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Medicinal Uses of *Murraya koenigii* and *Aegle marmelos* for Fertility Augmentation in Animals: A Review

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A B S T R A C T

The hormonal therapies for the treatment of various reproductive disorders are accused to impair some neuro-endocrine and physiological activities. Besides, the residual effects of hormonal therapy in food animals and their products of public health importance seriously demands minimization of our dependence on hormones for therapeutic purposes. High cost, lack of quick assay facilities, non-availability of commercial preparations with ease and need of veterinary supervision are other limitations with use of hormones for animal fertility management/augmentation purposes. In countries like India, the validation and transferring of traditional/indigenous knowledge to the livestock raising farmers may serve indeed the livestock raisers for better farm economy. Two herbal plants namely *Murraya koenigii* and *A. marmelos* have been scientifically tested individually and in combination, for ovarian dynamic studies in rats, goats, cattle and buffaloes. These plants have been reported to be efficacious for the treatment of anoestrous, repeat breeding and endometritis.

Introduction

Ethno veterinary research has emerged as a fertile field for the generation (or regeneration) and transfer of appropriate and sustainable animal health technologies to rural and even peri-urban livestock raisers everywhere especially in the third world. Ethno veterinary practices still have significant contributions to animal health and are regarded as sustainable veterinary medicine in the new era (Lin *et al.*, 2003). The prefix 'Ethno' stands for traditional or indigenous and imbibes the knowledge passed on verbally from generation to generation. There cannot be any shadow of doubt on the poly valency of ethno veterinary medicines obtained from nook and corners of the world. The ethno veterinary practices, therefore, include all aspects of indigenous practices to prevent and treat a range of livestock diseases. As much as 90% of the world's population today still relies mainly on local ethno medicine for their health needs (Duke, 1992). Similar figures appear to hold for the livestock sector (McCorkle, 1998). Because of the cost

of random screening, perhaps only 1% of the higher plant species that have been used in ethno medicine are subjected to systemic scientific study for their therapeutic value in extract form (Farnsworth, 1983). The World Health Organization (WHO) has recognized the value and imperative need for adopting traditional herbal practices in global health care and recommended all member countries to initiate steps to conserve native medicinal plants and also emphasizes integrating indigenous health care system with modern health facilities (Dalal, 1992).

India and China are two largest countries in Asia which has richest array of medicinal plants. An herbal renaissance is blooming across the world; China is perhaps the only country of the world who has demonstrated the best use of traditional medicine in providing the best health-care to her people. The modern practices have replaced the traditional practices in some parts of the developed world (Tabuti *et al.,* 2003). In Indian subcontinent, the tradition of using plants for treating ailments is very old. India as a whole is the richest source of the medicinal plants which are distributed in almost all parts of the country (Ali, 1994) with wide variation in different climatic zones ranging from alpine to tropical region. It is significant to note that more that 90% of drugs used in traditional medicines practiced in India come from plants and 70% of modern medicines originate from natural resources and plants (Mukherjee and Wahile, 2006). It has been estimated that more than one third of the plant drugs mentioned in pharmacopeia of the world grow in state of nature in this country. Pharmaceutical companies engaged in the production of plant-based products showed around 15% of average growth rate (Kumar, 2003).

Existing hormonal therapies used for treatment of gynaecological disorders are believed by the masses to render harmful effects and are "accused" to impair some physiological activity and thus mitigates another disorders (Jadhav and Bhutani, 2005). Residual effects of hormone therapy in food animals and their products of public health importance seriously demands minimization of our dependence on hormones for therapeutic purposes. High cost, lack of quick assay facilities, non-availability of commercial preparations with ease and need of veterinary supervision are other limitations with use of hormones for animal fertility management / augmentation purposes. Herbal remedies may offer a potent alternative of hormones (Jadhav and Bhutani, 2005) and are low cost, efficacious, socially acceptable and mostly are the only available means (Reddy, 2008) with minimal side effect. Validation and transferring of traditional / indigenous knowledge to the livestock raising farmers would serve indeed the people of developing countries (Gesler, 1991).

