Review Article

Screening of Plants for Rodent Control: Review

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ABSTRACT

To meet the demands of ever-increasing human population which is thought to reach about 9.6 billion by 2050, it becomes necessary to develop and apply a promising alternative for rodent control as they are the reservoirs and vectors of various transmissible diseases and destroy the agricultural produce and cause economic loss. Rodent problem is due to their high rate of reproduction and greater adaptability. This review presents updated information about the plants and their extracts that can disturb estrous cycle by prolonging or reducing any particular phase in female rodents and can decrease their reproductive potential. It contributes innovative information for researchers to further develop non-toxic baits that can reduce the rodent population and therefore can reduce agricultural loss.

Keywords: Rodents, Fertility, Estrous cycle, Medicinal plants, Plant extracts.

INTRODUCTION

One of the major problems globally faced is the ever increasing human population that affects growth and economy of every country. Studies reported that there will be about 9.6 billion individuals by 2050 and up to 11 billion or more by 2100. There's an 80 percent chance that the actual number of people in 2100 may be between 9.6-12.3 billion.[1,2]

India being the heavily populated agriculture based country, the greatest impact is on agriculture to grow enough food sustainably for growing population and protect the food from vertebrate pests. Rodents are the most destructive vertebrate pests of agricultural produce like standing crops, stored food, poultry farm etc. They destroy growing crops before harvest and also damage the harvested crops by infestation.[3] Every year they inflict about 5-10 percent damage in different crops in India.[4] Rodents are implicated as reservoir and vectors of various transmissible diseases such as plague, leptospirosis, typhuses and rickettsiae, food-poisoning, leshmaniasis, dengue and lassa fevers, etc.[5,6] They may gnaw at water pipes (resulting in leakage and wastage of water), fabric of buildings and insulating materials causing electrical installations to be out of order and create fire hazards.[7,8]

Rodent problem is in fact due to their high rate of reproduction, complex behavior and ability to adapt under diverse ecological conditions prevailing in India. They exhibit short gestation period (12-47 days), short estrous cycle (4-7.4 days), large litter size (2-15 young ones/ litter / female) and high rate of animal productivity.[9] It has therefore, become imperative to develop and apply various types of rodent management strategies. In rodent control programme, population reduction through chemicals (rodenticides) remains the only practicable approach.[10] Two basic approaches have been adopted for the use of rodenticides in crop fields. First approach includes prophylactic treatment which breaks the natural cyclicity of rodents and the growth of their local population before damage occurs. The second approach includes the symptomatic treatment i.e; to kill the rodents which begin to threaten the crop.[4] Here it is noteworthy, not to completely eradicate them as they have an important place in the ecosystem and consume various insects, weed seeds and a variety of other items which is very essential to man's agriculture and public health.[11]

Indiscriminate use of persistent and toxic rodenticides has created serious problems like rodenticide resistance and increased environmental and social costs. So, it becomes necessary to develop and apply a promising alternative for the control of rodent's i.e; the use of biologically active substances of plant origin which are considered ecologically and environmentally safe and can interfere with the natural patterns of reproduction rather than to control fully grown and established species.

India has a vast resource of natural products and there is a considerable scope for developing new and improved fertility regulating agents of plant origin to meet the needs of rodent control.[12] Many plants have been used as pesticides by humans since ancient times. These plants are known to possess alkaloids that are considered secondary metabolites of plant origin with known or unknown phytoconstituents that may significantly inhibit fertility by adversely affecting reproductive processes either directly/indirectly ranging from gonadal function, gametogenesis, gestation and development, estrous cycle.[13]

Estrous cycle is exhibited by rodents and consists of 4 phase's diestrous, proestrous, estrous and metestrous. These stages are observed under the microscope by

taking the vaginal smears at regular intervals.[14] A diestrous phase will show many leucocytes indicating quiescent uterus and resting vaginal epithelium. Proestrous phases have many epithelial cells with granular cytoplasm indicating rapidly growing vaginal epithelium and also the preovulatory stage. Estrous phase is characterized by large, irregular cornified cells indicating maximum growth of vaginal mucosa. A metestrous phase have few cornified cells some leucocytes and few epithelial cells indicative of post ovulatory stage and desquamation of the vaginal mucosa. This shift in the number of cell types in smears is primarily governed by synthesis of ovarian estrogens under the influence of pituitary gonadotropins.[15] A correspondence between the appearance of vaginal smears and the layers of the epithelium from which the cells had desquamated, was established in the normal rats during estrous cycle.[16]

OBJECTIVE

The main purpose of this review is to summarize the plant extracts (1966-2015) worldwide that affect the rodent reproductive behavior (Table 1). It contributes innovative information for researchers to further develop non-toxic baits that can control rodents and can prevent agricultural damage and economic loss.

