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# Exploiting medicinal plant extracts to enhance male reproduction in livestock in sub-Saharan Africa: a review

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Reproductive efficiency in male livestock is essential for sustainable animal production; however, the use of synthetic reproductive drugs is constrained due to its, harmful side effects, antimicrobial resistance and effect on long-term reproductive health. Therefore, use of plant extracts to enhance reproductive performance in livestock has gained attention because of their bioactive compounds, affordability, and reduced side effects compared to synthetic drugs. The review analyses the impact of specific plants in sub-Saharan Africa (SSA) on male reproductive performance, concentrating on libido, testicular function, hormonal levels, and semen quality. *Moringa oleifera* and *Zingiber officinale* improve libido, testicular function, hormonal status, and semen quality of male animals. The bioactive components of those plants, including flavonoids, alkaloids, tannins, and saponins, have antioxidant, anti-inflammatory, and hormone-modulating effects that collectively improve reproductive outcomes. Further research is needed to optimise dosage, ensure safety, and promote the sustainable use of these plants to prevent over exploitation of specific species. Furthermore, the sustainable use of reproductive improving plants requires their cultivation, nursery development, farmer training, and community level processing to improve availability, quality control and economic value. Male animals can access these plants through managed browsing or grazing, cut and drying leaves and controlled supplementation, supported by separation of male animals to regulate breeding and accurately assess reproductive effects.

## KEYWORDS

libido, *Moringa oleifera*, testes function, *Tribulus terrestris*, *Withania somnifera*, *Zingiber officinale*

## 1 Introduction

Male livestock play a vital role in the SSA farming sector, contributing to food security, income generation, and agricultural sustainability (Swelum et al., 2021; Shai et al., 2022). Livestock production in SSA is predominantly smallholder-based and male reproductive inefficiency remains a major but often overlooked constraint to herd productivity. The productivity of breeding males, which contribute half of the genes in a herd or flock, can be

improved by using the right amount of feed to meet their energy needs for maintenance, reproduction, and other physiological functions (Gholami-Ahangaran et al., 2021). Poor management, inbreeding, harsh environments, diseases and parasites significantly compromise male reproductive performance (Gaughan and Cawdell-Smith, 2015; Fernandez-Fuertes, 2023). Stress is particularly detrimental to reproductive efficiency, as it induces lipid peroxidation in the cytoplasmic membrane of spermatozoa, damages the acrosomal membrane, and promotes oxidative degradation of deoxyribonucleic acid (DNA), leading to chromosomal abnormalities and reduced spermatozoa viability (Shai et al., 2022). Ultimately, a crucial aspect of male fertility lies in the testes' capacity to produce and convey morphological normal and functionally competent spermatozoa, which deliver paternal genetic material to the subsequent generation (Swelum et al., 2021). Furthermore, reduced testosterone synthesis, degeneration of Sertoli cells and breakdown of the blood-testicular barrier elevate oxidative stress, which interferes with spermatogenesis and reduces spermatozoa concentration, motility and fertility potential (Fernandez-Fuertes, 2023). but also supports the use of alternative dietary supplements that enhance male fertility (Shai et al., 2022). The improvement of male fertility relies on the use of synthetic drugs such as gonadotropin-releasing hormone (GnRH), anabolic agents and other reproductive-modulating pharmaceuticals.

The use of synthetic drugs to improve reproductive performance in male livestock has numerous challenges such as testicular degeneration, reduced spermatozoa quality and behavioural problems in animal production systems (Chen et al., 2024). In addition, concerns related to declining efficacy, drug resistance, toxicity and the presence of residues in animal products pose significant risks to consumer health and market acceptability (Shai et al., 2022). Long-term exposure to anabolic steroids has been associated with adverse reproductive outcomes, including testicular shrinkage and infertility (Skoupa et al., 2022). Although short-term administration of GnRH analogues may temporarily enhance hormonal secretion, excessive or prolonged stimulation can trigger negative feedback mechanisms (El-Shalofy and Hedia, 2021). Elevated testosterone concentrations, may induce reproductive abnormalities and suppress immune function, increasing susceptibility to pathogens and parasites (Kuralkar and Kuralkar, 2021). In response to these challenges, there has been growing interest in the use of medicinal plants to improve fertility in male livestock.

Medicinal plant extracts are used to address fertility-related disorders that decrease overall production efficiency in farm animals (Nejabatbakhsh et al., 2016; Hegde, 2019; Setyawati et al., 2024). In recent years, the use of phytogetic compounds has been explored as a natural approach to mitigate oxidative stress and enhance reproductive performance in livestock. *Moringa oleifera*, *Ocimum basilicum* and *Zingiber officinale* contain bioactive compounds with low toxicity, antioxidant properties, and high

levels of essential minerals, phenols, and carotenoids (Kosari et al., 2024). These natural antioxidants decrease lipid peroxidation, and increase the activity of the endogenous antioxidant enzymes, thus reducing oxidative damage in reproductive tissues (Faleh et al., 2024). Enhanced antioxidant enzyme activity improves testicular function, semen quality, and hormonal levels in males (Nasimi Doost Azgomi et al., 2018; Soetan et al., 2018). This review highlights the effects of plant extracts on libido, hormonal regulation, testicular function, and semen quality in males, with special attention to the mechanisms through which phytochemicals enhance spermatozoa quality, testicular activity, libido, and overall male fertility.

## 2 Methodology

This study was conducted as a structured narrative review aimed at synthesizing available scientific evidence on the effects of medicinal plant extracts on male reproductive performance in livestock, particularly focusing on libido, testicular function, hormonal regulation, antioxidant activity, and semen quality within Sub-Saharan African production systems. The literature was sourced from articles, books, and conference papers published in various databases, including Web of Science, Science Direct, and Google Scholar. Key words that were used are semen quality, testes function, libido, hormone levels, antioxidants, livestock male reproduction and effect of plant extracts on the male reproductive system. The first search process was conducted using the Google Scholar search engine, which listed 328,000 studies that included plant extracts and male reproduction as keywords. Therefore, the first search generated a pool of studies, which was narrowed by incorporating livestock-specific terms. Titles and abstracts were screened for relevance, and full-text articles were assessed where necessary. Studies were included if they evaluated the effects of plant extracts on male reproductive factor in livestock and reported important outcomes such as semen characteristics, hormonal changes, libido and antioxidant activity. Studies focusing exclusively on human fertility, lacking primary reproductive outcomes, or presenting duplicate data were excluded. Therefore the studies were reduced to 116 which are in the current study.

## 3 Role of male reproduction in livestock

Reproduction ensures the continuous production of animals and the sustained supply of milk, meat and wool (Davis and White, 2020). In sub-Saharan Africa, livestock production accounts for approximately 35% of total agricultural output, with cattle, sheep, and goats serving multiple purpose, including the provision of draught power, manure and source of income (Shai et al., 2022). Efficient reproductive performance is fundamental to the sustainability of livestock production systems and ensures flock and herd expansion which is crucial for meeting the growing

**Abbreviations:** FSH, Follicle -stimulating hormone; LH, Luteinizing hormone; SSA, Sub-Saharan African; BW, Body weight; AI, Artificial insemination; DNA, Deoxyribonucleic acid; GR, Growth rate; GnRH, Gonadotropin releasing hormone; FAO, Food and Agriculture Organization.

demand for animal-derived proteins in sub-Saharan Africa (FAO, 2019).

