extract of *Polygonum*

Aristolic acid isolated from root of *Aristolochia indica* showed anti- implantation activity in mice (Pakrashi and Chakrabarti, 1978; Pal *et al*., 1982). Sesquiterpene isolated from the roots of same plant showed antiimplantation and antiestrogenic activity in female mice (Pakrashi and Shaha, 1977). Oral administration of P–Coumaric acid isolated from the roots of *A. indica* showed 100% interceptive activity (Pakrashi and Pakrashi, 1978).Ethanol, benzene and hexane extracts of *Artabotrys odoratissimus* leaves were found to have significant

antiimplantation activity in female albino rats (Mehata *et al*., 1999).Oral administration of ethanol extract of the seeds of *Butea frondosa* is found to have antifertility activity in female

Plants showing antiimplantation activity

Name of the Plant	Part used	Animal model	References
Acalypha indica	Whole plant	Rat	Hiremath *et al*., 1999
Achrostichum aureum	Whole plant	Rat	Dhar *et al*., 1992
Adhatoda vasica	Leaves	Rat	Prakash *et al*., 1985
Ailanthus excelsa	Leaves, stem bark	Rat	Dhanasekharan *et al*., 1993
Alangium salvifolium	Stem bark	Rat	Murugan *et al*., 2000
Aristolochia indica	Root	Mouse, Rabbit	Pakrashi and Shaha, 1977; Pakrashi and Chakraborti, 1978; Pakrashi and Pakrashi 1978; Pal *et al*., 1982.
Artabotrys odoratissimus	Leaves	Rat	Prakash and Mathur, 1977; Mehata *et al*., 1999
Asparagus pubescens	Root	Mouse, Rat, Rabbit	Nwafor *et al*., 1998
Azadirachta indica	Seed oil	Mouse	Juneja *et al*., 1994; Riar *et al*., 1988; Sinha *et al*., 1984' Lal *et al*., 1986
Butea frondosa	Seeds, petals	Rat, Mouse	Razdan *et al*., 1969; Kapila *et al*., 1970
Butea monosperma	Seeds	Rat	Bhargava, 1986
Carica papaya	Seeds	Mouse, Rat	Chinoy *et al*., 1997; Keshri *et al*., 1993
Cassia fistula	Seeds	Rat	Yadav and Jain, 1999
Catharanthus roseus	Leaves	Mouse	Mathur *et al*., 1996
Centratherum anthelminticum	Seeds	Rat	Sharma *et al*., 1992
Citrulus colocynthus	Leaves	Rat	Prakash *et al*., 1985
Citrus hystrix	Fruit peel	Rat	Piyachaturawat *et al*., 1985
Codonopsis ovata	Plant	Rat	Prakash *et al*., 1985
Coriandrum sativum	Seeds	Rat	Al-Said *et al*., 1987
Crateva narvala	Bark	Rat	Sharma *et al*., 1983
Curcuma longa	Rhizome	Rat	Bhatnagar, 1995
Dalberagia soxatilis	Whole plant	Rat	Uchendu *et al*., 2000
Dacus carota	Seeds	Rat	Garg 1975, Bhatnagar 1995
Embelia ribes	Berries	Rat	Prakash, 1981
Ficus religiosa	Bark	Rat	Ratnasooriya and Dharmasiri, 1999
Hibiscus rosa sinensis	Flowers	Mouse, Rat	Kholkute *et al*., 1976; Kholkute and Udupa, 1976; Pal *et al*., 1985; Murthy 1996.
Hyptis suacveolens	Leaves	Rat	Saluja and Santani 1981, 1983
Illicium anisatum	Seed oil	Rat	Dhar *et al*., 1990; Dhar, 1995
Ischinochiton camptus	Whole Plant	Rat	Dhar *et al*., 1993
Ixora finlaysoniana	Whole plant	Rat	Singh *et al*., 1993
Lagenaria breviflora	Fruit	Rat	Elujoba *et al*., 1985,
Lapidium capitatum		Rat	Singh *et al*., 1984
Mechelia champaka	Anthers	Rat	Sharma *et al*., 1992
Memcylon lushingtoni	Aerial parts	Rat	Keshri *et al*., 1998
Mentha arvensis	Leaves	Rat	Garg *et al*., 1978; Kanjanapothi *et al*., 1981
Montanoa frutescens	Leaves	Rat	Pedron, 1985
Montanoa tomentosa	Leaves, Whole Plant	Rat, Mouse, Hamster	Pedron, 1985; Hahn *et al*., 1981
Niegella sativa	Seeds	Rat	Keshri *et al*., 1995; Mehata *et al*., 1999
Ocimum sanctum	Leaves	Rat	Batta and Santhakumari 1970
Piper betle	Leaf stalk	Rat, Mouse	Adhikary *et al*., 1998
Plumbago Zeylanica	Root, Fruit	Rat	Garg, 1976; Premkumari *et al*., 1977; Devarshi *et al*., 1992
Pedocarpus brevifolius	Leaves	Rat	Kholkute and Munshi 1978
Pueraria tuberosa	Tubers	Rat, Hamster, Mouse	Prakash *et al*., 1985, 1985; Gupta *et al*., 1990; Shukla 1995
Randia dumetorum	Seeds	Rat	Prakash *et al*., 1985; Singh *et al*., 2000
Ricinus communis	Seeds	Rat, Rabbit, Guinea pig	Okwuasaba *et al*., 1991; Salhab *et al*., 1999; Makonnen *et al*., 1999.
Rivea hypocrateriformis	Aerial parts	Rat	Shivalingappa *et al*., 2001
Rubus species	Leaves	Rat	Dhanabal *et al*., 2000
Ruta graveolens	Root, aerial parts	Rat	Gandhi *et al*., 1991
Salvia fruticosa	Leaves	Rat	Elbeticha *et al*., 1998
Solanum crassypetalum	Aerial parts	Rat	Keshri *et al*., 1998
Striga densiflora	Whole plant	Rat	Hiremath *et al*., 1996
Striga lutea	Whole plant	Rat	Hiremath *et al*., 1990; Hiremath and Hanumantha Rao 1990.
Striga orobanchioides	Whole plant	Rat	Hiremath *et al*., 1994, 2000
Terminalia bellirica	Bark	Rat	Sharma *et al*., 1983;
Trichosanthin kikilowii	Roots	Mouse	Chang *et al*., 1979
Zingiber roseum	Stem	Rat	Prakash *et al*., 1992