DISCUSSION AND CONCLUSION

Regular cyclicity is an index of proper functioning of neuroendocrine-reproductive system and ovarian activity, whereas loss of cyclicity indicates disruption of ovarian progesterone and estrogen balance.[17] So, estrogenic (phytoestrogens) and anti-estrogenic compounds present in the plant extracts can affect the circulating levels of hormones and pituitary gonadotropins and can cause fertility loss.[18,19]

The review ([Table 1) presents updated information gathered on scientifically proved medicinal plants that are responsible for events occurring in the vaginal epithelium of rodents that can disrupt the ovarian functions and estrous cycle.

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Table 1: List of plants and their extracts interfering with the estrous cycle of rodents

Plant	Family	Extract/ part used	Mode of Administration/ Animal Model	Effect on estrous cycle	Reproductive activity	Ref.
Acacia catechu (L.f.) Willd, Acacia Arabica Mill., Tragia involucerta Linn.	Fabaceae Fabaceae Euphorbiaceae	Shanti Bori, a traditional contraceptive pill	Oral/Rat	No alteration in estrous cycle	Antifertility	20
Achrostichum aureum Linn.	Ceratopteridoideae	Ethanol extract of whole plant without root (BOO2)	Oral/Rat	No alteration in estrous cycle	Anti-estrogenic	21
Achyranthes aspera Linn.	Amaranthaceae	Methanol extract of leaves	Oral (fed)/Rat	Prolonged estrous & metestrous, Reduction in diestrous, Prolonged cycle	Antifertility Contraception	22
Aformosia laxiflora Benth. ex Bak.	Leguminosae	Extract of stem & bark	Oral/Rat	Blockade at diestrous (prolonged diestrous)	Anti-estrogenic	23
Anethum graveolens L. (dill)	Apiaceae	Aqueous & ethanol extract	Oral (fed)/Rat	Prolonged diestrous, Significant increase in duration of cycle	Antifertility	24
Angelica sinensis (Oliv.) Diels.	Apiaceae	Standardized ethanol extract of root	Oral/Rat	Prolonged estrous, Reduction in regular cyclicity	Estrogenic	25
Aristolochia indica Linn.	Aristolochiaceae	Aristolic acid	Oral/Mice	Prolonged diestrous	Anti-estrogenic Anti-implantation	26

Artobotrys odoratissimus Roxb.	Annonaceae	Ethanol & benzene extract of green leaves	Oral/Rat	Increase in diestrous, Decrease in estrous	Ethanol extract – weak estrogenic & antiestrogenic, Benzene extract – Strong antiestrogenic	27
Artobotrys odoratissimus Roxb.	Annonaceae	Benzene, alcohol & water extracts of leaves	Oral/Rat	Prolonged diestrous	Antifertility Anti-implantation	28
Aspilia Africana (Pers.) C.D. Adams	Compositae	Methanol extract of leaves	Oral/Rat	Prolonged diestrous, Reduced proestrous, estrous & metestrous	Anti-implantation Anti-estrogenic	29
Aspilia Africana (Pers.) C.D. Adams	Compositae	Aqueous extract of leaves	Oral/Rat	Prolonged proestrous, Reduced diestrous & estrous	Antifertility Anti-ovulatory	30
Avicennia alba Blume.	Acanthaceae	Methanol extract of aerial parts	Oral/Rat	Prolonged estrous	Estrogenic	31
Azadirachta indica A. Juss	Meliaceae	Ethyl alcohol extract of air dried powdered leaves	Oral/Rat	Prolonged estrous, Reduced metestrous & diestrous, Completely abolished proestrous	Estrogenic	32
Azadirachta indica A. Juss	Meliaceae	Leaf extract	Per os (Oral)/Rat	Absence of estrous stage	Anti-estrogenic	33
Azadirachta indica A. Juss	Meliaceae	Alcoholic extract of flowers	Oral/Rat	Prolonged diestrous	Antifertility	34
Azadirachta indica A. Juss	Meliaceae	Hexane and methanol fractions of seed extract	Oral/Rat	Reduced proestrous	Anti-estrogenic Antifertility Anti-implantation	35
Balanites roxburghii Planch.	Balanitaceae/Zygophyllaceae	Ethanol extract of fruits	Oral/Rat	Predominantly Estrous & proestrous	Antifertility Abortifacient Mild estrogenic Contraceptive Non-toxic	36
Bougainvillea spectabilis Willd.	Nyctaginaceae	Aqueous crude extract of leaves	Oral/Mice	Irregular & disturbed estrous cycle, Prolonged metestrous, Prolonged cycle by 1-2 days	Antifertility Anti-estrogenic	37
Blumea balsamifera (Linn.). DC.		Water extract of roots, shoots, stem & leaves	Oral (gavage)/Mice	Prolonged estrous & proestrous	Antifertility Anti-implantation Estrogenic	38
Bupleurum marginatum Wall ex DC	Apiaceae	Ethanol extract of sipil	Oral/Rat	Irregular cycle, Prolonged metestrous, Reduced estrous & diestrous	Abortifacient Anti-implantation Anti-estrogenic	39, 40