Male reproductive performance holds substantial economic value and because it directly influences the quantity and quality of semen used in artificial insemination (AI) programs, thereby facilitating genetic improvement and preservation of valuable livestock breeds (Shai et al., 2022). Improving reproductive potential and performance in livestock, while ensuring animal welfare, supports the sustainable production of future generations of high performing animals. Strategic attention to reproductive management and the integration of innovative reproductive technologies can, therefore, enhance productivity, profitability, and long term sustainability in the livestock sector.

## 4 Challenges in male livestock reproduction

Reproductive challenges in male livestock arise from multiple interacting factors, including nutrition, genetics, health and diseases, and environmental stressors. These factors have a direct impact on fertility, semen quality, and overall livestock productivity. Male fertility traits exhibit low heritability, making genetic improvement through selection difficult. Inbreeding further aggravates reproductive problems, increases the incidence of cryptorchidism and proportion of spermatozoa abnormalities (Mwai et al., 2015).

Health-related issues are another major constraint to male fertility. Brucellosis, trypanosomiasis and orchitis can severely impair spermatogenesis, testosterone secretion and sexual behaviour (Constable et al., 2016). Similarly, heavy parasite burdens lead to systemic weakness and hormonal imbalance, further reducing reproductive performance (Swelum et al., 2021). Nutritional deficiencies, especially in proteins, energy and essential micro-nutrients like selenium, zinc and vitamin E, negatively affect testicular function, spermatozoa motility and libido (Kumar et al., 2011). Adequate nutrition is therefore crucial to maintaining spermatozoa quality and antioxidant defence mechanisms within the testes. Environmental factors also play a significant role in male reproductive performance. Heat stress, for example, induces oxidative stress, damages spermatozoa DNA, disrupts spermatogenesis, and reduces libido (Hansen, 2019). Poor housing conditions, overuse of breeding males without sufficient rest, and inadequate semen evaluation practices further contribute to reduced breeding efficiency and lower fertility outcomes (Rahman et al., 2018). Collectively, these reproductive challenges lead to compromised testicular function, reduced semen volume and pH, and lower overall fertility rates. Therefore, mitigation strategies, including improved management, balanced nutrition, and use of plant-based extracts with antioxidant properties, can alleviate these challenges and enhance reproductive efficiency.

### 4.1 Poor nutrition

Nutrition directly influences fertility, hormonal balance, and gamete quality in both male and female. Imbalances in dietary

intake remain one of the major constraints to reproductive performance across livestock species. Poor quality feed and seasonal feed shortages often limit the intake of essential nutrients such as energy, protein, and minerals, leading to reduced semen quality, libido, and fertility in male animals (Ibtisham et al., 2018). Micronutrient deficiencies also contribute to poor reproductive efficiency. Phosphorus deficiency has been associated with delayed puberty and poor conception rates, while selenium and vitamin E deficiencies impair semen quality. Zinc deficiency has also been shown to negatively affect spermatogenesis and testosterone synthesis (Kumar et al., 2011). Piagentini et al. (2017) showed that rams supplemented with selenium (20 mg/kg) had a decreased percentage of spermatozoa abnormalities, semen volume, and spermatozoa viability, whereas total motility and concentration remained unchanged (Lukusa and Lehloenya, 2017). Conversely, Lukusa and Lehloenya (Ozer Kaya et al., 2020) reported that selenium supplementation in Saanen bucks improved testicular parameters, semen volume, spermatozoa viability, motility and normal spermatozoa morphology, confirming selenium's critical role in reproductive physiology. Vitamins also play a key role in reproductive performance. Vitamins A, D and E are important for spermatogenesis, steroidogenesis, and the antioxidant protection of reproductive cells (Ding et al., 2024). Kaya et al. (Kumar et al., 2014) showed that supplementation with vitamin B (300 mg/ram) significantly increased semen volume, spermatozoa motility, and concentration in rams. Both under-nutrition and over-nutrition negatively affect fertility. Whereas nutrient deficiencies lead to poor semen quality and low libido, over-nutrition can result in obesity, hormonal imbalances, and reduced spermatozoa motility. In sub-Saharan Africa, seasonal fluctuations in pasture quality and low-protein roughage during the dry season frequently result in energy and protein imbalances, ultimately reducing reproductive performance in livestock (Krishnan et al., 2017). Therefore, balanced nutrition encompassing optimal levels of energy, protein, minerals, and vitamins is important for maintaining hormonal levels, testicular function, and semen quality, thereby supporting sustainable reproductive performances in livestock.

### 4.2 Poor genetics

Genetics play a major role in livestock reproduction, influencing fertility, growth, adaptability, and overall productivity. Poor genetic potential, resulting from indiscriminate crossbreeding, inbreeding depression, or the absence of structured breeding programmes, significantly reduces reproductive efficiency and animal performance (Mwai et al., 2015). Uncontrolled mating systems, limited access to superior germplasm, and small effective population sizes contribute to inbreeding, which leads to reduced semen quality, libido, and congenital reproductive defects such as cryptorchidism. In Sub-Saharan Africa, the predominant reliance on indigenous breeds ensures adaptability to harsh environments and stress, such as heat, endemic diseases, and feed scarcity. However, this adaptability often comes at the expense of productivity, as indigenous breeds typically exhibit lower growth rates, milk yield, and reproductive performance compared to imported or crossbred animals (FAO, 2019). In contrast, although

imported breeds exhibit greater genetic potential for production traits, they are less resilient to tropical diseases, heat stress, and nutritional deficiencies. These factors often lead to sub-optimal reproductive outcomes in smallholder settings (Gholami-Ahangaran et al., 2021). Furthermore, limited access to advanced reproductive technologies such as AI, embryo transfer, and genomic selection continues to constrain genetic progress in many developing regions (FAO, 2019). Smallholder farmers frequently depend on natural mating because of insufficient infrastructure, a shortage of skilled personnel, and limited financial resources. This reliance contributes to ongoing genetic stagnation and low fertility rates (Shai et al., 2022). Addressing these genetic limitations necessitates the establishment of organised breeding programmes that integrate the adaptive characteristics of indigenous breeds with the productivity features of imported breeds. The conservation and genetic enhancement of local breeds through community-driven breeding initiatives, along with the use of assisted reproductive technologies, can improve fertility, adaptability, and productivity in livestock populations throughout Sub-Saharan Africa (Mwai et al., 2015).

### 4.3 High prevalence of diseases

Health and disease present major challenges to livestock reproduction; they directly influence fertility, conception rates, gestation, and offspring survival. Infectious diseases such as brucellosis, trypanosomiasis, leptospirosis, and campylobacteriosis are among the most significant causes of reproductive failure, leading to reduced semen quality, reduced libido, and lowered conception rates in male animals (Constable et al., 2016). These infections can disrupt spermatogenesis, harm reproductive organs, and induce inflammation in the testes and accessory glands, ultimately reducing reproductive efficiency. Parasitic infections, particularly gastrointestinal nematodes and ectoparasites, further exacerbate reproductive problems by inducing chronic anaemia, weight loss, and physiological stress, all of which reduce libido and semen quality (Chitura et al., 2018). Metabolic and nutritional disorders such as ketosis, hypocalcaemia, and deficiencies in essential trace minerals like selenium and zinc compromise reproductive efficiency by affecting hormone balance and ovarian function. In addition, sub-clinical infections, which often go unnoticed, can lead to repeat breeding and prolonged calving or kidding intervals, thereby reducing herd productivity (Constable et al., 2016). In Sub-Saharan Africa, limited access to vaccines increases the problem of reproductive health challenges. Handling these challenges requires integrated disease control strategies, regular health monitoring and the use of natural antibiotics to ensure sustainable reproductive performance in livestock.