The methanolic extract of *Asparagus pubescens* root was administered to mice, rats and rabbits from day 4-14 of pregnancy at the dose level of 1.5g/kg showed potent antiimplantation activity (Nwafor *et al*., 1998).Intravaginal application of neem oil during the pre-, peri - and post-implantation periods could prevent pregnancy in rats (Sinha *et* mice and rats (Razdan *et al*., 1969). The crystalline fraction composed of glycoside butrin and plastrin isolated from the alcohol extract of the petals of *B. frondosa* reduced the number of implants (Kapila *et al*., 1970).Butin isolated from the seeds of *Butea monosperma* administered orally at the dose level of 5, 10 and 20mg/rat from day 1 to day 5 of pregnancy showed

(Bhargava, 1986). Oral administration of hexane extract of dried seeds of *Carica papaya* at the dose level of 1mg/kg to adult female rats from day 1-10 of post-coitum prevented pregnancy in 70% animals. This antiimplantation activity is much progressed by the administration of fraction of seeds of *C. papaya* obtained from column and preparative layer chromatography (Keshri *et al*., 1993, Chinoy *et al*., 1997).Neem oil extracted from the seeds of *Azadirachta indica* was administered intravaginally to the rats on days 2-4, 4-6 or 7-9 post–coitum. In all three groups no viable implantations were observed in both the uterine horns (Riar *et al*., 1988). In vitro exposure of two cells mouse embryos to *A. indica* (neem) oil has resulted in failure of blastocyst development, trophoblast attachment, proliferation of cells and fertility loss (Juneja *et al*., 1994).Oral administration of aqueous extract of seeds of *Cassia fistula* to female rats from day 1-5 of pregnancy at the doses of 100 and 200mg/kg body weight resulted in respective 57.14% and 71.43% prevention of pregnancy, whereas 100% pregnancy inhibition was noted at 500mg/kg body weight (Yadav and Jain, 1999).The administration of ethanol and petroleum ether extracts of leaves of *Catharanthus roseus* (Mathur *et al*., 1996) and ethanol extract of *Centratherum anthelminticum* (Sharma *et al*., 1992) resulted in total inhibition of pregnancy in mice and rat respectively.Ethanol and benzene extract of *Citrulus colocynthus* leaves showed 70% antiimplantation activity when administered to female rats from days 1-7 post-coitum. Alcohol and chloroform extract of *Citrus hystrix* fruit peel administered orally to pregnant rats, found to inhibit implantation effectively (Piyachaturawat *et al*., 1985). Acetone extract and *Codonopsis ovata* plant showed 70% antiimplantation activity in female rats from days 1-7 post-coitum (Prakash *et al*., 1985).Aqueous extract of *Coriandrum sativum* seeds administered orally to pregnant rats, showed significant antiimplantation activity. This extract produced a significant decrease in serum progesterone levels on day 5 of pregnancy, which may be responsible for antiimplantation effect (Al-said *et al*., 1987).

Ethanolic extract of *Crateva narvala* bark showed 60% antiimplantation activity when administered orally at dose level of 250mg/kg from 1-7 days of pregnancy in rats (Sharma *et al*., 1983). The administration of ethanol and petroleum ether extracts of rhizome of *Curcuma longa*, resulted in total inhibition of pregnancy in rat (Bhatnagar, 1995).Triterpenoid glycosides (DSS) isolated from *Delbergia soxatilis* have shown significant antifertility activity in rats at dose level of 200mg/kg body weight (Uchendu *et al*., 2000).The chromatographic fractions of petroleum ether, alcohol and aqueous extracts of the seeds of *Daucus carota* were also studied. The chloroform of methanol fractions of petroleum ether, chloroform and methanol fractions of alcohol extract and chloroform and ethyl acetate fractions of the aqueous extract showed 80-100% inhibition of implantation in rats (Garg, 1975). The antifertility activity of ethanol extract of *D. carota* seeds was dose dependent. The lower dose shown antiimplantation activity, whereas higher dose caused foetus resorption (Bhatnagar, 1995).Dried berries of *Embelia ribes*, have a traditional reputation for an antifertility activity. One of its active components, embelin has been documented to hormonal activity is still controversial. Studies show that embelin is a potent oral contraceptive of plant origin that possesses 85.71% antiimplantation activity in rats when administered at 50mg/kg body weight for 7 days. Embelin is also known as embelic acid or to be chemically accurate 2,5 – dilydrony –3- undecyl –2, 5-cyclohexadiene-1, 4-benzoquinone (Merck Index). Embelin inhibited pregnancy and also possesses antiestrogenic and weak progestational activity. Therefore, administration of embelin may cause a disturbance in the hormonal level and thus prevent implantation, since specific hormonal equilibrium of estrogen and progesterone is required for egg implantation (Prakash, 1981).Oral administration of the methanolic extract of *Ferula asafoetida* resin at the dose of 400mg/kg body weight daily on day 1-10 post-coitum prevented pregnancy in 80% of the rats. Column chromatographic eluents of hexane and chloroform fractions of the extract have shown significant antifertility activity (Keshri *et al*., 1999).Some physicians in Sri Lanka claim that water extract of bark of *Ficus religiosa* has post-coital contraceptive activity in females. The treatment of extract from day 1-7 of gestation has marked post-coital contraceptive activity. The pre-implantation loss is mediated via powerful rhythmic contraction of the uterine musculatures and not by estrogenic mechanism (Ratnasooriya and Dharmasiri, 1999).The effect of *Hyptis suaveolens* leaves and its floral parts have shown significant antiimplantation activity due to its estrogenicity (Saluja and Santani, 1981, 1983).Trans-anethole, a major constituent of star anise oil derived from the fruits of *Illicium anisatum* has shown 100% antiimplantation and estrogenic activity at 80mg/kg body weight. (Dhar *et al*., 1990; Dhar, 1995). Aqueous and ethanol fractious of *Ischinochiton camptus* exhibited significant anti implantation activity in rats. This activity is probably due to their antiestrogenic property (Dhar *et al*., 1993).Oral administration of crude ethanolic extract of the serial parts of *Ixora finlaysoniana* Wall. to adult female rats at 250mg/kg dose on days 1-5 or 1-7 post-coitum prevented pregnancy in 100% rats (Singh *et al*., 1993).Methanol extract of the *Lagenaria breviflora* fruit pulpwas administered to the rats at the dose level 2.5g/kg gave 80% and 5g/kg fruit pulp resulted in 100% antiimplantation activity (Elujoba *et al*., 1985).The benzene extract of M*echelia champaka* anthers showed 67% antiimplantation activity, at the dose level of 1000mg/kg (Sharma *et al*., 1992).Ethanolic extract of aerial parts of *Memcylon lushingtonii* administered orally to female rats from day 1-10 post-coitum showed significant antiimplantation activity (Keshri *et al*., 1998).Subcutaneous administration of the uterotonic fraction of *Mentha arvensis* to rats from day 1 to day 10 of pregnancy caused a significant interruption of pregnancy (Kanjanapothi *et al*., 1981).