Butea frondosa Roxb. ex Willd.	Fabaceae	Alcoholic extract of dried seeds	Oral/Rat, Mice	No alteration in estrous cycle	Antifertlity Anti-implantation Anti-estrogenic Abortifacient Non-teratogenic	41
Butea superba Roxb.	Fabaceae	Crude extract	Oral/Rat	Prolonged diestrous	Androgenic Anti-estrogenic	42
Caesalpinia decapetala (Roth) Alston	Fabaceae	Crude ethanol extract of aerial parts	Oral/Golden Hamster	No alteration in estrous cycle	Antifertility	43
Cannabis sativa Linn.	Cannabaceae	Crude preparation of flowering tops, leaves, seeds & stems	Intra-peritoneal/Gerbil	Prolonged diestrous	Antifertility	12, 44
Calotropis procera (Ait) R. Br.	Asclepiadaceae	Ethanol & aqueous extract of root	Oral/Rat	Prolonged diestrous	Anti-estrogenic	45
Carica papaya Linn.	Caricaceae	Fruits-ripe, unripe; seed; crude papain mixed with or without normal chow	Oral (fed)/ Rat	Prolonged diestrous	Antifertility Anti-estrogenic	46
Carica papaya Linn.	Caricaceae	Aqueous extract of ripe seeds	Oral/Rat	Prolonged diestrous	Antifertility Anti-implantation Abortifacient	47
Carica papaya Linn.	Caricaceae	Alcoholic extract of seeds	Oral/Rat	Prolonged diestrous	Antifertility	48
Carum carvi Linn.	Apiaceae	Aqueous & ethanol extract of seeds	Oral/Rat	Blockage of estrous	Antifertility	49
Cissampelos pareira Linn.	Menispermaceae	Methanol extract of leaves	Oral/Mice	Prolonged diestrous	Antifertility	50
Cnidoscolous aconitifolius (Miller) I.M. Johnston	Euphorbiaceae	Aqueous extract of leaves	Oral//Rat	Irregular estrous cycle	Infertility Contraceptive	51
Cola nitida Schott & Endl.	Malvaceae	Extract of stem & bark	Oral/Rat	Blockade at diestrous (prolonged diestrous)	Anti-estrogenic	23
Corchorus olitorius Linn.	Malvaceae	Methanol extract of seeds	Oral/Mice	Prolonged diestrous	Antifertility Anti-steroidogenic	52
Couroupita guianensis Aubl.	Lecythidaceae	Benzene, alcohol & water extracts of bark	Oral/Rat	Prolonged diestrous	Antifertility Anti-implantation	28
Couroupita guianensis Aubl.	Lecythidaceae	Benzene, alcohol & water extracts of flowers	Oral/ Rat	Prolonged diestrous	Antifertility Anti-implantation	28

