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Ethnobotanical survey and pharmacological evaluation of aphrodisiac plants used in the department of Oumé (Central-West Côte d'Ivoire)

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ABSTRACT

Erectile dysfunction is a major public health issue. The aim of this study was to identify local aphrodisiac plants in order to evaluate their pharmacological properties. An ethnobotanical survey was conducted in the department of Oumé using the snowball sampling technique. Subsequently, various secondary metabolites were identified through tube analysis. For the pharmacological tests, rats were divided into control and experimental groups receiving orally aqueous extracts of *Turraea heterophylla* and *Buxus acutata* for 21 consecutive days. Sexual parameters (mounts, urogenital sniffing) were measured on days 7, 14, and 21, and serum testosterone levels were assessed on day 22 of the experiment. The ethnobotanical survey identified ten aphrodisiac species, divided into five morphological types: shrubs, trees, herbs, lianas, and fungi. *Turraea heterophylla* (31.5%) and *Buxus acutata* (27.8%) were the most frequently cited. The phytochemical study revealed the presence of polyphenols, tannins and saponins known for their aphrodisiac properties, in the aqueous extracts of the two plants. In rats treated with plant extracts, the frequency of urogenital sniffing and mounts increased significantly, particularly at doses of 300 and 600 mg/kg. Serum testosterone levels showed a significant increase with *Turraea heterophylla* extracts, reaching 2.49 ± 0.21 and 5.69 ± 0.45 ng/mL, compared to 0.49 ± 2.85 ng/mL in the control group. *Buxus acutata* extracts produced the highest values, at 7.07 ± 0.44 and 9.35 ± 0.51 ng/mL. These results support the traditional use of these plants and highlight the need for further safety studies.

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INTRODUCTION

Erectile dysfunction (ED) is a major public health problem, affecting patients' sexual lives and well-being. Its prevalence varies from 5 to 35% in men of reproductive age and increases with age: approximately 40% of men over 40 and more than 70% of men in their seventies suffer from it (Gebrie *et al.*, 2026; Sarnoski *et al.*, 2026). Globally, the number of people affected could rise from 152 million in 1995 to 322 million in 2025. In Africa, 40 to 70% of men are affected by this condition. The main causes include hypertension, cardiovascular disease, diabetes, depression, and low testosterone. Often associated with vascular risks, ED can then reveal underlying pathologies such as coronary artery disease, hyperlipidemia or benign prostatic hyperplasia (Saffati *et al.*, 2026). It is thus considered a true barometer of health.

Erectile dysfunction, long hidden from view, causes profound distress, because sexuality represents much more than a simple act of procreation. Drug treatments, although prescribed according to the etiology of erectile dysfunction, are frequently associated with adverse effects such as liver toxicity, cardiovascular complications, and stimulation of prostate growth. Furthermore, their high cost is a significant limitation to their accessibility (Salonia *et al.*, 2023).

In the face of this, interest in alternatives to natural substances continues to grow. In Africa, many plants are traditionally used for their aphrodisiac or androgenic properties, such as *Zingiber officinalis*, *Aframomum melegueta*, *Piper guineensis*, *Mondia whitei*, *Basella alba* (Moundipa *et al.*, 1999; Watcho *et al.*, 2004; Akinmoladun *et al.*, 2022; Okeke *et al.*, 2024). This traditional knowledge has sparked the interest of researchers in the development of medicinal plants. In this context, evaluating the aphrodisiac properties of plants used in Oumé to treat male reproductive disorders appears relevant.

MATERIALS AND METHODS

Ethnobotanical survey

The survey was conducted in the Oumé Department. A survey form was developed to guide semi-structured interviews with traditional healers in the department. The snowball sampling technique was used for individual interviews, which was designed to gather high-quality information. Questions were asked to understand how plants are used in treatments. Traditional leaders, such as village chiefs and interpreter-guides, facilitated access to the healers.

Collection and identification of plant species

Following the semi-structured interview with the traditional healers, a second appointment was scheduled for the collection of plant parts. This allowed for verification of the accuracy of the information provided by the healer. The samples were photographed, and herbarium specimens were prepared. The botanical identification of the species was confirmed at the National Floristic Center (CNF) at Felix-Houphouët Boigny University, Abidjan, Cocody, Côte d'Ivoire. The APG (2016) classification system was adopted for the taxonomic names.