### 4.4 Harsh environmental conditions

Environmental factors are major obstacles to livestock reproduction, as they directly affect fertility, hormonal balance, and overall reproductive performance. Heat stress, resulting from high ambient temperatures and humidity, remains one of the most critical constraints, as it affects spermatogenesis and reduces semen

quality (Hansen, 2019). Drought and seasonal fluctuations in feed availability exacerbate reproductive problems by limiting access to quality forage and water, which in turn leads to poor body condition and reduced libido (Asfaw et al., 2022). Furthermore, climate variability contributes to the increased incidence and distribution of vector-borne diseases such as trypanosomiasis and Rift Valley fever, both of which impair reproductive efficiency. Exposure to environmental toxins, particularly mycotoxins in contaminated feed, has also been shown to cause hormonal imbalances and compromise semen quality (Chitura et al., 2018). Smallholder farmers in Sub-Saharan Africa are especially vulnerable to these environmental stressors because of limited access to adaptive technologies, inadequate housing, and poor availability of climate-resilient feed resources (Constable et al., 2016). To mitigate these effects, adaptive strategies such as the selection of heat-tolerant and disease-resistant breeds, the use of natural feed additives or antibiotics, and the adoption of climate-smart livestock management practices are recommended (FAO, 2019).

## 5 Role of medicinal plants in enhancing male reproduction

Incorporating plant-based supplements into animal production systems enhances not only reproductive performance and productivity but also supports the principles of sustainable and organic farming. Plant extracts provide a natural alternative to synthetic drugs, thereby minimising issues associated with antimicrobial resistance, chemical residues in animal products, and environmental contamination (Ara et al., 2023; Chavda et al., 2024; Vilar Neto et al., 2025). These extracts contain diverse bioactive compounds such as flavonoids, tannins, alkaloids and essential oils, which play a significant role in improving male reproductive functions, including spermatogenesis and hormonal regulation. The use of phyto-genic feed additives supports animal health, reduces dependence on conventional veterinary drugs, and promotes resilience within production systems (Vilar Neto et al., 2025). Moreover, the adoption of plant remedies are locally available, to improve agro-biodiversity, and sustainable resource use, making it particularly beneficial for smallholder and resource-limited farmers (Chavda et al., 2024). Overall, integrating ethnoveterinary knowledge and phytotherapy into livestock management contributes to healthier animals, a safer food system, and more environmentally responsible farming practices (Ahmad Zaenuri et al., 2023).

Plants are increasingly recognised as natural alternatives for improving reproductive performance in male animals. Their bioactive components contribute to enhanced libido and improved semen quality, and better hormonal regulation and testicular structure. *Tribulus terrestris* is one of the most extensively studied medicinal plants in this regard. Traditionally used as an aphrodisiac in many African regions, it contains steroidal saponins, particularly protodioscin, which stimulate luteinising hormone (LH) and testosterone secretion, thereby enhancing spermatogenesis and overall reproductive capacity (Abdelfattah et al., 2023). Similarly, *Moringa oleifera* administered at 300 mg/kg body weight (BW) has

showed significant reproductive benefits because of its high antioxidant content, such as quercetin and vitamin C, which help reduce oxidative stress in the testes and improve spermatozoa viability and morphology (Maina, 2024). Another well-known medicinal plant, *Withania somnifera*, while often linked with traditional medicine practices, is also applied in African ethno-veterinary practice (Asfaw et al., 2022). Supplementing bulls and rams with *Withania somnifera* has been shown to improve testosterone levels, sperm concentration, and semen volume while lowering infertility associated with high corticosterone (Setyawati et al., 2024). Similarly, *Zingiber officinale*, or ginger, improves testosterone levels, spermatozoa motility, and testicular antioxidant defence systems (Sanagoo et al., 2019). Collectively, medicinal plants such as *Moringa oleifera*, *Withania somnifera*, *Zingiber officinale* and *Tribulus terrestris* are used to improve libido, testes function, hormonal levels such as testosterone, follicle-stimulating hormone (FSH), LH and semen quality (Clément et al., 2012; Gakuya et al., 2013). Nevertheless, a comprehensive assessment of their long-term safety, optimal dosages, and potential toxicological effects remains essential before routine integration into livestock reproductive management.

## 5.1 Libido

*Moringa oleifera*, *Withania somnifera*, *Zingiber officinale*, and *Tribulus terrestris* can improve libido by increasing nitric oxide levels and sexual behaviour in male animals (Oli et al., 2024). Alkaloids, flavonoids, terpenoids, proanthocyanidins, hydrolysable tannins, and saponins are among the many bioactive substances found in these plants that have antibacterial, antiparasitic, anti-inflammatory, antioxidant, and immunomodulatory qualities (Makhafola et al., 2019). Such properties make medicinal plants valuable adjuncts to counter the rising concerns over antibiotic resistance and chemical residues in animal products. Phytogetic compounds have been used in livestock production to improve libido and overall reproductive performance. The incorporation of medicinal plants into animal production systems promotes animal welfare and productivity and resonates with the principles of sustainable and organic farming practices (Swelum et al., 2021). Several plant spices, including *Mondia whitei*, *Tribulus terrestris* and *Fadogia agrestis*, are well documented for their aphrodisiac and stimulant effects, primarily through the stimulation of LH secretion, which subsequently enhances testosterone synthesis and sexual behaviour (Shai et al., 2022). Nutrient imbalances and deficiencies can lead to low libido, a factor associated with reproductive inefficiency in bucks (Robbani et al., 2022; Oli et al., 2024; Mariani et al., 2022). In addition, Mariani et al. (Collen and Elizabeth Bosede, 2020) found that local bucks showed low libido in their initial assessments, with the first mount reaction time averaging 107 seconds (Collen and Elizabeth Bosede, 2020). A reaction time exceeding 65 seconds is typically considered indicative of low libido (Lacuesta et al., 2018; Boublata et al., 2021; Visuvanathan et al., 2022). Lacuesta et al. (Robbani et al., 2022) reported that local Boer bucks struggled to express their reproductive potential compared to the Boer does (Robbani et al., 2022). In Indonesia, 7 out of 20 Boer bucks had low libido and poor

semen quality (Meddows-Taylor and Ramadwa, 2024). There is a need for more research to assess a broad range of medicinal plants with similar properties, such as *Warburgia salutaris* (Nyaba et al., 2018).

## 5.2 Testis function

The influence of plant extracts on testicular function has become an important focus of research, especially for their potential to improve reproductive performance in livestock (Ford et al., 2009). Several herbal formulations have been shown to stimulate spermatogenic activity, resulting in improved semen quality and fertility rates (Swelum et al., 2021). However, while some natural products can be advantageous, they may also lead to male infertility under certain conditions, showing the complex nature of their effectiveness (Kerketta et al., 2014). High inclusion levels of raw pigeon pea seeds reduces spermatozoa motility, viability and testicular function in bucks (Hegde, 2019). Furthermore, Zhao et al. (Eka Budhiyadnya et al., 2020), showed that use of icariin as a phytogetic feed additive in the diet of dairy goats, may provide benefits in improving testicular tissue and increasing the testis's antioxidant capacity (Clément et al., 2012). In addition, feeding on *Pentas schimperiana* improved testicular volume, size, and weight in the bucks (Suyadi, 2012). These plants affect testicular morphology, spermatogenesis, and the reduction of oxidative stress. *Garcinia kola*, *Mucuna pruriens*, and *Withania somnifera* (Ashwagandha) medicinal plants are rich in antioxidants, which help in reducing oxidative stress, protect testicular cells (Leydig cells), improve testicular weight, and improve the function of testes because of their anti-inflammatory properties (Shai et al., 2022; El-Harairy et al., 2016).