Crotalaria juncea Linn.	Papilionaceaea	Ethanol extract of seeds	Oral/Rat	Prolonged estrous & metestrous Reduced diestrous & proestrous	Antiovulatory Estrogenic	53
Croton tiglium Linn.	Euphorbiaceae	Water extract of roots, shoots, stem & leaves	Oral (gavage)/Mice	Prolonged estrous phase	Antifertility Anti-implantation Estrogenic	38
Curculigo orchioides Gaertn.	Amaryllidacea	Alcoholic extract of rhizomes	Oral/Rat	Prolonged estrous phase	Estrogenic	54
Curcuma longa Linn.	Zingiberaceae	Aqueous & ethanol extract of rhizome	Oral/Rat	Blockage of estrous	Antifertility	49
Cuscuta reflexa Roxb.	Cuscutaceae	Methanol extract of stem	Oral/Mice	Prolonged diestrous	Antifertility Anti-steroidogenic	52
Cynodon dactylon (Linn.) Pers.	Poaceae	Aqueous extract of whole plant	Oral/ Rat	Prolonged diestrous, Reduced proestrous, estrous & metestrous	Antifertility	55
Dissotis rotundifolia (Sm.)Triana	Melastomataceae	Ethanol extract of leaves	Oral (gavage)	Prolonged diestrous Reduced estrous & proestrous	Antifertility	56
Dolichandrone falcate Seem.	Bignoniaceae	Alcoholic & aqueous extract of leaves	Oral/Rat	Prolonged diestrous	Antifertility Abortifacient Non-toxic	19
Embelia ribes Burm.	Myrsinaceae	Embelin extracted from powdered berries	Oral/Rat	Prolonged diestrous	Antifertility	57
Fagraea racemosa Jack ex Wallich.	Loganiaceae	Water extract of roots, shoots, stem & leaves	Oral (gavage)/Mice	Prolonged estrous phase	Antifertility Anti-implantation Estrogenic	38
Ferula alliaceae Boiss	Apiceae	Byakangelicin extracted from fruits	Intra-muscular / Rat	Prolonged estrous	Antifertility	58
Ficus asperifolia Miq.	Moraceae	Dried fruits extract & aqueous extract	Per os (oral)/Rat	Normal estrous cycle, Prolonged estrous & proestrous	Pro-implantation Pro-development Uterotrophic Uterotonic	59
Garcinia kola Heckel	Guttiferae	Seed extract	Oral/ Rat/	Prolonged diestrous	Anti-ovulatory Teratogenic	60
Garcinia kola Heckel	Guttiferae	Methanol extract of seeds	Intra-peritoneal/Rat, Mice	Prolonged estrous	Uterotrophic Weak estrogenic Anti- conceptive	61
Gossypium spp. Linn.	Malvaceae	Gossypol- a phenolic compound	Sub-cutaneous/ Rat	Prolonged diestrous & metestrous, Reduced proestrous & estrous	Impair fertility Anti-steroidogenic	62
Hibiscus rosa sinensis Linn.	Malvaceae	Benzene extract of flowers	Oral/ Rat	Prolonged diestrous	Antifertility Anti-implantation	15

Hymenocardia acida Tul.	Phyllanthaceae	Ethanol extract of stem bark	Oral/Rat	Prolonged diestrous & estrous, Reduced proestrous & metestrous, Prolonged irregular cycle, Loss of cyclicity	Antifertility Anti-implantation	63
Indigofera trifoliate Linn.	Fabaceae	Aqueous extract of leaves	Intra gastric(i.g.)/ Rat	Prolonged diestrous Reduced proestrous & estrous Irregular pattern Prolonged estrous cycle	Anti-implantation Contraceptive Abortifacient Estrogenic	64
Jatropha curcas Linn.	Euphorbiaceae	Aqueous extract of seeds	Oral/Guinea pig	Prolonged diestrous, Reduced estrous	Antifertility	65
Leptadenia reticulata Wight & Am.	Asclepiadaceae	Ethanol extract of whole plant	Oral/ Rat	Prolonged estrous phase	Anti-implantation Uterotrophic Estrogenic	66
Malvaviscus conzatti Greenm.	Malvaceae	Ethyl alcohol extract of flower	Oral/Gerbil	Prolonged diestrous	Antifertility	12
Metroxylon sagu Rottb.	Arecaceae	Water extract of roots, shoots, stem & leaves	Oral (gavage)/Mice	Prolonged estrous, proestrous & later metestrous	Antifertility Anti-implantation Estrogenic	38
Melia azedarach Linn.	Meliaceae	Dry hydoalcoholic extract of root	Per os (oral)/Rat	Absence of Vaginal cornification i.e estrous	Antifertility	67
Melia azedarach Linn.	Meliaceae	Methanol fraction of seeds Hexane fraction of seeds	Oral/ Rat	Appearance of two or more successive stages, no significant alteration in estrous cycle	Antifertility Anti-implantation Abortifacient Anti-estrogenic	68 ,69
Mimosa pudica Linn.	Fabaceae	Methanol extract of air-dried root	Oral/Mice	Prolonged diestrous, Prolonged estrous cycle	Antifertility	70
Momordica cymbalaria Hook. f.	Cucurbitaceae	Ethanol extract of root	Oral/Rat	Reduced estrous	Anti-implantation Antifertility	71
Nicotiana tabacum Linn.	Solanaceae	Nicotine	Intra-peritoneal/Rat	Prolonged diestrous & metestropus, Reduced proestrous & estrous, Prolonged cycle	Anti-estrogenic Anti-steroidogenic	72
Nigella sativa Linn.	Ranunculaceae	Hexane extract of seeds	Oral/Rat	Prolonged estrous	Antifertility Anti-estrogenic Contrceptive Weak uterotrophic	73
Ocimum sanctum Linn.	Lamiaceae	Powdered shade dried leaves & soft stem	Oral (fed)/Rat	Prolonged cycle by 5-10 days, prolonged estrous	Antifertility	74
Ocimum sanctum Linn.	Lamiaceae	Extract of fresh leaves	Oral/Rat	Prolonged diestrous	Lordosis quotient L.Q. (reproductive behavior) least	75