There are two approaches to develop efficacious phytotherapies. One is phytochemical approach which emphasizes the development of pure phytochemicals as drugs. In general, it is expensive and time consuming. The second approach is phytotherapeutic approach wherein crude plant preparations, (extracts, active fractions or mixtures of them) or ayurvedic types of formulations can be used as drugs with modern standards of safety and efficacy which is cost–effective and more relevant to our conditions (Subramaniam, 2001). Plants in their crude form show combination of activities and huge potential as a source of new drug (Gilani and Rahman, 2005). The active principles of plants may be carbohydrate, glycosides, tannins, lipids and alkaloids (Ramchandran and Mehtani, 1990). Herbal combinations might exhibit significant effects as a result of synergistic or additive actions of their active principles (Ramteke *et*

al., 2008). *Aegle marmelos* (bel) and *Murraya koenigii* (curry), medicinal plants have currently drawnmany research attention for various reproductive ailments in farm animals (Mehrotra, 2002; Jondhale, 2007; Kumar, 2008, Dutt *et al.,* 2010, 2011; Kumar *et al.,* 2016; Kumawat *et al.,* 2016; Rautela *et al.,* 2017, 2018). Individually the medicinal plants *M. koenigii* (Mehrotra, 2002) and *A. marmelos* (Jondhale, 2007 and Kumar, 2008) and in combination (Dutt *et al.,* 2010; 2011; Kumar *et al.,* 2016; Baitule *et al.,* 2016) have been used to augment the reproductive function in laboratory rats and anestrus goats, cattle/buffalo.

Botanical description, chemical constituents and biological properties of *Murraya koenigii*

It is a genus of shrubs or small trees distributed from South and East Asia to Australia.

Murraya koenigii (L.) Spreng.

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Sapindales
Family: Rutaceae
Genus: *Murraya*
Species: *koenigii*

Common terminology

Tamil: Karivempu, Karuveppilei
Hindi: Kathnim, Mitha neem, Kurrypatta,
Assamese: Narsinghs, Bisharhari,
Bengali: Barsanga, Kariphulli
Gujarathi: Goranimb, KadhiLimdo
Kannada: Karibevu
Malayalam: Karriveppilei
Marathi: Karhinimb, Poospala,
Oriya: Barsan, Basango,
Punjabi: Curry patta
Sanskrit: Krishna nimba
Telugu: Karipedu

Botanical description

M. koenigii (Linn.) Spreng., (Family Rutaceae) is commonly known as curry leaf plant or Indian curry leaf plant, is a highly valued plant for its characteristic aroma and medicinal properties. Its leaves are extensively used in making curries, chutneys especially south Indian dishes. Its leaves are used to prepare curry powder which is an important export commodity of India causing handsome earning of foreign exchange to country, every year. *M. koenigii* is a deciduous aromatic shrub or small tree upto 6 m in height and 15-40 cm in diameter. It grows wild and found almost throughout India upto an altitude of 1500 m. Leaflets alternate with leaves 10-20 foliate and bark dark brown or almost black.

Major chemical constituents

Alkaloids

The leaves of *M. koenigii* yielded a number of alkaloids including koenigicine apart from koenimbine (Kureel *et al.,* 1969), cyclomahanimbine, bicyclomananimbine and mahanimbidine. The hexane extract yielded mahanimbine, girinimbine and two more alkaloids isomahanimbine and koenimbidine (Joshi *et al.,* 1970). Mahanine, an alkaloid has been isolated from the leaves of the plant and studied in detail by Fidrous (1988).

Amino acids

The free amino acids present in the leaves are asparagine, glycine, serine, aspartic acid, glutamic acid, threonine, alanine, proline, tyrosine, tryptophan, Y-amino butyric acid, phenylalanine, leucine, isoleucine and traces of ornithine, lysine, arginine and histidine (Anon, 1962).

Minerals and vitamins

The leaf extract of *M. koenigii* was found to contain 66.3% moisture,6.1% protein, 1% fat (ether extract), 16% carbohydrate, 6.4% carbohydrate and 4.2% mineral matter. It contains 810 mg calcium, 600 mg phosphorus, 3.1 mg iron, 12,600 IU carotene, 2.3 mg nicotinic acid and 4 mg Vit. C/100 g of leaf extract (Kumar *et al.,* 1999). It is evident that plant is rich source of Vit. A, calcium and phosphorus.

Biological properties

Effect of *M. koenigii* was studied on carbohydrate metabolism in rats by Khan *et al.,* (1995). It showed significant hypoglycaemic action. There was an increase in concentration on hepatic glycogen and glycogenesis and decease in glycogenolysis and gluconeogenesis.