The citation frequency (C.F.) was calculated using the formula employed in the work of Dossou *et al.* (2012):

$$CF=(n/N)\times100$$

Where n is the number of people who mentioned the plant and N is the total number of people surveyed.

Preparation of aqueous extracts

The plant parts were harvested, cleaned, rinsed, and then dried in a well-ventilated room for two weeks. The dried samples were ground into fine powders, which were then stored in glass jars.

The extraction method used in this study was maceration. 25 g of plant powder were mixed with 250 mL of distilled water. The mixture was placed in a blender, blended, and then filtered. Each blending cycle lasted half a minute, and the process was repeated five times. The resulting filtrate was evaporated in an oven at 45°C for 48 hours. The dry extracts obtained were weighed and then stored in jars for further testing.

Phytochemical screening

Tests for the detection of major groups of chemical compounds were carried out on the dry residues of plant extracts. The analytical techniques described in the work of Bekro *et al.* (2007) were used to identify phytocompounds.

Acute toxicity

The toxicity test was conducted using the OECD 425 dose adjustment method (OECD, 2001). The test consisted of testing aqueous extracts of *Buxus acutata* root and *Turraea heterophylla* stem at a dose of 2000 mg/kg body weight (BW). For each plant extract, the test was conducted with 6 female mice of the species *Mus musculus*. Thus, after 15 hours of fasting (from 6 p.m. to 9 a.m. the following day), the mice were equally divided into control and experimental groups. The control group consisted of three (3) female mice that received distilled water. The experimental groups consisted of 3 female mice each that received plant extracts at a dose of 2000 mg/kg BW at a rate of 10 ml/kg BW. The animals' behavior (mobility, tremors, grooming, respiration, agitation, fecal appearance, and mouse death) was monitored 3 hours after administration of the plant extracts and then over a period of 14 days. During this period, weight variations were noted. The experiment was repeated with either 5000 mg/Kg BW or 300 mg/Kg BW, when all the mice survived or had died respectively during the 14 days of follow-up.

Determination of the LD_{50}

The 50% lethal dose (LD50) represents the dose of a substance that causes the death of half of these individuals after a specific time when administered to a batch of individuals of a given species. It is determined from the TREVAN curve which translates the percentage of mortality of treated subjects as a function of the decimal logarithm of the administered doses. For this purpose, 50 female mice weighing between 20 and 25 g were divided into 5 groups of 10 mice each, treated respectively with 1800, 1400, 1000 and 600 mg/kg PC of aqueous extract of *Buxus acutata* root. The animals in the control group received distilled water. The substances were administered at a rate of 10 mL/kg body weight. At the end of the 14-day experiment, the number of deaths was recorded for the Trevan curve.

Evaluation of aphrodisiac properties in male rats treated with *Buxus acutata* and *Turraea heterophylla*

The animals were divided into five (5) groups of five (5) male rats each. They were fasted for 24 hours and treated for 21 consecutive days with aqueous extracts of *Buxus acutata* and *Turraea heterophylla*. Group 1, a negative control, received distilled water (0.5 mL/100 g per day). Groups 2, 3, 4, and 5 were treated with the aqueous extracts at doses of 300 and 600 mg/kg body weight (BW) per day, respectively. All products were administered orally. On days 4, 11, and 18 of treatment for male rats, 30 female rats were treated with subcutaneous injections of estradiol (Ethinyl-estradiol EFFIK 50 µg) (600 µg/kg body weight/day) for three days to induce receptivity (Wankeu-Nya *et al.*, 2014; Ondele *et al.*, 2015). On days 7, 14, and 21, the animals were placed in cages in pairs, six hours after the last administration. Sexual parameters such as the number of mating events and anogenital sniffing were observed for one hour.

Evaluation of androgenic properties

The test was performed following a slightly modified protocol from Talla *et al.* (2021). The animals were divided into five (5) groups of five (5) male rats each. The rats received the different plant extracts orally via a feeding tube for 21 consecutive days. Group 1, the negative control, received distilled water (0.5 mL/100 g per day), while groups 2, 3, 4, and 5 were treated with aqueous extracts of *Buxus acutata* and *Turraea heterophylla* at doses of 300 mg/kg and 600 mg/kg BW per day for three weeks. On day 22, the animals were sacrificed by decapitation, and their blood was collected in tubes, centrifuged, and the resulting serum was used for testosterone measurement.