					during diestrous, L.Q. maximum during proestrous followed by estrous and metestrous	
Parkia platycephala Benth.	Fabaceae	Ethanol extract of leaves	Oral/Rat	Prolonged diestrous, Reduced proestrous, Other stages not altered	Reproductive toxicity, Anti-estrogenic	76
Pergularia daemia (Forssk.) Chiov.	Apocynaceae	Alkaloid fraction of stem & leaves	Oral/Mice	No alteration in estrous cycle	Antiestrogenic Antizygotic Antiblastocytic Antifertility	77
Pergularia daemia (Forssk.) Chiov.	Apocynaceae	Steroidal fraction of ethanol extract of dried powder of stem & leaves	Oral/Mice	Prolonged diestrous	Antifertility Anti-implantation	78
Piper longum Linn.	Piperaceae	Benzene & chloroform extract of fruits	Oral/Rat	Prolonged diestrous by 5-10 days	Antifertility Anti-estrogenic	79
Piper betle Linn.	Piperaceae	Crude extract of stalk	Oral/Rat	Prolonged diestrous	Antifertility Anti-estrogenic	80, 81
Piper betle Linn.	Piperaceae	Ethanol extract of petiole	Oral/Rat	Irregular, Prolonged cycle	Antifertility Anti-estrogenic	82
Piper betle Linn.	Piperaceae	Methanolic extract of stalk	Oral/Rat	Decreased estrous, No significant change in proestrous, metestrous & diestrous	Antifertility	83
Plumbago rosea Linn.	Plumbaginaceae	Acetone extract of stem	Oral/Rat	Prolonged diestrous	Antiovulatory Antifertility Estrogenic Antiestrogenic	84
Plumbago zeylanica Linn.	Plumbaginaceae	Acetone extract of stem	Per os (oral)/Rat	Prolonged diestrous, Reduced estrous & metestrous, Prolonged estrous cycle	Antifertility Anti-ovulatory Anti-estrogenic Estrogenic	85
Plumbago zeylanica Linn.	Plumbaginaceae	Acetone & ethanol extract of leaves	Oral/Rat	Prolonged diestrous	Antifertility Anti-ovulatory	86
Plumeria rubra Linn.	Apocynaceae	Ethanol extract of pods	Oral/ Rat	Prolonged diestrous Prolonged estrous cycle	Antifertility	87
Podocarpus brevifolius Stapf Foxw.	Podocarpaceae	Chloroform extract of leaves	Oral/ Rat	No alteration in estrous cycle	Antifertility	88
Podocarpus brevifolius Stapf Foxw.	Podocarpaceae	Petroleum ether extract of leaves	Oral/Rat	Prolonged diestrous	Antifertility	88