Curry leaf as a feed supplement in rats (10% of diet for 3 months) caused reduction in total serum cholesterol, low density lipid and lipoprotein and increase in high density lipid (Khan *et al.,* 1996). Antifungal activity has been reported from essential oil of its leaves (Pandey and Dubey, 1997).

Crude ethanol extract of leaves and the chloroform soluble fraction showed promising antibacterial activity against all type of tested bacteria (Nutan *et al.,* 1998). Tender and mature leaves of the plant are reported to possess activities of enzymatic antioxidants (catalase, peroxidase and superoxidase dismutase).

This suggests that leaves would render the cell protection against oxidative damage (Padma *et al.,* 1998). Kesari *et al.,* (2005, 2007) observed the hypoglycemic effects of aqueous extract of leaves of *M. koenigii* on normal and alloxan diabetic laboratory animals.

Medicinal uses

The plant is having several curative properties in traditional therapy. The leaves, root and bark of the plant are considered tonic, stomachic and carminative (Raghunathan and Mitra, 1982) and are used in medicine. An infusion of toasted leaves is used for checking vomition. The leaves are given in the decoction with bitters as a febrifuge. The juice of root is given to the patients suffering from pain associated with kidneys (Brooker and Gajjar, 1953).

The leaves and root are bitter, acrid, cooling alexeteric, anthelmentic, analgesic, cures piles, allay heat of the body thirst, inflammation, itching, useful in leucoderma and blood disorders. The green leaves are described to be eaten raw for the cure of dysentery and when they are boiled in milk and ground, they form a good application to cure poisonous bites and eruptions (Nadkarni, 1954).

Sundersanam *et al.,* (1995) found the use of plant leaves in folk herbal medicine to promote fertility in animals. *M. koenigii* alone was equally effective in inducing fertility in anestrus buffaloes, as was in combination with mineral mixture and low dose of GnRH injection (Umashanker *et al.,* 2006). Hegde *et al.,* (2002) studied the use of *M. koenigii* for the treatment of repeat breeding in dairy animals and recorded 80% efficacy of *M. koenigii. M. koenigii* has the potential to stimulate the ovarian function in rats and encouraging treatment response in acyclic goats and cattle, in terms of estrus induction and conception (Mehrotra, 2002).

Similarly, Satheshkumar and Punniamurthy (2005) recorded that supplementation of 100g of *M. koenigii* leaves for 30 days daily in rural crossbred heifer results induction of estrus in 60% of animals with elevation in serum calcium and phosphorus concentrations.

Botanical description, chemical constituents and biological properties of *Aegle marmelos*

It is commonly found in the sub-Himalayan tract up to an altitude of 1200 m in the dry deciduous forests of central and southern India.

Aegle marmelos (L.) Spreng.

Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliophyta
Sub class: Rosidae
Order: Sapinales
Family: Rutaceae
Genus: *Aegle*
Species: *marmelos*

Common terminology

English: Golden Apple, Bengal Quince
Hindi: Bel (Bael), Belgiri, Beli
Kannada: Belpatra, Bilva, Maaluraa
Bengali: Bel (Bael)
Sanskrit: Bilva, Shivadrumaa
Tamil: Vilva Marum, Vilvama
Telugu: Bilva, BilvaPandu, Maaredu
Urdu: Bel, Bel Kham, Belgiri
Malayalam: Maaredy
Marathi: Bel (Bael), Vel
Oriya: Belo
Assamese: Bel (Bael)
Gujarati: Bel, Belli, bili

Botanical description

It is a medium-sized, deciduous tree, up to 7.5 m in height and the branches are armed with about 2.5 mm long sharp spines.

Leaves are glabrous, attenuate and trifoliate, flowers are large, greenish-white and sweet scented with numerous seeds. The ripe fruits are large and sub spherical, greenish-white with a tough woody outer coat. The roots are woody, fairly large and often curved. The bark is corky and light grey in color (Elizabeth, 2002).

Major chemical constituents

Alkaloids

The leaves contain alkaloids including aegelenine and aegeline. The roots and aerial parts contain skimmianine (Bhavan, 1992).

Anthraquinones, tannins and triterpenes

7,8-Dimethoxy-1-hydroxy-2-methylanthraquinone and 6-hydroxy-1-methoxy-3-methyl anthraquinone. The fruit contains tannic acid. The tannin content of the fruit and rind is 7-9% and 18-22% respectively. The leaves also contain condensed tannins. The roots contain β-sitosterol and lupeol (Srivastava *et al.,* 1996).

