ECRONICON OPEN ACCESS

EC MICROBIOLOGY
Research Article

Syzygium aromaticum and Zingiber officinale: A Promising Duo for Male Fertility, Cardiovascular and Renal Health

Didiane Méfokou Yemele[1,2]*, Leïla Djamilatou[3], Sadiaa Halimatou[1], Richard Dama[1], Romuald Gbayara Ndjida[1] and Sélestin sokeng Dongmo[4]

[1]*Department of Biomedical Sciences, Faculty of Sciences, University of Ngaoundere, P.O. Box 455, Ngaoundere, Cameroon*

[2]*Ngaoundere Sunshine Diagnostics Research Laboratory, Ngaoundere, Cameroon*

[3]*Faculty of Medecine and Biomedical Sciences, University of Garoua, Cameroon*

[4]*Department of Biolocal Sciences, Faculty of Sciences, University of Ngaoundere, P.O. Box 455, Ngaoundere, Cameroon*

***Corresponding Author:** Didiane Méfokou Yemele, Department of Biomedical Sciences, Faculty of Sciences, University of Ngaoundere, P.O. Box 455, Ngaoundere, Cameroon and Ngaoundere Sunshine Diagnostics Research Laboratory, Ngaoundere, Cameroon.

Received: March 18, 2025; **Published:** January 22, 2026

Abstract

Reproduction is a process that ensures the survival of an organism by passing on life and forming a new living being. Unfortunately, several couples face a variety of reproductive health issues, including infertility. Male infertility is a common issue that can be caused by a variety of factors, including hormonal changes. In the city of Ngaoundéré, traditional practitioners play a significant role in the care of individuals suffering from this disease. These practitioners use plants and traditional remedies to improve fertility. The overall goal of this study was to assess the effect of an aqueous extract of *Syzygium aromaticum* and *Zingiber officinale* on male reproductive function.

The various dosages of extract were prepared in the manner specified by the practitioner. The treatment of the animals consisted of administering different doses of extract (146, 292 and 584 mg/kg) on a daily basis, as well as controls. During the week-long treatment, the animals were divided into five groups of four animals each, and they received appropriate treatment every day between 7 a.m. and 10 a.m. using an endoscopic sonde. At the end of the 8-day treatment, these individuals were sacrificed, and their blood and organs were collected for various studies following established protocols.

The results of this study showed that administering the extract at a concentration of 292 mg/kg causes a significant increase in the levels of testosterone and FSH, implying that these plants stimulate reproductive function, justifying their traditional use in the treatment of male infertility. The use of toxicity markers has also demonstrated that administering various amounts of these extracts has no adverse effects on the consumer.

Keywords: *Male Infertility; Traditional Practitioners; Traditional Plants; Toxicity*

Introduction

Couple infertility is defined by the World Health Organization (WHO) as the absence of pregnancy in a couple of reproductive age after 12 months or more of regular unprotected intercourse. Infertility is a global public health issue that affects approximately 17.5% of the adult population, or one in six people [1]. This prevalence is similar in high, middle, and low-income countries [1]. Approximately 15% of couples of reproductive age suffer from infertility problems [2]. The causes of infertility are varied and can be attributed to male factors, female factors, or a combination of both. Among the male causes, there are sperm abnormalities, hormonal disorders, infections, and