Intrauterine administration of Zoapatle aqueous crude extract (ZACE) of *Montanoa frutescens* on the 4th day of rat pregnancy at concentrations equivalent to 50mg and 5mg of dry leaves, was associated with total inhibition of implantation sites (Pedron *et al*., 1975). ZACE from *Montanoa tomentosa* equivalent to 50 and/or 100mg of dry leaves though not inhibited implantation, most implants were found abnormal (Pedron *et al*., 1985). The plant extract of the *M. tomentosa* inhibited the implantation in rats and mice when administered

on day 1-6 and in hamsters when administered on days 1-6 of gestation (Hahn *et al*., 1981).Hexane and benzene extract of *Nigella sativa* seeds and their chromatographic fraction administered for 1-10 day prevented pregnancy in rats (Keshri *et al*., 1995, Mehata *et al*., 1999).Benzene and Petroleum ether extracts of leaves of *Ocimum sanctum* administered day 1-5 of pregnancy showed respective 80% and 60% antifertility activity in rats (Batta and Santhakumari, 1970).

Alcohol extract *of Piper beetle* leaf stalk administration is proved to reduce plasma progesterone and LH (Adhikary *et al*., 1998).Plumbagin a crystalline compound from *Plumbago zeylanica* administered orally (1 and 2mg/100g body weight) reported to have potent antiimplantation and abortifacient activity in albino rats without any teratogenic effect (Garg, 1976; Premkumari *et al*., 1977).Chloroform extract of leaves of *Podocarpus brevifolius* altered normal estrous cycle in rats and prevented implantation at the dose level of 20mg/100g body weight (Kholkute and Munshi, 1978).Puerorin, diazein and tuberosin isolated from of ethanol extract of *Pueraria tuberosa* tubers showed significant antiimplantation activity (Gupta *et al*., 1990, Shukla 1995). Butanolic extract of *P. tuberosa* prevented pregnancy (100%) in female rats when administered orally on days 1-2, 1-3, 2-3 and 3-5 post-coitum respectively. However 100% inhibition was obtained by higher dose of 150-200mg/100mg body weight when administered to hamsters (Shukla, 1993, Prakash *et al*., 1985).The seed extract of *Randia dumetorum* inhibited pregnancy in 50-60% rats when administered orally from day 1 to 7 of pregnancy (Prakash *et al*., 1985).An ether soluble fraction of a methanol extract of *Ricinus communis* seeds administered subcutaneously to adult female rats and rabbits at doses 1.2g/kg and 600mg/kg respectively, in divided doses showed antiimplantation and anticonceptive activities (Okwuasaba *et al*., 1991). The intraperitonial injections of *Ricinus communis* and ricin-A-Chain on days 1-6 of gestation exhibited significant reduction in implantation sites (Salhab *et al*., 1999).The seed extract of *R. communis* also exhibited significant antiimplantation and abortifacient effects in guinea pigs (Makonnen *et al*., 1999).Ethanol extract of *Rivea hypocrateriformis* (Shivalingappa *et al*., 2001) and Rubus species (Dhanbal *et al*., 2000) have shown potent antiimplantation activity. The antifertility activity of *R. hypocrateriformis* was reversible on exogenous administration of hydroxy-progestene.

The powdered root and aerial parts of *Ruta graveolens* administered orally to female rats (Days 1-10 post coitum), showed potential antiimplantation activity (Gandhi *et al*., 1991).Crude ethanolic extract of aerial parts of *Solanum crassypetalum* and their fractions were administered to rats orally on days 1-10 of postcoitum, showed significant antiimplantation activity (Keshri *et al*., 1998).Ethanol extract of *Striga densiflora* has exhibited significant antiimplantation activity in rats (Hiremath *et al*., 1996).Petroleum ether and chloroform extract of *Striga lutea* showed 100% inhibition of implantation sites in albino rats (Hiremath *et al*., 1990). Acacetin and Luteolin, which are the isolated flavones of *Striga lutea* have shown significant antiimplantation activity (Hiremath and Hanumantha Rao, 1990). Ethanol extract of *Striga orobanchiodes* has exhibited significant antiimplantation activity in rats (Hiremath *et al*., 1994). The two flavones, apigenin and luteolin, isolated from *S. orobanchiodes* administered from day 1 to 4 of pregnancy showed dose dependent and significant antiimplantation activity. (Hiremath *et al*., 2000).Ethanol extract of *Terminalia bellirica* bark has shown significant antiimplantation activity in rats when administered from D_1-D_7 of pregnancy (Sharma *et al*., 1983).α-Trichosamthin isolated from the root of *Trichosanthin kikilowii* administered alone to pregnant mice from day 1-4 was not able to disturb gestation in mouse (Chang *et al*., 1979). However, when α-Trichosanthin was administered together with reserpine and testosterone, total inhibition of implantation was reported in mouse, rat, rabbit including human (Zhou *et al*., 1982).