## 5.3 Reproductive hormonal status

Plant extracts either stimulate or inhibit the production of reproductive hormones (Alahmadi, 2020). They restore the action of testosterone, LH, and FSH (Bakeer et al., 2021; Shai et al., 2022). *Moringa oleifera* and *Zingiber officinale* supplementation improve serum concentrations of testosterone, FSH, and LH levels. El-Gindy et al. (Woldemeskel, 2024; Zhao et al., 2024) reported that bucks which were supplemented with 400 g and 800 g of *Allium cepa L* showed improved FSH and LH concentrations. Sanad et al. (Wyse et al., 2022) showed an increase in testosterone level, LH, and FSH in rams supplemented with 5 g of *Panax ginseng* (Wyse et al., 2022). *Moringa oleifera*, *Zingiber officinale*, and *Allium cepa L*, therefore, have the potential to enhance male fertility.

## 5.4 Semen quality

The quality of semen has a direct impact on fertility rates, genetic diversity, and overall livestock productivity. Semen quality is measured by different parameters, such as spermatozoa motility, morphology, concentration, and ejaculate semen volume (Gurunathan et al., 2022). These indicators are directly associated with male reproduction efficiency and the success of breeding programmes (Kohli et al., 2023). There is a broader scientific trend toward natural remedies in reproductive health management (Shai et al., 2022). *Mucuna pruriens*, *Sesbania grandiflora*, and *Moringa oleifera* improve spermatozoa motility,

morphology, concentration, semen volume, and pH (Farahbod and Soureshjani, 2018; Nyaba et al., 2018; El-Gindy et al., 2023). Ahmad et al. (Maroyi, 2016) found that supplementing Kacang bucks with *Sesbania grandiflora* tablets significantly improved spermatozoa quality and viability (Maroyi, 2016). Similarly, Mutwedu et al. (Sanad et al., 2021), also reported that dietary inclusion of 3% *Mucuna pruriens* seed meal improves reproductive performance and semen volume, pH, spermatozoa motility and viability in bucks, whereas a lower level (1.5%) showed no improvement (Sanad et al., 2021). Dietary supplementation with 60 mg/head *Moringa oleifera* extract improved semen volume in bucks (Lacuesta et al., 2018; Khan et al., 2024). Similarly, Gouda et al. (Binsila et al., 2018), reported that feeding bucks with a diet containing 14% *Moringa oleifera* showed improved spermatozoa motility, live spermatozoa, spermatozoa concentration, and reduced abnormal spermatozoa, such as mid-piece and tail regions in bucks (Binsila et al., 2018). Comparable results were also observed when bucks were supplemented with 2.5% *Moringa oleifera*, which led to increased semen volume, spermatozoa motility, and viability; however, higher inclusion levels decreased spermatozoa storage potential and daily semen production (Rwodzi and Masika, 2014). *Warbugia salutaris* has promising reproductive benefits. Supplementation with *Warbugia salutaris* extract improved testosterone levels, as well as improve spermatozoa morphology, viability, motility, concentration, and live spermatozoa count (Collen and Elizabeth Bosede, 2020). These findings underscore the potential of medicinal plant extracts to improve semen quality, such as spermatozoa viability, motility and morphology in livestock. Therefore, determining the optimal dosage and inclusion levels of these plant extracts is crucial to avoid reproductive drawbacks while maximising benefits. Plants not only hold traditional and ethno-veterinary significance but also offer a scientifically supported approach for enhancing semen volume, pH, spermatozoa motility, viability, and morphology, thereby paving the way for future experimental research in livestock reproductive performance.

## 6 Pharmacological properties of medicinal plants

Plants have antimicrobial, anti-inflammatory, antioxidant, immunomodulating, antiviral, anti-tumour, growth-stimulating and anti-parasitic properties (Mutwedu et al., 2019). The use of plant extracts and their active compounds plays a crucial role in enhancing reproductive health in livestock. These plants are increasingly recognised as valuable nutraceuticals that can mitigate various stressors affecting animal production (Swelum et al., 2021). In addition, polyphenols may have immunomodulatory and anti-inflammatory effects, which could further benefit reproductive performance by reducing inflammation and enhancing immune function. For example, curcumin, a compound derived from turmeric, exhibits remarkable properties that support animal well-being by addressing stress-induced challenges related to toxicity and inflammation (Hansen, 2019; Makhafola et al., 2019; Eka

Budhiyadnya et al., 2020). However, its low bio-availability poses limitations for the widespread use of plants in livestock diets (Gouda et al., 2020). As the livestock production industry seeks alternative antibiotics and growth promoters, their incorporation of plants such as fenugreek, *Moringa oleifera*, and *Zingiber officinale* has gained traction because of their inherent nutritional and therapeutic benefits (Ewuola et al., 2019). These plants do not only promote improved health and production but also enhance reproductive efficiency, thus directly influencing semen quality and overall fertility in livestock (Ivanova et al., 2024).

Enhancing testis function, testosterone levels, LH, and FSH through plant extracts is primarily attributed to their ability to modulate endocrine activity and improve seminal parameters (Rokana et al., 2022; Visuvanathan et al., 2022). For example, *Withania somnifera* promotes reproductive health by increasing semen quality and decreasing infertility rates. It improves enzymatic activity in seminal plasma and reduces oxidative stress, both of which are critical for optimal spermatogenesis (Nasimi Doost Azgomi et al., 2018). Furthermore, plants influence hormonal levels, such as LH and FSH, thus supporting folliculogenesis and gonadal weight. This procedure does not only improve spermatozoa production but may also enhance reproduction as a whole (Kosari et al., 2024). The most commonly used plant extracts, their active compounds and how the plant affects or improves reproduction in livestock are shown in Table 1. These plants are found in Sub-Saharan Africa. The *Tribulus terrestris* plant is found across Africa, whereas *Withania somnifera* is predominant in Southern Africa (Afewerky et al., 2021). *Zingiber officinale* is found in tropical and subtropical areas across the world (Dissanayake et al., 2020), and *Trigonella foenum-graecum* is widely cultivated in Africa (Varshney and Siddique, 2023; Singh et al., 2022), whereas *Moringa oleifera* is found across the world (Piagentini et al., 2017). *Panax ginseng*, *Asparagus racemosus*, *Elephantorrhiza elephantina*, *Bulbine natalensis*, *Securidaca longepedunculata*, and *Eriosema kraussianum* plants are found across the Southern African countries (Ateba et al., 2021). Table 2 shows a summary of studies investigating the effects of various plants on sperm quality, libido, hormone levels and testis function in different animal species. It also presents the application methods and the dosage levels that resulted in significant differences. As shown in Table 2, the oral method is the most commonly used to supplement plants with animals.