environmental factors [3]. This situation affects not only the physical health but also the psychological and social well-being of couples [4]. In Africa, infertility is also a major concern, affecting between 15% and 30% of couples [5]. Infections, often caused by untreated sexually transmitted diseases, are a major cause of infertility on the continent. Social stigma and cultural pressures exacerbate the challenges faced by infertile couples, making the situation even more complex [6]. Efforts to improve access to fertility care and raise awareness among populations about the causes and treatments of infertility are essential to address this public health issue. Thus, various tests may be prescribed: a spermogram, a hormonal test, a urological examination, a testicular biopsy, or an infectious disease assessment [7]. Depending on the results of these tests, therapeutic solutions may exist. It may involve hormonal treatments or antibiotics (to combat infections of the urogenital system). Surgical corrections are offered in cases of anatomical problems: obstruction of spermatic ducts or segment rupture [8]. These treatments offered by modern medicine are often too expensive, inaccessible, of questionable effectiveness, and sometimes have numerous side effects. Moreover, hospital facilities capable of providing such treatments are generally very rare [9]. The population then turns to medicinal plants as a last resort to solve this infertility problem, due to their accessibility, low cost, and limited side effects [10]. Previous studies conducted in Cameroon have identified several plants used to improve male and female reproductive function [11-14]. Among the plants studied for their potential effects on male fertility, *Syzygium aromaticum* and *Zingiber officinale* stand out for their promising pharmacological properties. *Syzygium aromaticum* is recognized for its antioxidant, anti-inflammatory, and antimicrobial properties [15]. Other studies have shown that extracts of *Syzygium aromaticum* can improve sperm quality and increase testosterone levels [16]. Zingiber officinale, for its part, is renowned for its anti-inflammatory and antioxidant effects [17]. Research has shown that the consumption of *Zingiber officinale* extract can improve sperm motility and viability [16]. During a survey conducted among traditional practitioners in the city of Ngaoundéré, some indicated the beneficial effects of the infusion of the mixture of *Syzygium aromaticum* and *Zingiber officinale* on libido and infertility in men. The effect of this combination has not been documented in the literature review, so our main objective in this study is to evaluate the effect of administering the aqueous extract mixture of these two plants on the male reproductive system, using animal models.

Materials and Methods

Material

Type and location of study

The experimental study was conducted on one hand at the biochemistry laboratory of ENSAI at the University of Ngaoundéré and on the other hand at the central laboratory of the regional hospital of Ngaoundéré. The ethnobotanical survey was conducted in the Adamaoua region of Cameroon with thirty (30) traditional practitioners. This study was conducted over a period of 5 months from May to September 2024.

Plant material

The plant material used consists of cloves and ginger purchased at the market in the Ngaoundere town. The different extracts were prepared in the biochemistry laboratory of the University of Ngaoundéré.

Animal material

The experiment was conducted on mature male Wistar albino rats, aged seven to eight weeks, weighing an average of 120g ± 3.5g. These animals were raised under ambient temperature conditions with sufficient ventilation and were given water ad libitum and a diet consisting of a mixture of cornmeal (20%), corn bran (50%), complete feed (15%), 5% concentrate (10%), and vitamins (1%) in the laboratory of the Department of Biological Sciences at the Faculty of Sciences of the University of Ngaoundéré. The experiments were conducted in accordance with the recommendations of the Cameroonian National Ethics Committee on the use of laboratory animals.

Methods

Preparation of the extract and determination of the therapeutic dose

The plants were dried in the shade and then ground using an electric mill. Two hundred (200) grams of powder from each plant were macerated in 1500 ml of tap water. After maceration, the mixture was filtered using a fine sieve and then filtered again. The obtained filtrate was dried in an oven at 45°C until all the water had evaporated. The obtained extract was stored at 4°C until use. To determine the doses to be tested in this study, the dosage prescribed by the traditional healer was considered ass the "Human Equivalent Dose" (HED). The obtained dose was 4600 mg and 5600 mg respectively for *Syzygium aromaticum* and *Zingiber officinale* (for an average 70 kg body weight man), which is approximately 65.7 mg/kg and 80 mg/kg. Thus, the "No Observable Adverse Effect Dose" in rats, that is, the dose to be administered to rats that would not induce any notable side effects, was rounded to 146 mg/kg.

Distribution of animals and treatment

Before the actual treatment began, the animals (20) were acclimated for two weeks to the animal facility conditions at room temperature and a natural photoperiod. They had free access to water and a standard composition diet. During the treatment, which lasted 08 days, the animals were divided into 5 groups of 4 rats each and treated as follows using an endogastric probe: 1mL per 100g of body weight for animals in the first normal control group; The rats in groups 2, 3, and 4 received the extract at the dose and multiples of the tratitional therapeutic dose. The animals in group 5 (positive control) were treated with Provirion.