Benzene extract of *Achyranthus aspera* showed 100% abortifacient activity in rabbits at a single dose of 50mg/kg body weight (Pakrashi and Bhattacharya, 1977). Steroids isolated from unripe fruits juice of *Ananas comosus* and *Aristolochia indica* showed abortifacient activity in mice when administered during 6-7 days of gestation (Pakrashi and Chakrabarty, 1981; Pakrashi and Shaha, 1978).Alcoholic extract of leaf and stem bark of *Ailanthus excelsa* at a dose of 250mg/kg body weight, exhibited early abortifacient activities. The results are in agreement with the traditional use of this plant as a abortifacient by the Irula women of the Nilgiri district.

Plants showing abortifacient activity

Name of the Plant	Parts used	Animal model	References
Achyranthes aspera	Stem bark	Mouse	Pakrashi *et al*., 1977
Ailanthus excelsa	Leaves, stem bark	Rat	Dhanasekaran et el, 1993
Ananas comosus	Unripe fruits and Juice	Mouse	Pakrashi and Bhattacharya, 1977
Aristolochia indica	Root	Mouse	Pakrashi and Shaha, 1978
Azadirachta indica	Seeds	Rat, Rabbit, Baboon	Mukherjee and Talwar, 1996; Mukherjee *et al*., 1996; Talwar *et al*., 1997,
Cinnomomum Zeylanicum	Leaves	Rat	Pellegatti *et al*., 1994
Embelia ribes	Seeds & berries	Rat, Human	Prakash and Mathur, 1976
Gardenia josminoides	Flower	Human	Zhou *et al*., 1989
Gossypium herbaceum	Seeds	Rat	Nath *et al*., 1997
Jatropha curcas	Whole plant	Rat	Goonasekera *et al*., 1995
Peganum harmala	Seeds	Rat	Nath *et al*., 1993
Physalis minima	Plants without root	Rat	Dhawan *et al*., 1980
Plumbago zeylanica	Root	Rat	Premkumari *et al*., 1977
Ricinus communis **(Castor bean)**	Seeds	Mouse	Salhab, 1996; Salhab *et al*., 1998; Makonnen *et al*., 1999; Dafalha and Mutairy, 1994; Salhab *et al*., 1997.

Oral administration of praneem a purified *Azadirachta indica* (neem) extract, to pregnant rats lead to resorption of embryos with elevated levels of interferon gamma (IFN-Y) and tumor necrosis factor alpha (TNF-α) (Mukherjee and Talwar, 1996). A post implantation abortifacient response to orally administered neem was similarly observed in rabbit and baboon (Mukherjee *et al*., 1996). The partially fractionated active principle of neem has been suggested to function as an immunomodulator in causing pregnancy failure with decline in chorionic gonadotrophin (hCG) and progesterone levels in the baboon (Talwar *et al*., 1997).Extracts of leaves of *Cinnomomum zeylanicum* (Pellegatti *et al*., 1994), seeds of *Embelia ribes* are claimed to possess abortifacient activity (Prakash and Mathur, 1976). An Ayurvedic drug (for birth control) with the ingredients derived from *Embelia ribes, Lucifer lacca* and *Areca catechu* were proved to be effective abortifacient in humans.Ethyl acetate extract of flowers of *Gardenia jasminoides* showed a significant action on termination of pregnancy in rats. Two cycloartene triterpenoids, gardenic acid-A and gardenolic-B were isolated and identified as the active ingradients. Gardenic acid showed potential activity to damage the pregnancy in women at a concentration of 5mg/ml (Zhou *et al*., 1989).

bean) extract and Ricin-A-chain caused midterm abortion in mice and Rabbits (Salhab, 1996; Salhab *et al*., 1998). Further the fertility rate of treated animals was also decreased (Dafallha and Mutairy, 1994; Salhab *et al*., 1997). The seed extract of *R. communis* was found to possess abortifacient effects in guinea pigs (Makonnen *et al*., 1999). Similar results were found after treatment to pregnant rats with extracts of *Jatropha curcas* (Goonasekera *et al*., 1995).

The methanolic extract of *Asparagus pubescens* administered to ovariectomized immature young rats and mice, decreased uterine weight and exhibited closed vagina indicating its antiestrogenic activity (Nwafor *et al*., 1998).Aristolic acid or its methylester isolated from roots of *Aristolochia indica* (Pakrashi and Chakrabarti, 1978) showed antiestrogenic activity in mice.Ethanolic extract of seeds of *Bupleurum morginatum* has shown estrogenic activity in immature rats (Jonathan *et al*., 1995). Butin isolated from the seeds of *Butea monosperma* exhibited significant estrogenic and anticonceptive activity in ovariectomized rats (Bhargava, 1986). 3,5,4 – Trihydrosy dibenzyl isolated from *Cannabis sativa* and also its synthesized compounds have shown potent estrogenic activity (El – Feraly, 1984).