Coumarins

The fruit contains marmelosin, allo-imperation, marmelide and psoralen and the roots umbelliferone, psoralen, xanthotoxin, dimethoxycoumarin, scopoletin. The heartwood yields α-xanthotoxol-8-O-β-D-glucoside and the seeds contain luvangetin (Bharthakur and Arnold, 1989).

Biological properties

Ponnachan *et al.,* (1993) reported that active principles in *A. marmelos* leaves extract have similar anti-hyperglycaemic activity to insulin treatment in alloxan induced diabetic rats. Leaf extract of *A. marmelos* also helps in the regeneration of damaged pancreas (ß-cells) in diabetic rats (Das *et al.,* 1996). 75% methanol extract of leaves of *A. marmelos* is found to reduce blood sugar in alloxan diabetic rats (Sabuand Kuttan, 2004). Aqueous and alcoholic extracts of leaves given orally

produced significant hypoglycaemia in normal fasted rabbits, but not the petroleum ether extract. Aqueous extract showed cardiac stimulant, smooth muscle relaxant and uterine stimulant properties (Ayushveda.com).Kesari *et al.*, (2006) reported the hypoglycemic and anti-hyperglycaemic activity of *A. marmelos seed* extract in normal and diabetic rats. The leaf of the *A. marmelos* plant also has hepatoprotective effect (Singanan *et al.*, 2007).

Medicinal uses

It is used in reproductive disorders like miscarriage, retention of the placenta, repeated estrus in cows and buffaloes, vaginal haemorrhages, orchitis and in addition, milk fever etc. The fruits, leaves, roots and bark are used in folk veterinary medicine to treat wounds, burns, poisoning and disorders of the digestive systems including dysentery, enteritis and intestinal lesions, tympanitis and for flat and thread worms (Elizabeth, 2002). Leaves are used for the induction of estrus in large animals (Koradia, 1995). Effect of *A. marmelos* in rats was examined by Jondhale (2007), who reported that it significantly advances onset of puberty and results in higher ovarian and uterine weight, increased large surface follicles and number of ovulations. Kumar (2008) recorded enhanced fertility in anestrus goats and buffaloes upon treatment with *A. marmelos* leaves.

Potency has been tested for *in-vitro* antibacterial effect against a number of Gram positive and negative bacteria obtained from pure laboratory culture (Abirami *et al.*, 2014, Yesaswini *et al.*, 2014) coincidentally reported to be associated with bacterial endometritis in cattle (Bhat *et al.*, 2014).

Table.1 *In- vitro* antibacterial activity of different extracts of *A. marmelos* and *M. koenigii* against various bacteria isolated from endometritic cows

Organism	Zone of inhibition(mm)						Ciprofloxacin
	Aqueous extract			Ethanolic extract			
	AM	MK	AM+MK	AM	MK	AM+MK	
***Bacillus* spp.**	6	8	10	10	12	14	22
***Corynebacterium* spp.**	-	6	9	10	14	13	20
E. Coli	-	6	10	9	11	14	26
***Staphylococcus* spp.**	6	7	13	10	17	16	26
***Salmonella* spp.**	-	-	-	4	7	9	18

AM: *A. marmelos* extract; MK: *M. koenigii* extract; AM + MK, *A. marmelos and M.koenigii* extracts incombination

Clinical uses of *Murraya koenigii* and *Aegle marmelos* in fertility augmentation

Ovarian dynamics in rodents

The oral administration of methanolic extracts of *M. koenigii*@500 mg/kg b.w. advanced the age of attainment of puberty, relative ovary and uterus weight and the number of ovarian surface follicles in female Wistar albino rats from 20 to 70 days of age. The significant advancement in the mean age of attainment of puberty was observed along with increase in number of surface follicles on both the ovaries attributed due to the effects of phytoestrogens present in the methanolic extracts of *M. koenigii* (Nandini *et al.*, 2010).

The effect of 50% ethanolic extract of *A. marmelos* was examined on the onset of puberty in rats at three dose levels i.e. 100, 300 and 1000 mg/kg b.w. based on LD50

studies. Extracts were administered orally from day 26 to 35 of age and induction of vaginal opening was used as an index of puberty and a significantly earlier onset of puberty was recorded (Jondhale *et al.,* 2009a). Similarly, 50% ethanolic extracts of *A. marmelos* @1000 mg/kgb.w. in same age group of rats resulted in significantly higher uterine weight, large surface follicles and serum estrogen concentrations. The number of ovulations and serum progesterone concentration recorded in treated animals also depicted favourable effect of plant extract. It may be concluded that *A. marmelos* has potential to positively influence the ovarian function in rats (Jondhale *et al.,* 2009b).