Sacrifice and sampling

At the end of the 8th day of treatment, and after a 12-hour fast, all the animals were sacrificed under chloroform anesthesia. The blood was collected by cardiac puncture into dry tubes. After letting them rest for 30 minutes at room temperature, the tubes were centrifuged at 3000 rpm for 15 minutes, then the serum was collected into cryo tubes for the measurement of certain biochemical parameters, toxicity markers, as well as some reproductive hormones. Certain organs such as the liver, testicles, kidneys, prostate, lungs, and epididymis were carefully collected and rinsed with 0.9% NaCl, then weighed using a sensitive balance.

Testosterone and FSH measurement

The hormonal assay was performed using the ELISA method.

Using a micropipette, we pipetted 50 µl of the standard and the sample, which we introduced into the microplates. Next, we added 100 µl of the conjugated enzyme and then added 50 µl of the biotin reagent. After about 30 seconds of homogenization, the plate was covered and then incubated for 60 minutes at room temperature. The wells were then emptied of their contents and washed with the wash solution. 100 µl of the TMB substrate was then added to the plates, and after 30 minutes of incubation at room temperature, 50 µl of the stop solution was added to all the wells and the absorbance was read at 450 nm using an ELISA reader.

Measurement of toxicity biomarkers

Measurement of ASAT and ALAT

The dosage kit consisted of two reagents R1 and R2. After taking the kit out of the refrigerator, we let it reach room temperature for about 15 minutes on the previously cleaned bench, then we prepared the working reagent by using tips and a micropipette to take 4 parts of reagent R1 and 1 part of reagent R2, which we mixed in a vial. Using a micropipette, 100 µl of the patient's serum were added to 1000 µl of the working reagent, and the mixture was homogenized and then incubated for 1 minute at 37°C. The initial absorbance of the sample was read on a brand spectrophotometer every minute for 4 minutes. The ASAT activity in the sample was determined according to the following formula:

$A_{AST/ALAT}$ =DO/min x 1750 = U/L.

Creatinine measurement

Creatinine is the product of the catabolism of creatine phosphate, which is used by skeletal muscle. Daily production depends on muscle mass. It is completely excreted from the body by the kidney. After taking the kit out of the refrigerator, let it reach room temperature, then zero the spectrophotometer with a blank. Using a micropipette, 50 µl of the standard or sample were added to 500 µl of the working reagent and the absorbance was read. The concentration of creatinine in the different samples was determined using the following formula:

Creatinine conc.mg/dl = × 2.

Urea measurement

Urea is the final product of protein metabolism; it is formed in the liver from its breakdown. A high level of urea in the blood (uremia) can occur in the context of excessive protein diets and/or renal obstructions. After taking the kit out of the refrigerator, let it reach room temperature, then zero the spectrophotometer with the blank. Using a micropipette, 10 µl of the standard or sample were added to 1000 µl of the working reagent, incubated for 5 minutes at 37ºC, and then read at the absorbance (A) of the standard and the sample, compared to the reagent blank at a wavelength of 580nm. The color remains stable for at least 30 minutes at 15-25ºC.

Triglyceride measurement

Triglycerides are fats that provide energy to the cell. Just like cholesterol, they are transported to the body's cells by blood lipoproteins. A diet high in saturated fats or carbohydrates can raise triglyceride levels. After taking the kit out of the refrigerator, let it reach room temperature, then zero the spectrophotometer with the blank. Using a micropipette, 10 µl of the standard or sample were added to 1000 µl of the working reagent, incubated for 5 minutes at 37ºC, and then read at the absorbance (A) of the standard and the sample, compared to the reagent blank at a wavelength of 580 nm. The activity of triglycerides in the sample was determined using the following formula:

Standard / (A) Sample × 200 (standard conc.) = mg/dl of triglyceride in the sample conversion factor: mg/dl ×0,0113 = mmol/L.

HDL measurement

Cholesterol transported by high-density lipoproteins (HDL) is often called «good cholesterol,» as high levels are associated with a lower cardiovascular risk. A low level of HDL cholesterol is considered one of the main cardiovascular risk factors. After taking the kit out of the refrigerator, let it reach room temperature, then zero the spectrophotometer with a blank. Using a micropipette, 5 µl of the standard or sample were added to 500 µl of the working reagent, incubated for 5 minutes at room temperature, and then read at the absorbance (A) of the standard and the sample at a wavelength of 505 nm.