Plants showing estrogenic/antiestrogenic activity

Name of the Plant	Part used	Animal mode	References
Aristolochia indica	Roots	Mouse	Pakrashi and Chakrabarti, 1978
Asparagus pubescens	Root	Rat, Mouse	Nwafor *et al*., 1998
Bupleurum morginatum	Whole plant	Rat	Jonathan *et al*., 1995
Butea monosperma	Seeds	Rat	Laumas and Uniyal, 1966, Bhargava, 1986
Cannabis sativa	Seeds	Rat	El – Feraly, 1984
Carica papaya	Seeds	Rat	Keshri *et al*., 1993
Cassia fistula	Seeds	Rat	Yadav and Jain, 1999
Calotropis procera	Roots	Rat	Jagadish *et al*., 2002
Datura quercifolia	Whole Plant	Rat	Chandhoke, 1978
Echinops echinatus	Roots	Rat	Sharma *et al*., 1988
Embelia ribes	Berries	Rat	Prakash 1981
Ensete superbum	Seeds	Rat	Datta *et al*., 1970
Ferula jaeschkeana	Whole Plant rhizome	Rat	Singh *et al*., 1985
Foeniculum vulgare	Seeds	Rat	Malini *et al*., 1985
Hibiscus rosa sinensis	Flowers	Mouse	Murthy *et al*., 1997
Hyptis suaveolens	Leaves, floral parts	Rat	Saluja and Santani, 1983
Ischinochiton camptus	Seeds	Rat	Dhar *et al*., 1993
Ixora finlaysoniana	Aerial parts	Rat	Singh *et al*., 1993
Malvaviscus conzatti	Flowers	Rat	Achari *et al*., 1984
Momordica charantia	Seeds	Rat	Sharanabasappa, 2002
Moringa oleifera	Roots	Rat	Shukla *et al*., 1988
Polygonum hydropiper	Roots	Mouse	Fukuyama, 1983
Pueraria tuberosa	Tubers	Rat, Mouse	Mathur *et al*., 1984, Prakash *et al*., 1985
Randia dumetorum	Seeds	Rat	Pillai *et al*., 1977
Ricinus Communis	Seeds	Rat, Mouse	Okwuasaba *et al*., 1991
Ruellia praetermissa	Whole plant	Rat	Salah *et al*., 2002
Striga densiflora	Whole plant	Rat	Hiremath *et al*., 1996
Striga orobanchioides	Whole plant	Rat	Hiremath *et al*., 1994
Tabernaemontana heynea	Roots	Rat	Mehrotra and Kamboj, 1978
Trifolium pratense **(red clover)**		Rat	Burdette *et al*., 2002
Vitex negundo	Seeds	Mouse	Bhargava, 1984

Aqueous seed suspension of *Peganum harmala* was found to cause abortion of 68.5% rat foetuses, when administered at the daily dose of 200mg/kg body weight from day 1-10 of post-coitum (Nath *et al*., 1993).Physalin-B and Physalin-D isolated from the ethanolic extract of *Physalis minima* were found to possess significant abortifacient activity (Subramaniam and

1g/kg dose of hexane extract of the seeds of *Carica papaya* administered orally to bilaterally ovariectomized immature female rats caused mild uterine weight gain (Keshri *et al*., 1993). Ethanolic extract of *Cassia fistula* has shown estrogenic activity in immature rats (Yadav and Jain, 1999). A strong uterotrophic activity was observed with the ethanolic

250mg/kg (Jagadish *et al*., 2002).Daturalactone isolated from the whole plant of *Datura quercifolia* has shown significant pregnancy interceptive and estrogenic properties (Chandhoke, 1978).The root extract of *Echinops echinatus* have shown excellent antiestrogenic activity. The water extract showed moderate antiestrogenic activity, while benzene, hexane and alcohol extracts showed to possess rich antiestrogenic active principle (Sharma *et al*., 1988).Embelin from *Embelia ribes* berries has shown to have antiestrogenic activity (Prakash, 1981). The VIDR – 2GD isolated from *Ensete superbum* has weak estrogenic activity and has been reported to intercept implantation in mice, rat, hamsters and guinea pigs (Datta *et al*., 1970).Ferujol isolated from *Ferula jaeschkeana* exhibited estrogenic activity in rats (Singh *et al*., 1985). Carotane sesquiterpanes isolated from the rhizomes of *Ferula jaeschkeana* administered to ovariectomized immature rats, exhibited estrogenic activity (Singh *et al*., 1988). Oral administration of acetone extract of *Foeniculum vulgare* seeds to female rats for 10 days lead to vaginal cornification (Malini *et al*., 1985).Benzene extract of *Hibiscus rosa sinensis* when administered to the prepubertal mice for 5 days showed estrogenic activity (Murthy *et al*., 1997). Petroleum ether extract of air-dried powdered leaves and floral parts of *Hyptis suaveolens* has been fractioned into saponable and unsaponable fractions. The unsaponiable matter has been shown to possess estrogenic activity in rats (Saluja and Santani, 1983). Oral administration of ethanolic extract of the aerial parts of *Ixora finlaysoniana* to immature rat, found to possess estrogenic activity as evidenced by dose dependent increase in uterine weight and cornification of the vaginal epithelium. It also induced premature opening of the vagina (Singh *et al*., 1993). Kaempfenol and its derivatives of isolated compounds of flowers of *Malvaviscus conzatti* have shown significant antifertility activity (Achari *et al*.,1984). Benzene extract of *Momordica charantia* seeds showed estrogenic activity as evidenced by increase in uterine weight and cornification of the vaginal epithelium in immature ovariectomized rats (Sharanabasappa, *et al*., 2002).Oral administration of aqueous extract of *Moringa oleifera* roots progressively increased the uterine wet weight of bilaterally ovariectomized rats. This estrogenic activity is supported by stimulation of uterine histoarchitecture (Shukla *et al*., 1988).Delta lactone and 2 – quercetic glycosides isolated from roots of *Polygonum hydropiper* have shown significant antifertility activity against female mouse because of its estrogenic activity (Fukuyama, 1983).The various extracts of *Pueraria tuberosa* tubers administered to normal cyclic rats, induced cornification of vaginal epithelial cells and increase in uterine weight indicating the estrogenic nature of the extracts (Mathur *et al*., 1984; Prakash *et al*., 1985).Oleanolic acid 3-β-glycoside isolated from *Randia dumetorum* seeds has shown antiimplantation activity in rats and found to be antiestrogenic in nature (Pillai *et al*., 1977).