Statistical analyzes

The survey data were entered using Epidata 3.1 software and transferred to GraphPad Prism 8.0.1 software for the analysis of the pharmacological trial

data. Results are presented as means (± standard deviation). The difference between means was determined by one-way analysis of variance. Significant differences between means were determined at the theoretical threshold α = 5%. The smallest significant difference between means was determined using Dunnett's test. Microsoft Excel 2007 software was used to generate the graphs.

RESULTS

Sociodemographic characteristics

The sociodemographic characteristics of the participants are presented in Fig. 1. A total of 120 people, comprising 37 women and 83 men, were interviewed. The highest proportion of those with no formal education (45.84%) was identified, followed by those with a primary school education (38.33%). Three age groups were identified, with the 46–65 age group being the most represented at 44.16%, followed by the 29–45 age group at 35%.

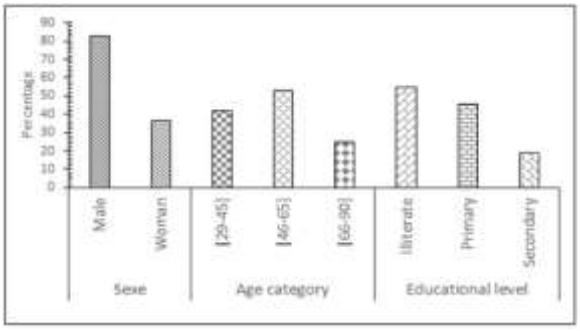


Fig. 1. Socio-demographic characteristics of the traditional healers interviewed

Variety of aphrodisiac plants

A list of ten (10) aphrodisiac species was compiled following an ethnobotanical survey conducted in the Oumé Department. These species are distributed among 9 genera and 9 botanical families. The two plants with the highest citation frequencies are *Turraea heterophylla* Sm (Meliaceae) and *Buxus acutata* Friis (Buxaceae). The most represented family was Malvaceae, with a citation frequency of 20%. The plants belong to five (5) morphological types: shrubs, trees, herbs, lianas, and fungi. The most represented morphological type is the shrub, at 55.55%. The species are divided into two phytogeographical types : the Guineo-Congolian (GC) type and the Guineo-Congolian and Sudano-Zambezian (GC-SZ) type. The Guineo-Congolian type was the most represented, with a frequency of 66.67% (Table 1).

Preparation methods and routes of administration

Aphrodisiac remedies are prepared using solvents such as water, liquor, koutoukou (traditional alcohol), and palm wine. The proportions are such that koutoukou, at 41.89%, is the most commonly used solvent, followed by liquor (36.49%), water (12.12%), and palm wine (9.50%). Maceration is used in 77.03% of cases, and mastication in 22.97%. All preparations were administered orally.

Plants selected for the study

The plants were selected based on their high citation frequency and the fact that they have been less investigated in this area. Thus, *Turraeae heterophylla* (Meliaceae) and *Buxus acutata* (Buxaceae), with citation frequencies of 31.5% and 27.8% respectively, were selected for this study. Water, which is universally accepted, was used as the solvent for the extractions.

Qualitative phytochemical composition of plant extracts

Phytochemical studies have revealed the presence of polyphenols, tannins, sterols, polyterpenes, flavonoids, and alkaloids in the various plant extracts. Extracts of *Turraea heterophylla* contain all the compounds mentioned above. *Buxus acutata* contains all the compounds mentioned, except for the alkaloids.

Acute toxicity following administration of plant extracts

The study of the acute toxicity of aqueous stem extracts of *Turraea heterophylla* (Meliaceae) revealed that at doses of 300 and 2000 mg/kg BW, no observed toxicological parameters were affected compared to the control. At a dose of 5000 mg/kg BW, immediately after administration of the extracts,

mice exhibited accelerated respiration, which returned to normal one hour later. At the end of the 14-day observation period, no deaths were observed in the mice treated with *Turraea heterophylla* extracts at the administered doses. At a dose of 300 mg/kg BW of the aqueous extract of *Buxus acutata* root (Buxaceae), no signs of toxicity were observed. However, at a dose of 2000 mg/kg BW, abnormal signs such as accelerated respiration, agitation, and paralysis of the lower limbs were observed. The animals subsequently died one hour after administration of the extract.