Total cholesterol measurement

Cholesterol is a fatty substance present in all the cells of the body. The liver naturally produces all the cholesterol it needs to form cell membranes and to produce certain hormones. The determination of cholesterol is one of the most important tools for diagnosing and classifying lipemias. The increase in cholesterol levels is one of the possible cardiovascular risk factors. After taking the kit out of the refrigerator, let it reach room temperature, then zero the spectrophotometer with the blank. Using a micropipette, 5 µl of the standard or the sample were added to 500 µl of the working reagent, incubated for 5 minutes at 37ºC, and then read at the absorbance (A) of the standard and the sample, compared to the reagent blank at a wavelength of 505 nm. The total cholesterol activity in the sample was determined using the following formula: (A) Standard - (A) Blank / (A) Sample - (A) Blank x 200 (standard conc.) = mg/dl of cholesterol in the sample.

Results

Sociodemographic characteristics of traditional practitioners and knowledge of medicinal plants utilized for infertility

Gender	Male			Female	
	63.30%			36.70%	
Age	[20-25]	[25-40]	[40-55]	[55-70]	[70+]
	13.30%	20.00%	40.00%	20.00%	6.70M
Profession	Herborists		Famers		Sellers
	58.60%		24.10%		17.20%
Origin of knowledge	Initiation			Ancestors	
	3.30%			96.70%	
Route of administration	Oral			Topic	
	86.70%			13.30%	

Table 1: *Age, gender, profession, and expertise of traditional healers regarding medicinal plants.*

Table 1 indicates that among the 30 traditional healers met, 19 (63.30%) are men and 11 (36.70%) are women. Traditional healers aged 40 to 55 constitute the majority (40%), followed by those aged 20 to 40 and 55 to 70, each representing 20%. 96.70% of traditional healers acquire their knowledge from their ancestors, and 86.70% of the preparations were intended for oral administration.

Effect of the treatment on the weight evolution of rats

The evolution of the weight gain in rats is represented in figure 1. The results indicate that the rats receiving the aqueous extracts and the reference androgen exhibit a faster weight gain than the control rats. The weight gain of the rats treated with aqueous extracts was even faster than that of the rats given the reference androgen.

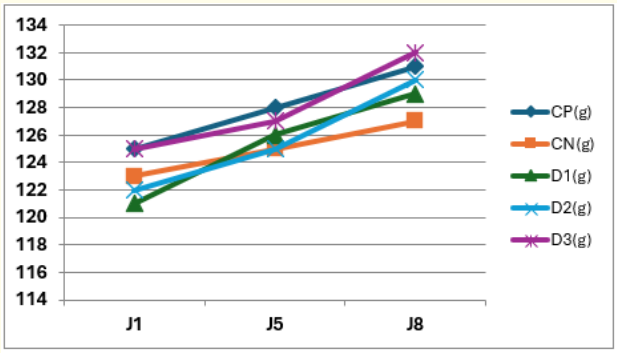

Figure 1: *Weight evolution of rats according to treatments.*

Levels of urea, creatinine, FSH, and testosterone

As shown in table 2, the administration of different doses of the extract to the rats resulted in a dose-dependent decrease in creatinemia and uremia compared to the control group. It is also noted an increase in serum levels of FSH and testosterone in rats at doses 1 and 2 compared to the negative control.

Treatment	FSH (ng/mL)	Testosterone (ng/mL)	Creatinine	Urea
CP	47.74	2.58	1.50	49.6
CN	24.54	1.2	1.30	45.01
D1	32.18	1.88	1.10	43.75
D2	38.84	2.39	1.10	42.60
D3	23.44	1.99	0.90	39.97

Table 2: *levels of blood FSH, testosterone, urea, and creatinine in rats according to treatments.*

The analysis of table 3 reveals a slight reduction in transaminase levels in the three treated groups compared to the positive control group. Similarly, the administration of various doses of extract to the animals led to a reduction in total cholesterol levels, triglycerides, LDL, and an increase in HDL.