Anestrous

In a study, Dutt *et al.,* (2010) with *M. koenigii* and *A. marmelos* combination treatment in acyclic goats reported induction of estrus in 85.71% (6/7) animals at a mean interval of 5.33±0.60 days after end of treatment (9 days) out of which 83.33% (5/6) conceived in same estrus. The duration of estrus in responded does in control and treatment group was recorded as 24 and 16.0±1.73 hours, respectively. *M. koenigii* treatment alone resulted in expression of estrus in 50% (3/6) of anestrous goats on 18.66±2.18 days from end of treatment with 100% ovulation rate (Mehrotra, 2002). On the other hand, Kumar (2008) recorded estrus induction in 57.14% (4/7) acyclic goats after treatment with *A. marmelos* with a period of 6±1.15 days following end of treatment and conception in all the animals. Treatment with *M. koenigii* and *A. marmelos* combination led to induction of estrus comparatively at shorter interval of time. The induction of estrus with *M. koenigii* and *A. marmelos* combination was higher as compared to individually *M. koenigii* (Mehrotra, 2002) and *A. marmelos* treated goats (Kumar, 2008). Percent conception with *A. marmelos* treatment alone had been recorded relatively lesser (Kumar, 2008) compared to *M. koenigii* and *A. marmelos* combined treatment (57.14 vs. 71.43%). Furthermore, Dutt *et al.,* (2012) in acyclic goats found that the mean value of tri-iodothyronine was higher ($P<0.05$) on day 8, 12 and 16 (1.78±0.06, 2.32±0.20 and 2.10±0.28 ng/ml) post treatment with *M. koenigii* and *A. marmelos* combination, compared to control (1.24±0.33, 1.03±0.15 and 1.09±0.20 ng/ml). The increasing levels ($P>0.05$) of peripheral thyroid hormones with resumption of cyclicity (60%) between day 8-16 post treatment provides evidence that of tri-iodothyronine and thyroxine might be metabolic signals triggering onset of ovarian cycle (Riest *et al.,* 2003).

In another study, Dutt *et al.,* (2011) examined the effect of combination treatment of *M. koenigii* and *A. marmelos* on restoration of fertility in anestrous buffaloes. Effective 50% ethanolic extract doses of both the plants were extrapolated from rats (1000 mg/kg) to buffaloes using dose equivalent system and converted into powder form based on per-cent yield. Final doses were prepared by mixing of half of the calculated dose of both the plants on body weight basis. After treatment for 9 days, estrus was induced in 60% (6/10) animals with a mean interval of 9.33±1.11 days from end of experiment followed by 66.67% (4/6) pregnancy confirmation on day 45 post mating. After treatment with *M. koenigii* and *A. marmelos* for 9 days as per Dutt *et al.,* (2011),the growth rate of large follicles was faster ($P< 0.05$) in herbs treated (0.55 mm/day) than control (0.25 mm/day) delayed pubertal buffaloes heifers, it was concluded that supplementation of *A. marmelos* and *M. koenigii* can influence the growth processes of large follicles by the attainment of dominance, accelerated growth rate, preovulatory size and the process of ovulation(Kumar *et al.,* 2016). The estrus response was recorded as 33.33, 50.00, 75.00,

and 33.33% in treatment with *A. marmelos*, *M. koenigii*, *A. marmelos* plus *M. koenigii* and control groups, respectively having six animals in each group. In animals treated with combination of both the plants, serum calcium was found significantly ($p<0.05$) higher on day 8 post-estrus as compared to other groups at a similar interval. In addition, the ovulation and conception rates were also comparatively better in the group treated with combination of both plants.

Das *et al.,* (2016) examined the estrus induction response and fertility performance in delayed pubertal cattle heifers treated with *A. marmelos* in combination with *M. koenigii*. A total of 11 heifers were treated as per Dutt *et al.,* (2011) and six heifers were kept as untreated control. Six out of 11 (54.1%) heifers in treatment group and 1 out of 6 (16.7%) in control group exhibited standing estrus. All these estrus heifers were inseminated and conceived.