Sub-Saharan Africa is home to various plants that have been important to traditional healing systems. These plants are used to treat reproductive disorders and infectious diseases (Chitura et al., 2018). The reliance on plants is mostly attributed to their accessibility, affordability, and cultural acceptability. Medicinal plants possess alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolics, which contribute to their therapeutic effects (Asfaw et al., 2022), as presented in Table 3 which shows medicinal plant parts used and phytochemical found in them and the method of chemical characterization. For example, *Warbugia salutaris* has shown potent antimicrobial and antioxidant activities. Plants also possess antimicrobial, anti-inflammatory, and hepatoprotective effects (Maroyi, 2016). Although, these plants have healing

TABLE 1 Commonly used plants and their effects in livestock in Sub-Saharan Africa.

| Type of plant                       | Active compounds                                                                                                                                   | Dosage                                 | Effect of the plant                                                                                                                                                                                                                             | Reference                                                                                         |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| <i>Tribulus terrestris</i>          | Saponins, alkaloids, flavonoids.                                                                                                                   | –                                      | <ul style="list-style-type: none"><li>Improves testosterone levels, enhances spermatozoa volume, and increases libido in various livestock species.</li></ul>                                                                                   | (Semerdjieva and Zheljaskov, 2019; Stefanescu et al., 2020; Saeed et al., 2024)                   |
| <i>Withania somnifera</i>           | Withanolides.                                                                                                                                      | –                                      | <ul style="list-style-type: none"><li>Known for its adaptogenic properties, it can reduce stress-induced reproductive dysfunction and improve sperm motility and viability.</li></ul>                                                           | (Nasimi Doost Azgomi et al., 2018; Sengupta et al., 2018; Paul et al., 2021; Chavda et al., 2024) |
| <i>Zingiber officinale</i> (Ginger) | Gingerol, shogaol                                                                                                                                  | 500-1000 mg/kg of animal's body weight | <ul style="list-style-type: none"><li>1000mg/kg of <i>Zingiber officinale</i> exhibits antioxidant properties, reducing oxidative stress in the testis, leading to improved spermatozoa count, concentration, viability and mobility.</li></ul> | (Gholami-Ahangaran et al., 2021; Fathy et al., 2022; Shai et al., 2022; Abdelfattah et al., 2023) |
| <i>Moringa oleifera</i>             | Vitamins, minerals, antioxidants                                                                                                                   | 100 300 mg/kg of animals body weight   | <ul style="list-style-type: none"><li>Nutrient-rich profile of the plant supports overall reproductive health and 300 mg/kg has been shown to enhance semen quality in rams.</li></ul>                                                          | (Ghadimi et al., 2024; Setyawati et al., 2024; Ismail et al., 2025)                               |
| <i>Asparagus racemosus</i>          | Steroidal saponins, flavonoids, alkaloids, and vitamins                                                                                            | –                                      | <ul style="list-style-type: none"><li>Improve spermatozoa count and motility, supporting overall reproductive function.</li></ul>                                                                                                               | (Alahmadi, 2020; Oli et al., 2024)                                                                |
| <i>Elephantorrhiza elephantina</i>  | Alkaloids, flavonoids, phenols, saponins, tannins, anthocyanidins, anthraquinones, esters, fatty acids, glycosides, polysterols, and triterpenoids | –                                      | <ul style="list-style-type: none"><li>Could enhance libido and support testicular function.</li></ul>                                                                                                                                           | (Robbani et al., 2022)                                                                            |
| <i>Bulbine natalensis</i>           | Anthraquinones, saponins, tannins, alkaloids, cardiac glycosides, and particularly                                                                 | –                                      | <ul style="list-style-type: none"><li>It may increase testosterone levels and improve spermatozoa morphology and viability.</li></ul>                                                                                                           | (Teffo et al., 2024)                                                                              |
| <i>Securidaca longepedunculata</i>  | Flavonoids, terpenes, coumarins, and steroids                                                                                                      | –                                      | <ul style="list-style-type: none"><li>Improve semen quality and testicular function.</li></ul>                                                                                                                                                  | (Asfaw et al., 2022)                                                                              |
| <i>Eriosema kraussianum</i>         | Isoflavones                                                                                                                                        | –                                      | <ul style="list-style-type: none"><li>May stimulate sexual behaviour and improve reproductive organ health.</li></ul>                                                                                                                           | (Chassagne and Morgan, 2020; Ateba et al., 2021)                                                  |
| <i>Warbugia salutaris</i>           | Drimane sesquiterpenoids polygodial and warburganal                                                                                                | –                                      | <ul style="list-style-type: none"><li>May increase sexual behaviour and improve hormone levels and semen quality.</li></ul>                                                                                                                     | (Meddows-Taylor and Ramadwa, 2024)                                                                |

- indicates that the dosage to be given to animals has not been studied.

properties, they also have toxicity found in them which are shown in Table 4. This Table shows the toxicity profile of the individual plants and it safety concern. Therefore, it is essential to explore their medicinal potential, safety and ensure their sustainable use.

6.1 Tribulus terrestris

*Tribulus terrestris* has various traditional practices. It is used to enhance libido and reproductive health in animals (Sanagoo et al., 2019). *Tribulus terrestris* promotes reproductive processes in livestock, potentially benefiting fertility and productivity (Adetunji et al., 2025). The plant is valued for its anti-inflammatory and antioxidant properties. It is known to enhance libido and boost testosterone level and semen volume.

6.2 Withania somnifera

*Withania somnifera* is an evergreen shrub of the Solanaceae family. It is recognised for its adaptogenic properties, aiding in stress reduction and immune modulation. It improves testosterone levels, spermatozoa

viability, count, and morphology, and libido (Hansen, 2019). It also has antioxidant properties that decrease oxidative stress by scavenging free radicals. Therefore, *Withania somnifera* is powerful in stress management and reproductive health.

6.3 Zingiber officinale

*Zingiber officinale*, also known as ginger, exhibits antioxidant and immunostimulatory effects. It is widely distributed and has therapeutic properties across traditional and modern medicine (Rahman et al., 2018). It contains gingerols and shogaols, which inhibit pro-inflammatory pathways. *Zingiber officinale* also shows several medicinal properties beneficial for reproductive health and semen quality. It enhances the production and quality of spermatozoa. It improves motility and viability of spermatozoa and increases testosterone levels. In addition, ginger possesses antioxidant properties that reduce oxidative damage in the testes (Abdelfattah et al., 2023). *Zingiber officinale* supports male reproductive performance and immune health through its anti-inflammatory and antioxidant mechanisms.

TABLE 2 Plants and their effect on reproductive performance of male livestock in sub-Saharan Africa.