Treatment	Total cholesterol	HDL	LDL	Triglyceride	ASAT	ALAT
CP	162.60 ± 8.36	33.93 ± 6.23	102.90 ± 7.36	118.87 ± 5.20	58.64	50.68
CN	127.02 ± 11.04	39.29 ± 4.299	72.30 ± 6.24	87.1 ± 4.27	52.73	49.15
D1	161.90 ± 6.91	41.35 ± 6.06	98.52 ± 4.57	110.17 ± 8.36	52.13	48.94
D1	152.50 ± 5.22	42.42 ± 3.27	90.59 ± 8.2	97.45 ± 8.28	50.19	43.16
D3	129.42 ± 8.12	46.19 ± 5.24	64.52 ± 6.33	93.57 ± 6.20	49.72	40.39

Table 3: *Impact of different treatments on transaminase levels and the lipid profile.*

Discussion

In many cultures, including Ngaoundéré, traditional healers play a crucial role in managing male infertility. These practitioners use medicinal plants and traditional remedies passed down from generation to generation.

Sociodemographic characteristics of traditional healers

Traditional healers are often individuals with extensive experience in traditional medicine, which is generally correlated with age. Older traditional healers are often perceived as wiser and more experienced. Their advanced age can inspire trust and respect within the community, which is crucial for the acceptance of their treatments [18]. The experience accumulated over the years allows traditional healers to pass on valuable knowledge to the next generations, thus ensuring the continuity of traditional practices [19]. Most traditional healers acquire their knowledge through informal learning, often passed down from generation to generation. Indeed, unlike modern medicine, the training of traditional healers is based on practical learning and direct observation. This can influence the way they perceive and treat diseases [20]. The gender of traditional healers can also play a role in the dynamics of their practices. In some cultures, men are more often traditional healers, which can influence the types of treatments offered and the manner in which they are administered. However, women also play a crucial role, particularly in reproductive care [21].

Effect on reproductive function

The results of the hormonal assay revealed a significant increase in testosterone and follicle-stimulating hormone (FSH) levels in rats treated with *Syzygium aromaticum* and *Zingiber officinale* extract at a concentration of 292 mg/kg. These hormones are crucial for the regulation of spermatogenesis and male reproductive function. FSH stimulates the Sertoli cells in the testes, which is essential for sperm maturation, while testosterone, produced by the Leydig cells, is necessary for the development of secondary sexual characteristics and the

maintenance of libido [22]. Provirion (Mestérolone), a drug used as a positive control in this study, binds to its target receptors, leading to the activation of the PI3K enzyme. This enzyme phosphorylates phosphatidylinositol-4,5-bisphosphate (PIP2) to form phosphatidylinositol-3,4,5-trisphosphate (PIP3). PIP3 acts as a second messenger that recruits and activates Protein Kinase B (AKT) by phosphorylating it at the Thr308 and Ser473 residues. The activation of the PI3K/AKT pathway stimulates cell proliferation and steroidogenesis.

In Leydig cells, the activation of this pathway can increase testosterone synthesis, thereby contributing to the improvement of reproductive function. The bioactive components present in Syzygium aromaticum, such as eugenol, and in Zingiber officinale, like gingerol, can also activate the PI3K/AKT pathway. Moreover, the activation of this pathway can also influence the release of FSH by the pituitary gland, thereby contributing to the regulation of gametogenesis and the improvement of fertility. These results corroborate certain previous studies that have shown that eugenol, a phenolic compound present in cloves, has been shown to activate the PI3K/AKT pathway, contributing to anti-inflammatory and anti-apoptotic effects. Gingerol, the main active compound in ginger, also possesses modulatory properties on the PI3K/AKT pathway. It can activate this pathway, leading to an increase in AKT activation, which is associated with protective effects against oxidative stress and apoptosis in various cells [23]. These results corroborate with those of Chaieb., *et al*. [15] who demonstrated that the extract of *Syzygium aromaticum* possesses antioxidant properties that can improve sperm quality and increase testosterone levels. Similarly, Khaki., *et al.* [16] reported that *Zingiber officinale* can improve sperm motility and viability, probably due to its antioxidant and anti-inflammatory effects. These results corroborate the traditional use of these plants to improve male fertility.