Ether soluble fraction of a methanol extract of *Ricinus communis* showed increased uterine wet weight in immature rats. Furthermore, the extract induced premature opening of the vagina and increased number of cornified cells in the vaginal smear. This exhibited strong estrogenic activity of the extract (Okwuasaba *et al*., 1991). The methanolic extract of *Ruellia praetermissa* showed estrogenic activity in rats (Salah *et al*., 2002).The ethanolic extract of whole plant of *Striga densiflora* (Hiremath *et al*., 1996) and *Striga orobanchioides* (Hiremath *et al*., 1994) showed estrogenic activity as evidenced by significant increase in the uterine weight in immature ovariectomized rats, premature opening of the vagina and increased number of cornified cells in the vaginal smear. Coronariodine isolated from *Tabernaemontana heynea* has shown estrogenic activity (Mehrotra and Kamboj, 1978). *Trifolium pratense* extract was administered in virgin, ovariectomized 50 days old rats, caused an increase in uterine weight and differentiated vaginal cells, but did not stimulate cell proliferation in the mammary glands. These data suggest that the extract is weakly estrogenic in the ovariectomized rat model (Burdette *et al*., 2002).5,7,3' – trihydroxy – 6,8,4' – trimethoxy flavone (VI – II) from *Vitex negundo* has shown weak estrogenic and antiestrogenic properties (Bhargava, 1984).Shivalingappa *et al*., (2001) demonstrated antiprogestational activity of the ethanol extract of whole plant of *Rivea hypocrateriformis* in rats.Aqueous extract of seeds of Coriandrum sativm administered to rats produced a significant decrease in serum progesterone levels on day 5 of pregnancy, which may be responsible for the antiimplantation effect (Al – Said *et al*., 1987).Benzene extract of flowers of H. rosa sinensis administered to rats showed antiprogestational activity probably, this activity is able to provoke antifertility activity (Pal *et al*., 1985).An aqueous extract of Moringa oleifera roots administered to rats at the dose level of 600mg/kg body weight showed antiprogestational activity by interfering in deciduoma formation (Shukla *et al*., 1988).Crude powder of Pueraria tuberosa tubers administered to mice and rats, showed significant progestational activity (Prakash *et al*., 1985).

Male antifertility activity

A successful fertility regulating agent/ method for the male should satisfy the following requirements:

- Be safe and produce no unwanted side effects on metabolic functions.
- Be effective and should not lead to unwanted pregnancy.
- The effects should be reversible.
- Not affect libido, accessory gland and seasonal functions.
- Maintain circulating levels of androgens at normal

Plants showing progestational/antiprogestational activity

Name of the Plant	Part used	Animal mode	References
Coriandrum sativum	Seeds	Rat	Al – Said *et al*., 1987
Hibiscus rosa sinensis	Flower	Rat	Pal *et al*., 1985
Moringa oleifera	Root	Rat	Shukla *et al*., 1988
Pueraria tuberosa	Tubers	Rat, Mouse	Prakash *et al*., 1985
Rivea hypocrateriformis	Aerial Parts	Rat	Shivalingappa *et al*., 2001.

The major target sites for fertility regulations in the male reproductive tract are:

a) Testes, where spermatogenesis and sperm production occur and the use of antispermatogenic compounds which lead to azoospermia.
b) Epididymis, where spermatozoa acquire progressive motility and fertilizing capacity (sperm maturation). This organ represents an ideal extragonadal site for fertility regulation.
c) Vas deferens is a passage for transport of spermatozoa during ejaculation. Intervention at this site would lead either azoospermia or inability of spermatozoa to initiate fertilization associated events.

mating with treated male rats was markedly declined (Rao, 1987). Oral feeding with the bark extract of *Alstonia scholaris* caused reduction in the production of step – 19 spermatids by 79.6%. The population of proleptotene and pachytene spermatocytes was decreased by 61.9% and 60.1%, respectively. Spermatogonia and Sertoli cell population were also affected. Reduced sperm count and motility resulted in a total suppression of fertility. The fructose content in the seminal vesicle was lowered (Gupta *et al*., 2002). The leaf extract of *Andrographis peniculata*, when fed to male albino rats, caused the arrest of spermatogenesis. Andrographolide, a compound isolated from *A. peniculata* was administered to rats for 48 days, resulted in decreased sperm count, caused abnormalities in spermatozoa and decreased their motility (Akbarsha and Murugaian, 2000).