Portulaca oleracea Linn.	Portulacaceae	Chloroform extract of dried aerial parts	Oral/Rat	Prolonged diestrous, Prolonged cycle	Antifertility Anti-ovulatory	89
Portulaca oleracea Linn.	Portulacaceae	Extract of dried aerial parts	Oral/Rat	Irregular estrous cycle	Antifertility Anti-implantation Abortifacient	89
Pterocarpus erinaceus Poir.	Leguminosae	Extract of stem & bark	Oral/Rat	Blokade at diestrous (prolonged diestrous)	Anti-estrogenic	23
Rhynchosia sublobata (Schumach) Meikle	Leguminosae	Ethanol extract of leaves	Oral/Rat	Prolonged estrous & proestrous Reduced metestrous & diestrous	Antifertility	90
Ricinus communis var. minor Linn.	Euphorbiaceae	Ether –soluble fraction of methanol extract extract of seeds	Sub-cutaneous/Rat, Rabbit	Prolonged estrous & proestrous, Reduced diestrous	Anti-conceptive Anti-implantation Estrogenic	91
Rivea hypocrateriformis Desr. Ex. Lam.	Convolvulaceae	Ethanol extract (?)	Oral/Rat	Prolonged proestrous, Reduced estrous & metestrous	Uterotrophic Anti-steroidogenic Anti-ovulatory	92
Rumex steudelii Hochst.	Polygonaceae	Methanol extract of root	Oral/Rat	Prolonged diestrous, Prolongation of estrous cycle	Antifertility Contraceptive	93
Saraka indica Linn. (10%), Symplocos racemosa Roxb.(6.6%), Adhatoda vasika Nees. (4%), Aloe vera (Linn.) Burm. (5%), Asparagus racemosus Willd. (6.4%), Boerhaavia diffusa Linn. nom. cons. (6.4%), Bombax malabaricum DC. (2.4%), Cocos nucifera Linn. (6.4%), Tinospora cardifolia (Willd.) Miers ex Hook.f. & Thoms. (6.6%)	Caesalpiniaceae Symplocaceae Acanthaceae Liliaceae Asparagaceae Nyctaginaceae Malvaceae Arecaceae Menispermaceae	U-3107 A herbal preparation	Per os (oral)/Rat	No alteration in average length of estrous cycle	Estrogenic Non progestational	94
Senecio biafrae	Asteraceae	Aqueous extract of leaves & stem (AESb)	Oral/Rat	No change in length of estrous cycle, Slight decrease in duration of proestrous	Antifertility Anti-implantation Estrogenic	95
Sida acuta	Malvaceae	Polar and non	Oral/Rat	Prolonged estrous	Anti-implantation	96

Burm.Fl.Ind		polar solvent extract of dried seeds			Contraceptive Estrogenic	
Sida carpinifolia Linn. f.	Malvaceae	Methanol extract of whole plant	Oral/Rat	Prolonged diestrous	Antifertility	88
Sida carpinifolia Linn. f.	Malvaceae	Petroleum ether & chloroform extract of whole plant	Oral/Rat	No alteration in estrous cycle	Antifertility	88
Solanum xanthocarpum Schrad. & Wendl.	Solanaceae	Ethanol extract of fruits	Oral/Rat	Prolonged estrous stage	Moderately estrogenic	97
Thespesia populnea Corr.	Malvaceae	Crude extract of flowers	Intra-peritoneal/Mice	Prolonged metestrous	Anti-estrogenic Anti-steroidogenic	98
Trichosanthes cucumerina var.cucumerina Linn.	Cucurbitaceae	Ethanol extract of whole plant	Oral/Rat	Prolonged estrous & metestrous, Reduced diestrous & proestrous	Anti-ovulatory Non-toxic	99
Trigonella foenum graceum Linn.	Leguminosae	Trigonelline	Per os (oral) Rat/	No alteration in estrous cycle	Antifertility Anti-estrogenic Non-abortifacient Non-teratogenic	100
Wilbrandia verticillata Cogn. (Cabeca de Negro)	Cucurbitaceae	Purified fraction of rhizomes	Oral/Mice	Suppression of estrous phase	Anti-ovulatory Anti-implantation	101
Azadirachta indica A.Juss Piper longum Linn. Gossypium indicum Linn.	Meliaceae Piperaceae Malvaceae	Ethanol extract of leaves, stem ,bark Ethanol extract of fruits Methanol extract of seeds	Oral/ Rat (combination 2:1:1)	Prolonged diestrous phase	Weak estrogenic	102
Azadirachta indica A.Juss Piper longum Linn. Emblica officinalis Gaertn. Gossypium indicum Linn.	Meliaceae Piperaceae Euphorbiaceae Malvaceae	Ethanol extract of leaves, stem Ethanol extract of fruits Ethanol extract of berries Ethanol extract of seeds	Oral/ Rat (combination 1:1:1:1)	Prolonged diestrous phase	Weak estrogenic	102
Azadirachta indica A.Juss Piper longum Linn. Emblica officinalis Gaertn. Gossypium indicum Linn.	Meliaceae Piperaceae Euphorbiaceae Malvaceae	Benzene extract of leaves Solvent ether extract of berries Petroleum ether extract of seeds Petroleum ether extract of fruits	Oral/ Rat (combination 1:1:1:1)	Prolonged diestrous phase	Weak estrogenic	102

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