Table 1. Ethnobotanical characteristics of the aphrodisiac plants

N°	Scientific name	Family	Chorology	Morphology	Organs used	CF
1	*Turraea heterophylla* Sm	Meliaceae	GC	Shrub	Stem	31.5
2	*Buxus acutata* Friis	Buxaceae	GC	Shrub	Stem, Roots	27.8
3	*Euadenia trifoliate* (Schumach. & Thonn.) Oliv.	Capparaceae	GC	Shrub	Roots	9.25
4	*Paullinia pinnata* L.	Sapindaceae	GC-SZ	Liana	Roots, Stem	9.25
5	*Microdesmis keayana* J. Leonard	Pandaceae	GC	Shrub	Roots, Stem	5.55
6	*Termitomyces schimperi* (Pat.) R. Heim	Lyophyllaceae	GC	Mushroom	fruiting bodies	5.55
7	*Abutilon mauritianum* (Jacq.) Medik. (L.)	Malvaceae	GC-SZ	Shrub	Stem, Leaves	3.7
8	*Lannea acida* A. Rich	Anacardiaceae	GC-SZ	Tree	Stem	3.7
9	*Cola nitida* (Vent.) Schoott & Endl.	Malvaceae	GC	Tree	Seeds	1.85
10	*Palisota hirsute* (Thunb.) K. Schum	Commelinaceae	GC	Herb	Roots	1.85

CF: Citation frequency; GC: Guineo-Congolian; GC-SZ: Guineo-Congolian/Sudano-Zambezian

Table 2. Mortality rates after administration of the aqueous extract of *Buxus acutata*

Lot	A	B	C	D
Doses (mg/Kg BW)	1800	1400	1000	600
Total number of mice	10	10	10	10
Number of dead mice	8	6	4	0
% mortality	80%	60%	40%	0%

Determination of the LD_{50} of aqueous extracts of *Buxus acutata* root.

Determination of the LD_{50} of aqueous extracts of *Buxus acutata* root

Administration of the extracts at doses of 1800, 1400, 1000, and 600 mg/kg body weight resulted in dose-dependent animal death ranging from 80% to 40% (Table 2). Thus. the LD50 of the *Buxus acutata* (Buxaceae) extract, determined by the Trevan method, was 1182 mg/kg body weight (Fig. 2).

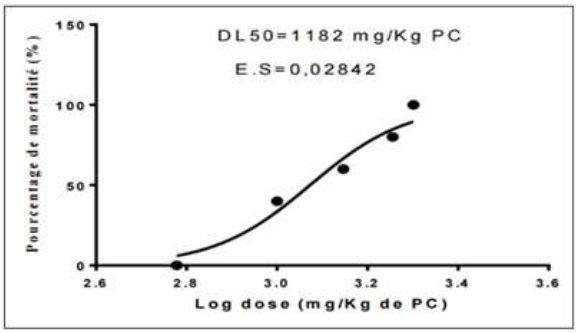


Fig. 2. LD_{50} determination curve of the aqueous extract of Buxus acutata.

Classification of plant extracts according to the Hodge and Sterner scale (1943)

Table 3 shows the classification of plant extracts according to their toxicity index. The results showed that the *Turraea heterophylla* extract is not toxic when administered in a single dose of up to 5000 mg/kg body weight. As for the aqueous extract of Buxus acutata root. it is slightly toxic according to the classification of Hodge and Sterner (1943).

Aphrodisiac properties of *Buxus acutata* and *Turraea heterophylla* in rats

Effect of plant extracts on animal weight

The administration of aqueous plant extracts at doses of 300 mg/kg and 600 mg/kg BW did not cause any changes in animal behavior. No mortality was recorded during the 21 days of treatment. Fig. 3 shows the weight gain of all treated animals. This weight gain was significantly low ($p < 0.0001$) compared to the negative control and for each week.

Table 3. Toxicity class according to the Hodge and Sterner toxicity scale (1943)

Plant species	Organs	Method of preparation	LD_{50} interval	Toxicity index
Buxus acutata	Roots	Maceration	$300<LD_{50}<2000$	Slightly toxic
Turraea heterophylla	Stem	Maceration	$LD_{50}>5000$	Almost non-toxic

LD_{50} : Lethal dose likely to kill 50% of animals.