Plants/plant products showing antifertility activity in males

Name of the Plant	Part used	Animal model	References
Abrus precatorius	Seeds	Rat	Rao, 1987; Sinha, 1990
Alstonia scholaris	Bark	Rat	Gupta *et al*., 2000
Astracantha longifolia	Seeds	Rat	Bansal *et al*., 1997
Andrographis peniculata	Leaves	Rat	Akbarsha and Murugaian, 2000
Azadirachta indica	Seed oil, Leaves	Rat	Choudhary *et al*., 1990; Purohit and Dixit, 1991; Manoranjitham *et al*., 1993; Upadhyay *et al*., 1993; Joshi *et al*., 1996; Aladakatti and Ahamad 1999; Purohit, 1999; Aladakatti *et al*., 2001.
Berberis chitria	Root	Dog	Gupta and Dixit, 1989
Bambusa arundinacea	Shoot	Rat	Vanithakumari *et al*., 1989
Barleria prionitis	Root	Rat	Gupta *et al*., 2000
Carica papaya	Seeds	Rat, Rabbit, Monkey, Human	Lohiya and Goyal, 1992; Lohiya *et al*., 1994, 1999, 2000, 2000, 2002; Verma and Chinoy, 2001; Pathak *et al*., 2000.
Casiarea tomentosa	Leaves	Rat	Choudhary *et al*., 1990
Catharanthus roseus	Leaves	Rat	Mathur and Chandan, 1985
Chordia dichotoma	Leaves	Rat	Chaudhary *et al*., 1990
Cichorium intybus	Roots	Mouse	Ray and Bhatt, 1996
Colebrookia oppositifolia	Leaves	Rat	Gupta *et al*., 2001
Diospyros embrgopteris	Leaves	Rat	Choudhary *et al*., 1990
Echinops echinatus	Root	Rat	Chaturvedi *et al*., 1995
Embelia ribes	Berries	Monkey	Purandare *et al*., 1979
Gossypol	Seed oil	Monkey, Rat, Rabbit, Human	Qian *et al*., 1980; Lohiya *et al*., 1990; Kumar *et al*., 1997; Sharma *et al*., 1999; Zhi-Ping *et al*., 2000; Chang *et al*., 1982.
Hibiscus rosa sinensis	Flowers	Rat, Mouse	Kholkute, 1977; Reddy *et al*., 1997
Malviscus conzatti	Flowers	Rat	Chakraborty and Pakrashi, 1991
Martynia annua	Root	Rat	Mali *et al*., 2002
Mentha arvensis	Leaves	Mouse	Sharma and Jacob, 1996, 2001
Melia azadarach	Leaves	Rat	Choudhary *et al*., 1990
Milltia auriculata	Leaves	Rat	Choudhary *et al*., 1990
Mondia whitei	Root bark	Rat	Watcho *et al*., 2001
Myrica rubra	Bark	Rat	Matsuda *et al*., 2001
Ocimum sanctum	Leaves	Rat	Khanna *et al*., 1986
Pentadiplandra brazzeana	Root	Rat	Kamtchouing *et al*., 2002
Piper betle	Leaf stalk	Rat, Mouse	Adhikary *et al*., 1989; Chaterjee *et al*., 1994; Sarkar *et al*., 2000
Quassia amara	Stem	Rat	Nair *et al*., 1995; Raji and Bolarinwa, 1997
Sapindus emarginatus	Fruit	Rat	Ahmed and Garg, 1998
Sacrostemma acidum	Stem	Rat	Verma *et al*., 2002
Solanum xanthocarpum	Seeds, Beries	Rat, Dog, Monkdy	Rao, 1988; Dixit and Gupta, 1982; Dixit *et al*., 1989
Stephania hernandifolia	Leaves	Rat	Ghosh *et al*., 2002
Terminalia catappa	Seeds	Rat	Ratnasooriya and Dharmasiri, 2000;
Trigonella foenum graecum	Whole plant	Rat	Bansal *et al*., 1997
Tripterygium wilfordii	Whole Plant	Rat	Ma and yang, 1993; Zhen *et al*., 1995
Vinca rosea	Leaves	Mouse	Murugavel and Akbarsha, 1991
Vitex negundo	Seeds	Dog	Bhargava, 1989
Withania Somnifera	Root	Rat	Ilaperuma *et al*., 2002
Zingiber officinale	Rhizome	Rat	Kamtchouing *et al*., 2002.

The alcohol extract of the seeds of *Abrus precatorious* was administered to rats for 60 days, resulted in lowered sperm motility in cauda epididymis and caused decapitation, acrosomal damage and formation of bulges on midpiece

The seed oil of *Azadirachta indica* when injected at single dose into the vas deferens of the rat showed an antifertility response throughout 8 months and also reported to have antispermatogenic properties (Purohit and Dixit, 1991;

the same plant also showed antispermatogenic and antiandrogenic properties, and gradual recovery after withdrawal (Aladakatti and Ahamad, 1999; Aladakatti *et al*., 2001; Joshi *et al*., 1996).Palmitine hydroxide a compound isolated from the roots of *Berberis chitria* produced significant antifertility activity in dogs by impairment of primary and secondary spermatocytes and elongated spermatids (stages IV–VIII). The primary and secondary spermatocytes were reduced by 60% and 68% respectively, and elongated spermatids were decreased by 58%. The production of immature and mature Leydig cells decreased by 66% and 27% respectively. The antispermatogenic action of palmitine hydroxide may be mediated by disturbances in Leydig cell function (Gupta and Dixit, 1989).An ethanolic extract of *Bambusa arundinacea* tender shoots (BASE) has reduced the fertility index in male rats. The number of cohabited females being successfully inseminated was reduced especially after 4 days of treatment. Complete recovery of mating behaviour was evident 8 days after BASE withdrawal (Vanithakumari *et al*., 1989).

Oral administration of root extract of *Barleria prionitis* to male rats decreased the number of spermatids by 73.6% and proleptotene spermatocytes by 42%. The extract reduced the fertility of male rats by 100% (Gupta *et al*., 2000).

The contraceptive efficiency of an aqueous and chloroform extract of *Carica papaya* seeds found to be reversible in nature without influencing toxicological profile and libido in rats and rabbits (Lohiya and Goyal, 1992, Lohiya *et al*., 1994, 1999, 2000). The benzene chromatographic fraction of the chloroform extract of the seeds of *C. papaya* showed suppression of cauda epididymal sperm motility with decrease in sperm count, viability and increase in the percent abnormal spermatozoa (Pathak *et al*., 2000). Administration of benzene chromatographic fraction of chloroform extract of the seeds of *C. papaya* to human resulted in instant fall in the sperm motility. Scanning and transmission electron microscopy revealed deleterious changes in the plasma membrane of the head and mid piece of spermatozoa. The effects were spermicidal but not spermiostatic as revealed by the sperm revival test (Lohiya *et al*., 2000). The administration of chloroform extract of *C. papaya* seeds to langur monkey, resulted in inhibition of sperm motility, decrease in sperm viability and increase in sperm abnormality. Treatment withdrawal resulted in a gradual recovery in these parameters. Hematology and serum biochemistry study disclosed no significant toxicological effect and the serum testosterone level was not affected (Lohiya *et al*., 2002).Oral administration of *Catharanthus roseus* Linn. leaf extract caused widespread testicular necrosis, hyalinization of tubules and scrotal cell-only-syndrome. Biochemical studies revealed notable reduction in glycogen and fructose levels in reproductive tissues (Mathur and Chandan, 1985).The treatment of aqueous suspension of roots of *Cichorium intybus* and ethanolic leaf extract of *Colebrokia oppositifolia* showed notable depression of spermatogenesis in mice and rats (Ray and Bhatt, 1996, Gupta *et al*., 2001).The root extract of the *Echinops echinatus* administered to rats showed significant decrease in the weight of testes and accessory sex organs. Sperm motility and density were also reduced. The concentration of protein, sialic acid, also decreased (Chaturvedi *et al*., 1995).Powdered berries of *Embelia ribes* administered to bonnet monkeys affected the quantity and quality of semen. Testosterone level was also decreased. LH levels were however not affected (Purandare *et al*., 1979).