| Type of plant                                         | Type of breed and animal          | Method of application          | Level                              | Effect observed                                                                                                                                                                       | References                       |
|-------------------------------------------------------|-----------------------------------|--------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <i>Spirulina platensis</i>                            | Sahrawi and Jabbali Goat Bucks.   | Oral (Dietary supplementation) | 2 and 4 g/head/day                 | • Inclusion of 2 and 4 g/head/day <i>Spirulina platensis</i> on the diet improved semen quality.                                                                                      | (Al-Yahyaey et al., 2023)        |
| <i>Moringa oleifera lamm</i>                          | Capra hircus Goats                | Oral                           | 10, 20 and 30%                     | • 20% of <i>Moringa oleifera</i> leaf powder supplementation could improve the sexual behaviour and spermatozoa motility, and semen volume of Kacang bucks.                           | (Rokana et al., 2022)            |
| <i>Ocimum basilicum</i>                               | Lambs                             | Oral                           | 12.5 and 25%                       | • 25% dietary supplementation improves spermatozoa quality and increases testosterone level while decreasing cortisol levels in the ram.                                              | (Kosari et al., 2024)            |
| <i>Moringa oleifera leaves</i>                        | Barki rams                        | Oral                           | 5 and 10%                          | • 10% of <i>Moringa oleifera</i> leaves fed to rams showed improvement in semen volume, spermatozoa motility, vitality and normality, reduced spermatozoa motility, and abnormalities | (Fathy et al., 2022)             |
| <i>Moringa Oleifera leaves</i>                        | Red Chittagong Bulls (Bangladesh) | Oral                           | 25 and 50%                         | • <i>Moringa</i> mash at 25% and 50% levels improved spermatozoa motility in bulls                                                                                                    | (Sultana et al., 2021)           |
| <i>Moringa Oleifera seed extract</i>                  | Yankasa rams                      | Oral                           | Water dose rate of 1000–3000 mg/kg | • 3000mg/kg increased testosterone, FSH, and LH                                                                                                                                       | (Iliyasu et al., 2020)           |
| <i>Moringa Oleifera</i>                               | Red Sokoto goats                  | Oral                           | 12.5, 25, 37.5 and 50%             | • 50% inclusion improved spermatozoa motility and semen pH                                                                                                                            | (Raji and Njidda, 2014)          |
| <i>Ziziphus Spina-Christi Leaves</i>                  | Iraqi Buck goats                  | Oral                           | 2 and 4%                           | • 4% of <i>Ziziphus Spina-Christi Leaves</i> improved goat spermatozoa, morphology, motility, viability and, semen volume. It also significantly enhanced the testosterone hormone.   | (Faleh et al., 2024)             |
| <i>Punica granatum L. and Aloe barbadensis miller</i> | Bucks                             | Oral                           | 3 and 5%                           | • <i>Punica granatum L</i> showed improvement in spermatozoa motility and concentration.                                                                                              | (Bakeer et al., 2021)            |
| <i>Ginger rhizome powder</i>                          | Bucks                             | Oral                           | 0.5, 1 and 1.5%                    | • Addition of 1 and 1.5% of <i>Ginger rhizome powder</i> improved semen quality and seminal plasma.                                                                                   | (Embark, 2021)                   |
| <i>Allium cepa L</i>                                  | Bucks                             | Oral                           | 400 mg and 800 mg                  | • Both levels improved semen volume, spermatozoa viability, morphology and motility, FSH, LH, superoxide and dismutase, and catalase.                                                 | (El-Gindy et al., 2023)          |
| <i>Panax ginseng</i>                                  | Rams                              | Oral                           | 2 and 5 g                          | • Both levels of <i>Panax ginseng</i> resulted showed improvement in semen quality. LH, FSH and testosterone                                                                          | (Sanad et al., 2021)             |
| <i>Withania somnifera</i>                             | Black Belly breed Rams            | Oral                           | 100mg and 200mg                    | • 200mg of <i>Withania somnifera</i> improved testicular function, augmented seminal volume, and increased sexual behaviour in black belly rams.                                      | (Rodríguez-Sánchez et al., 2024) |

## 6.4 Moringa oleifera

*Moringa oleifera* leaves and seed meals are valuable sources of vitamins, flavonoids, and carotenoids. In ruminants, it contributes to preventive medicine and overall health (Setyawati et al., 2024). It has medicinal properties that can benefit male livestock, particularly regarding fertility and overall health. It improves semen quality, reducing oxidative stress, and enhancing libido (Piagentini et al., 2017). *Moringa oleifera* also improves digestion and immune function and potentially reduces susceptibility to infections (Fathy et al., 2022).

## 6.5 Asparagus racemosus

*Asparagus racemosus*, also known as Shatavari, possesses immunomodulatory and antioxidant properties. It increases libido and spermatozoa count and enhances immunity. It also exhibits antioxidant, anti-inflammatory, and digestive support properties,

which can help protect against cellular damage and reduce inflammation (Oli et al., 2024). *Asparagus racemosus* also contains antioxidants, anti-inflammatory, and reproductive-enhancing properties.

## 6.6 Elephantorrhiza elephantina

*Elephantorrhiza elephantina* is of the Fabaceae family and the *Elephantorrhiza* genus. Lesotho, Botswana, Namibia, and all provinces of South Africa are home to this widely distributed and abundant plant species, elephantine (Kumar et al., 2014; Mwai et al., 2015). The plant exhibits anthelmintic, antibacterial, antifungal, anti-inflammatory, and antioxidant effects. Such properties make it valuable in managing various livestock health issues (Constable et al., 2016). *Elephantorrhiza elephantina* helps manage infections in livestock and male reproductive health through its broad-spectrum antimicrobial and anti-inflammatory properties.

TABLE 3 Showing medicinal plant parts used and phytocompound found in them with method of chemical characterization.

| Medicinal plant                    | Part used            | Reported phytocompound                                                           | Method of chemical characterization                                                                        | Reference                                         |
|------------------------------------|----------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| <i>Tribulus terrestris</i>         | Leaves               | Parvispinoside B, F-Gitonin, Gitonin (steroidal saponins)                        | Ultra performance Liquid chromatography quadrupole time of flight mass spectrometry                        | (Mashabela et al., 2024; Srinivasan et al., 2025) |
| <i>Withania somnifera</i>          | Leaves and Roots     | Withanolides, alkaloids, sitoindosides, phenolics and flavonoids                 | Ultra performance liquid chromatography quadrupole time of flight mass spectrometry profiling              | (Uddin et al., 2012; Dhama et al., 2023)          |
| <i>Zingiber officinale</i>         | Rhizome              | Gingerols, shogaols and zingerone                                                | Ultra performance liquid chromatography quadrupole time of flight mass Spectrometry                        | (Kyarimpa et al., 2023)                           |
| <i>Moringa oleifera</i>            | Leaves               | Flavonoids, polyphenols, niazimicin, niazinin, and carotenoids                   | Phytochemical profiling                                                                                    | (Saha et al., 2024)                               |
| <i>Asparagus racemosus</i>         | Roots                | Steroidal saponins, flavonoids, alkaloids, phenolics                             | Ethnopharmacology surveys                                                                                  | (Wagh and Sharma, 2025)                           |
| <i>Elephantorrhiza elephantina</i> | Roots                | Anthraquinones, ethyl gallate, fatty acids (hexadecanoic, octadecadienoic),      | Gas chromatography - mass spectrometry                                                                     | (Maroyi, 2017)                                    |
| <i>Bulbine natalensis</i>          | Leaves, stems, roots | General phytochemical classes (phenolics and flavonoids) evaluated               | Comparative phytochemical analysis                                                                         | (Teffo et al., 2024)                              |
| <i>Securidaca longepedunculata</i> | Roots                | Flavonoids, alkaloids, terpenoids, saponins, tannins                             | Phytochemical screening                                                                                    | (Abonyi et al., 2024)                             |
| <i>Eriosema kraussianum</i>        | Roots                | Flavonoids, phenolic compounds                                                   | Thin-layer chromatography; Ultraviolet-visible spectroscopy                                                | (Kleynhans et al., 2020; Ateba et al., 2021)      |
| <i>Warburgia salutaris</i>         | Bark and leaves      | Drimane-type sesquiterpenoids (warburganal, muzigadial), Polygodial and drimenol | Nuclear magnetic resonance, Gas chromatography - mass spectrometry, High performance liquid chromatography | (Ramarumo et al., 2019)                           |