Effect on urea and creatinine levels

The administration of extracts of *Syzygium aromaticum* and *Zingiber officinale* showed a dose-dependent decrease in creatinine and urea levels in the treated rats, compared to the control group. These results suggest a potential beneficial effect of these extracts on renal function. Recent studies have confirmed that the active components of these plants, such as polyphenols and flavonoids, can exert nephroprotective effects by reducing oxidative stress and inflammation in renal tissues. A study conducted by Fatima., *et al.* [24] revealed that the administration of *Syzygium aromaticum* improves renal function markers in rats subjected to oxidative stress. The analysis of AST and ALT levels showed a slight decrease in the treated groups compared to the positive control. This indicates that extracts of *Syzygium aromaticum* and *Zingiber officinale* could have a hepatoprotective effect. Current research supports that these plants possess antioxidant properties that can protect the liver from damage caused by toxic substances [25]. A study by Abdulaziz., *et al.* [26] demonstrated that *Zingiber officinale* extract reduces transaminase levels in the context of induced liver damage, indicating a potential for liver protection. Similarly, *Syzygium aromaticum* has been documented for its beneficial effects on liver health, partly due to its phenolic compounds that reduce inflammation and oxidative stress [27]. Effect of the extract on the lipid profile the administration of extracts from *Syzygium aromaticum* and *Zingiber officinale* showed significant effects on the lipid profile of rats. The results indicate a decrease in total cholesterol, triglycerides, LDL (low-density lipoproteins), and an increase in HDL (high-density lipoproteins), suggesting a potential benefit for cardiovascular health. Zingiber officinale, commonly known as ginger, has also demonstrated hypolipidemic effects, contributing to the reduction of total cholesterol and triglyceride levels in several studies [28]. An increase in HDL and a decrease in LDL were observed with the administration of this extract. Indeed, an increase in HDL levels and a reduction in LDL levels are crucial for the prevention of cardiovascular diseases [29]. Similarly, ginger has been reported to improve the lipid profile by increasing HDL and decreasing LDL, thereby enhancing its cardiovascular health benefits [30].

Conclusion

The study demonstrated that extracts of *Syzygium aromaticum* and *Zingiber officinale* led to an increase in testosterone and FSH levels in rats. This convergence between scientific data and traditional knowledge strengthens the credibility of traditional practitioners and suggests that traditional remedies can be validated and integrated into modern medical approaches.

Bibliography

1. World Health Organization. "Infertility prevalence estimates, 1990-2021». ISBN 978-92-4-006831-5 (version électronique) ISBN 978-92-4-006832-2 (version imprimée) (2023).

2. Carson SA and Kallen AN. "Diagnosis and management of infertility». *Journal of the American Medical Association* 326.1 (2021): 65-76.

3. Agarwal A., *et al*. "A unique perspective on male infertility worldwide». *Reproductive Biology and Endocrinology* 13.1 (2015): 37.

4. Agostini F., *et al*. "Psychosocial support for infertile couples during assisted reproductive technology treatment». *Fertility and Sterility* 95.2 (2011): 707-710.

5. Abebe MS., *et al*. "Primary and secondary infertility in Africa: Systematic review with meta-analysis». *Fertility Research and Practice* 6.1 (2020): 20.

6. Tsevat DG., *et al*. "Sexually transmitted diseases and infertility». *American Journal of Obstetrics and Gynecology* 216.1 (2017): 1-9.

7. Perkash I., *et al*. "Reproductive biology of paraplegics: Results of semen collection, testicular biopsy and serum hormone evaluation». *Journal of Urology* 134.2 (1985): 284-288.

8. Dong B., *et al*. "Treatment of ejaculatory duct obstruction by seminal vesiculoscopy assisted flow modification». *Journal of Visualized Experiments* 8 (2023): 202.

9. Jimoh AG., *et al*. "Semen parameters and hormone profile of men investigated for infertility at Midland Fertility Center». *Journal of Basic and Applied Sciences* 8.1 (2012): 16-19.

10. Udoji NJ., *et al*. "Effect of methanolic extract of *Uvaria chamae* and *Cassytha filiformis* on reproductive hormones of female albino rats». *International Journal of Biological and Chemical Sciences* 15.5 (2021): 1717-1724.