Administration of purified gossypol acetic acid alone or in combination with potassium chloride, to male langurs for 120 days, resulted in severe oligospermia with impairment of sperm motility. Complete reversal of these changes was noted after 90 to 105 days of withdrawal of treatment (Lohiya *et al*., 1990, Kumar *et al*., 1997). Scanning electron microscopy of spermatozoa indicated abnormalities in the head and neckpiece. Testicular morphology following gossypol exposure resulted in the decrease in seminiferous tubular diameter and arrest of spermatogenesis (Sharma *et al*., 1999). The treatment of gossypol to male volunteers decreased the sperm density and motility. After cessation of drug administration the sperm data returned to pretreatment levels (Zhi-Ping *et al*., 2000).Benzene, chloroform and alcohol extracts of *Hibiscus rosa sinensis* administered to adult rats and mice showed significant reduction in the number of spermatogonia, spermatocytes and spermatids and also cauda epididymal sperms (Kholkute *et al*., 1977; Reddy *et al*., 1997). Flower extract of *Malvaviscus conzatti* has showed antispermatogenic activity in male rats (Chakraborty and Pakrashi, 1991).Chronic administration of ethanol extract of *Martynia annua* root to male rats resulted in reduced testicular sperm count, epididymal sperm count and motility. The spermatogenesis arrested at the secondary spermatocyte stage and Leydig cells were atrophied (Mali *et al*., 2002).Oral administration of aqueous and petroleum ether extract of leaves of *Mentha arvensis* showed a dose and duration dependent reduction in spermatogenic elements in mice (Sharma and Jacob, 1996, 2001). Chronic administration of *Mondiawhitei* root bark extract showed antispermatogenic activity in rats (Watcho *et al*., 2001).The feeding of *Ocimum sanctum* leaves to male rats, decreased sperm count, sperm motility and the weight of male reproductive organs (Khanna *et al*., 1986). Chronic administration of the extract of the stalk of *Piper betle* showed antispermatogenic activity in male rats (Adhikary *et al*., 1989; Chaterjee *et al*., 1994).Quassia and 2-menthony canthin-6-one compounds isolated from *Quassia amara* stem wood produced significant antifertility by inhibiting both the based and LH stimulated testosterone secretion of rat Leydig cells (Nair *et al*., 1995; Raji and Bolarinwa, 1997).Purified fraction of saponin containing emerginatosides B and C isolated from the pericarp of fruit of *Sapindus emerginatus* showed decreased motility of cauda epididymal spermatozoa and sperm concentration, after 45 days (Ahmed and Garg, 1998).Oral administration of methanol extract of *Sarcostemma acidum* stem to male rats showed reduced sperm motility as well as sperm density. No significant change in RBC and WBC count, haemoglobin, haematocrit, sugar and urea in the whole blood were observed. The protein and glycogen content of the testes and fructose of the seminal vesicle were significantly decreased.The number of primary spermatocytes, secondary spermatocytes and spermatids were also reduced (Verma *et al*., 2002).Extracts of seeds of *Solanum xanthocarpum* have shown

Solasodine ($C_{27}H_{43}O_2N$) compound isolated from *S. xanthocarpum* berries administered to dogs caused testicular lesions resulting in a severe impairment of spermatogenic elements. The epididymis was devoid of spermatozoa (Dixit and Gupta, 1982). The same compound was administered to rhesus monkey resulted decrease in spermatids by 69% (Dixit *et al*., 1989).

Aqueous extract of *Stephania hernandifolia* leaf administered to male rats, resulted in significant reduction in the weight of testis and accessory sex organs without any significant change in the liver and kidney weight. Activity of testicular steroidogenic key enzymes and plasma testosterone level were decreased, along with a significant reduction in the number of germ cells at stage VII of the spermatogenic cycle and in the seminiferous tubular diameter (Ghosh *et al*., 2002).International and national collaborations aimed to test five subfractions of the materials isolated from *Tripteryigium wilfordi*, viz, triptolide, tripdiolide, triptolidenol, trichlorolide, 16 – hydronytriptolide on male antifertility. All these compounds act mainly on metamorphosing testicular spermatids and epididymal spermatozoa (Ma and yung, 1993; Zhen *et al*., 1995).Aqueous leaf extract of *Vinca rosea* have reported to have antispermatogenic activity in rats (Murugavel and Akbarsha, 1991). The flavonoid-rich fraction (5,7,3'-trihydrony, 6,8,4-trimethony flavones) of *Vitex negundo* seeds administered to dogs resulted in disruption of the latter stage of spermatogenesis. The epididymis was devoid of spermatozoa. Protein, sialic acid and RNA contents of the testis and epididymis were reduced (Bhargava, 1989).

Conclusion

These selected plants showed potential antifertility activity both in males and females without noticeable side effects and can be used for fertility regulation. But it is important to find out the mechanism of action and clinical research on few selected plants.

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