6.7 Bulbine natalensis

*Bulbine natalensis* is a vascular plant native to South Africa, renowned for its recognised medicinal properties, particularly in relation to male livestock. This plant is believed to increase

testosterone levels and enhance libido (Collen and Elizabeth Bosede, 2020). *Bulbine natalensis* exhibits potential anti-inflammatory and analgesic effects, as well as possible advantages for wound healing. Furthermore, this remarkable plant possesses anti-diabetic properties, indicating that it will affect male

TABLE 4 Showing medicinal plant toxicity profile.

| Medicinal plant                    | Toxicological findings                                                                                           | Type of study                            | Major safety concern                            | Refences                                      |
|------------------------------------|------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------------------|-----------------------------------------------|
| <i>Tribulus terrestris</i>         | LD <sub>50</sub> > 2000 mg/kg (low acute toxicity)                                                               | Animal case reports                      | Possible liver injury at high doses             | (Stefanescu et al., 2020)                     |
| <i>Withania somnifera</i>          | No significant organ toxicity at therapeutic doses, LD <sub>50</sub> > 2000 mg/kg; may increase thyroid hormones | Animal and clinical trials               | Thyroid stimulation, rare hepatotoxicity        | (Paul et al., 2021)                           |
| <i>Zingiber officinale</i>         | Very high LD <sub>50</sub> ; generally recognized as safe; mild GI irritation at high doses                      | Animal and human data                    | Gastric irritation, bleeding risk in high doses | (Ali et al., 2008; Abdelfattah et al., 2023)  |
| <i>Moringa oleifera</i>            | Leaves safe up to 2000 mg/kg, root bark may have abortifacient/toxic alkaloids                                   | Animal studies                           | Root bark toxicity                              | (Pateh et al., 2021; Fathy et al., 2022)      |
| <i>Asparagus racemosus</i>         | Non-toxic up to 2000 mg/kg, no major histopathological changes                                                   | Animal studies                           | Possible hormonal modulation                    | (Oli et al., 2024)                            |
| <i>Elephantorrhiza elephantina</i> | Moderate cytotoxicity <i>in vitro</i> , limited <i>in vivo</i> toxicity data                                     | <i>In vitro</i> assays                   | High tannin content, limited safety data        | (Maphosa et al., 2010)                        |
| <i>Bulbine natalensis</i>          | Limited toxicological data, no severe toxicity reported in traditional use                                       | Ethnobotanical reports                   | Insufficient controlled safety data             | (Teffo et al., 2024)                          |
| <i>Securidaca longepedunculata</i> | Moderate toxicity at high doses, contains methyl salicylate                                                      | Animal studies                           | Salicylate like toxicity at high dose           | (Abonyi et al., 2024)                         |
| <i>Eriosema kraussianum</i>        | Mild cytotoxicity <i>in vitro</i> ; insufficient animal toxicity data                                            | <i>In vitro</i> studies                  | Limited toxicological evaluation                | (Kleynhans et al., 2020)                      |
| <i>Warburgia salutaris</i>         | Cytotoxic drimane sesquiterpenes; mucosal irritation at high dose                                                | <i>In vitro</i> and ethnomedical reports | Potent bioactivity, dose-dependent toxicity     | (Ramarumo et al., 2019; Leonard et al., 2023) |

reproductive health and the overall well-being of livestock (Teffo et al., 2024).

## 6.8 *Securidaca longepedunculata*

*Securidaca longepedunculata* is a plant widely used in traditional African medicine. It belongs to the family Polygalaceae, and it has shown anti-parasitic, antibacterial, anti-fungal, anti-inflammatory, and hypoglycaemic properties. These pharmacological activities support its traditional use in treating various ailments in livestock (FAO, 2019). In addition, *Securidaca longepedunculata* is used for its potential anti-parasitic, antibacterial, and anti-inflammatory properties.

## 6.9 *Eriosema kraussianum*

*Eriosema kraussianum* is a plant commonly used in South African traditional medicine, especially in the regions of Eastern Cape and KwaZulu-Natal, to improve male reproductive health. It possesses hypoglycaemic and vasorelaxant properties, implying potential advantages for managing blood glucose levels and encouraging vascular health in livestock (Maroyi, 2016). *Eriosema kraussianum*'s pharmacological properties support its traditional uses, suggesting promising applications in metabolic and male reproductive health.

## 6.10 *Warburgia salutaris*

*Warburgia salutaris*, known as the pepper-bark tree, is a medicinal species indigenous to southern Africa. Although the plant is widely used in traditional human healthcare, its use in the health of male livestock is not as thoroughly documented (Sanagoo et al., 2019). Still, some traditional uses and medicinal properties suggest that the plant could be helpful. Traditionally, this plant is used to address respiratory issues and digestive problems in livestock (Abdelfattah et al., 2023). *Warburgia salutaris* is valued for its antimicrobial, anti-inflammatory, antibacterial, antifungal, antimycobacterial, and antioxidant properties.

## 7 Future directions

Limited access to affordable, standardized, and quality-assured phytogenic products remains a significant constraint to improving male reproductive performance in livestock systems across Sub-Saharan Africa. In many smallholder contexts, the limited availability and relatively high cost of synthetic fertility-enhancing drugs have contributed to the continued use of plant extracts as alternative reproductive supplements (Luthfi et al., 2015; Nengovhela et al., 2021; Kowalczyk et al., 2022). However, the composition, dosage, and efficacy of these plant-based products vary substantially. Variability in soil characteristics, climatic conditions, harvesting stage, and processing methods can influence phytochemical composition, thereby affecting biological activity. In many cases, optimal dosage regimens, preparation procedures (e.g., decoction duration), and active constituent

concentrations are not well established, which may contribute to inconsistent reproductive outcomes and reduced user confidence (Gizzi, 2004; Edo et al., 2024).