In delayed pubertal cattle heifers, the supplementation of *A. marmelos* and *M.koenigii* leave powder induced behavioral estrusin higher percentage (92.3%) within day 4-26 following start of treatment as compared to untreated heifers (46.2%; $p<0.05$). The mean interval between initiations of herb treatment and exhibition of behavioral estrus was 11.25±1.91 days. The conception rate was 61.5% in herb treated group, whereas the corresponding figure in untreated group was 23.1%. The number of services per conception and calving rate in treatment group was 1.75 and 53.8%, respectively (Kumawat *et al.,* 2016) and the mean interval between the initiation of treatment to onset of estrus was 11.25±1.91 days which is comparatively longer than the interval reported earlier under field (8.75-9.84 days) and farm (6 days) conditions (Das *et al.,* 2016).Furthermore, these outcomes corroborated with earlier studies in which *A. Marmelos* and *M. koenigii* treatment individually produced fertile estrus in anestrous goat, cattle and buffalo (Mehrotra *et al.,* 2005; Kumar, 2008 and, Satheshkumar and Punniamurthy, 2009). Also, the effect of both the plants in combination was synergized to bring anestrous goat and buffaloes into estrus (Dutt *et al.,* 2010, 2011).

Endometritis

Recently, Rautela *et al.,* (2017) used aqueous and ethanolic extract (250 mg/ml) of *M. koenigii* and *A. marmelos* prepared as per the Firdaus *et al.,* (2014) and Akinnibosun and Umufo (2015), respectively, for investigating the *in-vitro* antibacterial effects of the extract of both the leaf either alone or in combination on the bacterial species isolated from the cows suffering from endometritis. The antibacterial activity was tested by agar-well diffusion method (Baskaran *et al.,* 2011). The ethanolic extract showed a better response than the aqueous extract, either alone or in combination. Further, ethanolic extract of leaves in combination showed 50 to 65% equivalent activity to ciprofloxacin during *in-vitro* sensitivity test (Table 1). Based on the *in-vitro* anti-bacterial sensitivity, the study showed rays of hope for the future *in-vivo* antibacterial potential of *A. marmelos* and *M. koenigii* for the treatment of bacterial endometritis. In an another study Rautela *et al.,* (2018), investigated the antibacterial, anti-inflammatory and antioxidant effects of leaves of *A. marmelos* and *M. koenigii* in 16 repeat breeder cows due to endometritis. The diagnosis was confirmed by endometrial cytology using >5% polymorphonuclear (PMN) as the cut-off point. Cows in the treatment group (n=6) were supplemented with 200 gm of *A. marmelos* and *M. koenigii* leaf powder daily for 9 days through oral route. The antibacterial, anti-inflammatory and antioxidant effects were assessed by evaluating the changes in

bacterial load, PMN cell count and oxidative parameters like malondialdehyde (MDA), ascorbic acid (ASCA), reduced glutathione (R-GSH), superoxide dismutase (SOD), and total antioxidant capacity (TAC) etc. respectively. Results showed significant reduction in the bacterial load and PMN cell count in the herb supplemented cows. The MDA concentration decreased drastically, whereas ASCA and R-GSH concentrations and TAC increased significantly in herb supplemented cows as compared to control. Although the SOD activity was not significantly different between the groups, there was a tendency of higher activity in herb supplemented cows. In conclusion, *A. marmelos* and *M. koenigii* reduce the bacterial load and inflammation in endometritic dairy cows with a concurrent increase in the endogenous antioxidants.

Studies concerning *Murraya koenigii*and *Aegle marmelos* individually or in combination revealed efficacy of both the plants in terms of induction of estrus, ovulation and pregnancy establishment in anestrus goats, cattle and buffaloes. It may be speculated that as a result of plants treatment FSH from anterior pituitary or other mimicking active principles might have been triggering the follicular dynamics by enhancing the follicular recruitment, selection and rescuing the atresia of follicles. Favourable effects in terms of estrus induction, ovulation, pregnancy establishment and shorter time period taken in induction of estrus are exhibited compared to individual plant treatment which could be a reflection of synergistic actions of plant active principles. The active principles seem to operate either through mimicking gonadotrophins activity or stimulating the central mechanism for endogenous release of gonadotrophins along with possibility of local action, requiring further more detailed studies. It is indicated also indicated that both the plants have anti-bacterial properties that might have resulted in reduction of bacterial load in and inflammation in endometritic dairy cows with a concurrent increase in the endogenous antioxidants. Further research to identify the active ingredients of both the plants is now need of the hour.

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