11. Djuidje K., *et al*. "Effects of the mixture of *Erigeron floribundus* (Asteraceae) and *Tragia benthamii* (Euphorbiaceae) on the growth and architecture of estrogen-sensitive sexual organs». *Pharmacology and Pharmacy* 12.12 (2021): 269-282.

12. Watcho P., *et al*. "In/ex copula ejaculatory activities of aqueous and methanolic extracts of *Aframomum melegueta* (Zingiberaceae) in sexually experienced male rats». *Andrologia* 50.2 (2023): 12861.

13. Lienou AL., *et al*. "Effect of the aqueous extract of *Seneciobiafrae* (Oliv. & Hiern) J. Moore on some fertility parameters in immature female rats». *Journal of Ethnopharmacology* 161 (2015): 156-162.

14. Yemele D., *et al*. "Ethnobotanical survey of medicinal plants used for pregnant women's health conditions in Menoua division-West Cameroon». *Journal of Ethnopharmacology* 160 (2015): 14-31.

15. Chaieb K., *et al*. "The chemical composition and biological activity of clove essential oil, *Eugenia caryophyllata* (*Syzygium aromaticum* L. Myrtaceae): A short review». *Phytotherapy Research* 21.6 (2011): 501-506.

16. Khaki A., *et al*. "The effects of ginger on spermatogenesis and sperm parameters of rat». *Iranian Journal of Reproductive Medicine* 7.1 (2012): 7-12.

17. Ali BH., *et al*. "Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale* Roscoe): A review of recent research». *Food and Chemical Toxicology* 46.2 (2013): 409-420.

18. Ngarivhume T., *et al*. "Medicinal plants used by traditional healers for the treatment of malaria in the Chipinge district in Zimbabwe». *Journal of Ethnopharmacology* 159 (2015): 224-237.

19. Gessler MC., *et al*. "Traditional healers in Tanzania: The perception of malaria and its causes». *Journal of Ethnopharmacology* 48.3 (2013): 119-130.

20. Mabina MH., *et al*. "The role of traditional healers in the fight against HIV/AIDS: A case study of Leribe District, Lesotho». *African Journal of Traditional, Complementary and Alternative Medicines* 14.2 (2017): 10-17.

21. Green EC., *et al*. "The experience of an AIDS prevention program focused on South African traditional healers». *Social Science and Medicine* 40.4 (2014): 503-515.

22. Oduwole OO., *et al*. "Role of follicle-stimulating hormone in spermatogenesis». *Frontiers in Endocrinology* 9 (2018): 763.

23. Koo HJ and Lee JH. "The protective effect of eugenol and gingerol on oxidative stress-induced apoptosis in human dermal fibroblasts». *Journal of Ethnopharmacology* 194 (2016): 69-76.

24. Fatima H., *et al*. "Therapeutic potential of selected medicinal plants against carrageenan induced inflammation in rats». *Dose-Response* 19.4 (2021): 15593258211058028.

25. Kone M., *et al*. "Evaluation de la toxicité d'un extrait aqueux de *Sacoglottis gabonensis* (Baille) Urban (Humiriaceae) chez les rongeurs, une plante utilisée dans le traitement de l'ulcère de Buruli en Côte d'Ivoire». *International Journal of Biological and Chemical Sciences* 3.6 (2009): 1286-1296.

26. Bardi DA., *et al*. "*In vivo* evaluation of ethanolic extract of *Zingiber officinale* rhizomes for its protective effect against liver cirrhosis». *BioMed Research International* (2013): 918460.

27. Liew KY., *et al*. "A review of Malaysian herbal plants and their active constituents with potential therapeutic applications in sepsis». *Journal of Herbal Medicine* 20 (2020): 100329.

28. Tsui P-F., *et al*. "Spices and atherosclerosis». *Nutrients* 10.11 (2018): 1724.

29. Adli DN., *et al*. "The effects of herbal plant extract on the growth performance, blood parameters, nutrient digestibility and carcass quality of rabbits: A meta-analysis». *Heliyon* 10.4 (2024): e25724.

30. Maranhão RC and Freitas FR. "Metabolism and atheroprotection». Advances in Clinical Chemistry (2014): 1-30.

Volume 22 Issue 2 February 2026