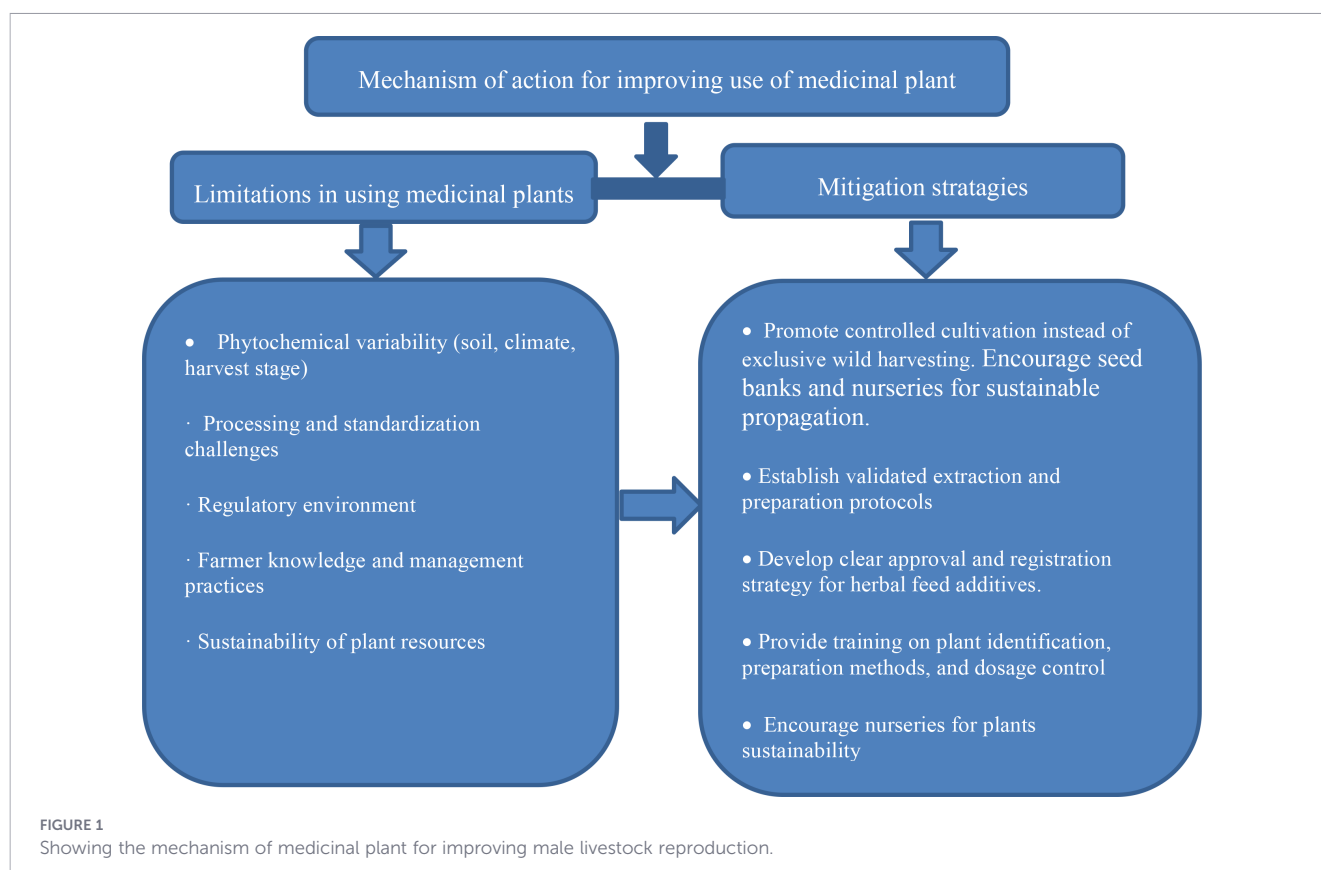
The feed-additive and nutraceutical markets in Sub-Saharan Africa remain relatively underdeveloped, and several structural constraints may limit the consistent application of phytogenic products in reproductive management. Supply-chain limitations, including irregular availability of plant materials, lack of standardized processing infrastructure and fragmented distribution systems, can affect product reliability (Louw and Jordaan, 2016). In addition, weak quality control mechanisms may result in variability in potential and safety. Limited commercialization and insufficient coordination among producers, processors, and end-users further contribute to inconsistencies in supply and product standardization. At the same time, the economic feasibility of large-scale cultivation and processing of medicinal plants remains uncertain in some regions, particularly where market incentives are unclear.

Regulatory frameworks governing herbal feed additives and plant-derived supplements are still evolving in many countries within the region. Gaps in evaluation, approval procedures, and quality assurance standards may allow products with variable concentrations of active compounds to enter the market (Nengovhela et al., 2021). This situation can make it difficult for farmers and veterinarians to distinguish between scientifically evaluated formulations and products with limited empirical validation. However, it is also important to note that regulatory harmonization across diverse national contexts presents logistical and institutional challenges, and rapid formalization may not be feasible in all settings.

Limited technical knowledge among farmers regarding plant identification, preparation methods, and administration practices may also contribute to inconsistent outcomes (Pyatt et al., 2025). Nevertheless, traditional knowledge systems continue to play a significant role in livestock health management, and their integration with scientific validation requires careful consideration to avoid undermining local practices. Generating evidence on cultivation practices, standardized formulations, and dose-response relationships could improve consistency, although such research requires sustained institutional investment.

The sustainability of wild-harvested medicinal species is another important consideration. Over-harvesting has been reported for certain species such as *warburgia salutaris* (Ndou et al., 2023), and long-term availability may depend on domestication and cultivation efforts. Integration of medicinal plants into existing farming systems, including agroforestry and climate-smart agriculture approaches, has been proposed as a potential strategy (Mofokeng et al., 2022; Mbelebele et al., 2024). However, adoption may be influenced by land availability, labour requirements, and competing production priorities. Similarly, the establishment of demonstration plots and community level processing initiatives may offer opportunities for knowledge transfer and value addition, but their effectiveness depends on institutional support, market access, and farmer participation.

Livestock management practices also influence the reliability of phytogenic supplementation. In browsing systems, animals may



consume variable quantities of medicinal plants, making dosage control difficult. More controlled approaches, such as cut-and-carry systems or incorporation of dried plant material into formulated feed, may improve dosage consistency (Selogatwe et al., 2021). Additionally, controlled breeding strategies, including separation of males and females during supplementation periods, may facilitate more accurate evaluation of reproductive responses (Mohlalole et al., 2015). However, implementation in communal grazing systems may require collective agreements and coordinated herd management.

Overall, while medicinal plant extracts present potential opportunities for enhancing male reproductive performance in livestock, their practical application is shaped by variability in phytochemical composition, regulatory limitations, economic feasibility, and management practices. Addressing these factors requires balanced consideration of scientific evidence, institutional capacity, and local production realities as presented in Figure 1. Which shows the limitations is use of medicinal plants in livestock and recommendations on how these issues can be addressed.

## 8 Recommendation

To enhance the reliability and practical application of phytogetic products for improving male reproductive performance in livestock systems across Sub-Saharan Africa, coordinated efforts are needed at research, regulatory, and production levels. Priority should be given to standardizing extraction methods, establishing dose–response

relationships, and validating active phytochemical concentrations through controlled *in vivo* studies. Strengthening regulatory frameworks and quality assurance mechanisms would help distinguish scientifically evaluated formulations from unverified products and improve user confidence. Sustainable cultivation and domestication of high-demand medicinal species should be promoted to reduce pressure on wild populations and ensure consistent supply. In addition, farmer training on plant identification, preparation, and controlled administration combined with improved breeding and supplementation management practices would enhance dosage consistency and reproductive outcome assessment. A balanced integration of scientific validation, institutional support, and traditional knowledge systems will be essential for achieving sustainable impact.

## 9 Conclusion

In conclusion plant extracts offer a promising and sustainable method for enhancing reproductive performance in livestock throughout sub-Saharan Africa. The use of plant extracts provides a significant and sustainable strategy for improving testicular function, libido, hormonal levels, and semen quality in livestock across sub-Saharan Africa. Previous research from various studies shows the effectiveness of specific indigenous plants, such as *Moringa oleifera* and *Zingiber officinale*, in enhancing testicular function, libido, hormonal balance, and semen quality. Both plants have been shown to enhance libido, improve testicular function, regulate

hormonal levels, and improve semen quality. Naturally occurring in South Africa, these plants serve as valuable resources for local livestock production systems. However, the focus on a few plants shows the need for research into other species with similar bioactive compounds. Increasing the range of plants studied can reduce over-reliance on individual plants and support more sustainable use. Future studies should focus on cultivation of these plants, identifying optimal dosages and mechanisms of action and ensuring consistent, scientifically validated application use of plant extract in enhancing reproductive results in different livestock species.

## Author contributions

PN: Investigation, Conceptualization, Writing – review & editing, Writing – original draft. TR: Visualization, Conceptualization, Supervision, Writing – review & editing. NM: Supervision, Validation, Writing – review & editing. MC: Visualization, Validation, Conceptualization, Supervision, Writing – review & editing.

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