Table 4. Effects of extracts of *Buxus acutata* and *Turraea heterophylla* on serum testosterone levels

plant extract	Doses (mg/Kg)	testosterone levels (ng/mL)
Control		0.49 ± 0.85
Buxus acutata	300	7.07 ± 0.44****
	600	9.35 ± 0.51****
Turraea heterophylla	300	2.49 ± 0.21*
	600	5.69 ± 0.45****

Effect of aqueous plant extracts on testosterone production in rats.

* $p < 0.05$: significant difference compared to the control

**** $p < 0.01$: very highly significant difference compared to the control

Table 5. Effect of extracts on sniffing frequency

	Day 0	Day 7	Day 14	Day 21
Control	26.20 ± 1.74	27. 20 ± 1.88	30 ± 2.7	27.20 ± 1.28
Buxus 300	26.80 ± 2.39	30 ± 3	33 ± 1.37	30 ± 3.53
Buxus 600	29 ± 1.78	29 ± 2	35 ± 1.84	21 ± 1.14
Turraea 300	22.60 ± 1.99	19 ± 1.41	28 ± 2.6	39 ± 4.49*
Turraea 600	29 ± 1.89	45 ± 5***	40 ± 1.7**	40 ± 0.7**
Anova Summary				
DF		5		
F	1.654	9.152	5.875	10.71
Pvalue	0.184	< 0.0001	< 0.0001	< 0.0001
R^2	0.256	0.656	0.55	0.69

Effect of extracts on the frequency of anogenital sniffing. Buxus 300: Aqueous extract of *Buxus acutata* at a dose of 300 mg/kg body weight; Buxus 600: Aqueous extract of *Buxus acutata* at a dose of 600 mg/kg body weight.

* $p < 0.05$: significant difference compared to the control

** $p < 0.01$: very significant difference compared to the control

*** $p < 0.05$: highly significant difference compared to the control

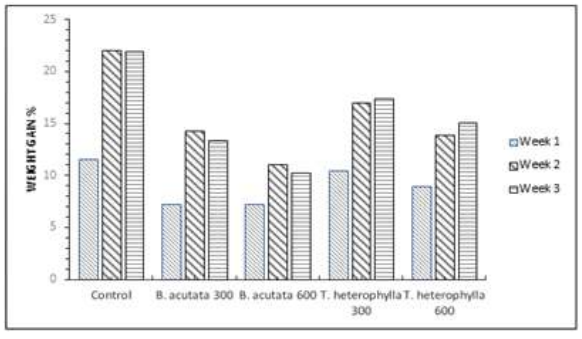


Fig. 3. Weight gain during treatment

Effect of aqueous plant extracts on testosterone production in rats

After 21 days of treatment, a significant increase in testosterone levels was observed in rats treated with extracts of *Buxus acutata* and *Turraea heterophylla* compared to controls. In animals treated with extracts of *Buxus acutata* plants, serum testosterone levels were 7.07 ± 1.44 ng/mL and 9.35 ± 0.51 ng/mL at doses of 300 and 600 mg/kg body weight, respectively. Compared to the control (0.49 ± 0.85 ng/mL), these testosterone levels observed with *Buxus acutata* were significantly higher ($p < 0.0001$).

The serum testosterone level in animals treated with *Turraea heterophylla* extract was 2.49 ± 0.21 ng/mL at a dose of 300 mg/kg and 5.69 ± 0.45 ng/mL at a dose of 600 mg/kg. As shown in Table 4. aqueous extracts of *Turraea heterophylla* caused a significant increase ($p < 0.05$) in serum testosterone levels at a dose of 300 mg/kg body weight. At a dose of 600 mg/kg body weight, the increase was highly significant ($p < 0.0001$).

Effect of extracts on the frequency of anogenital sniffing

The results showed a variation in the number of anogenital sniffs in all treated groups (Table 5). A significant increase was observed in animals treated with *Turraea heterophylla* extract. On days 7 and 14 of treatment with the aqueous extract of *Turraea heterophylla* at a dose of 600 mg/kg, the number of sniffs increased significantly ($p < 0.0001$) compared to the control. On day 21 of treatment, this significant increase ($p < 0.05$) was observed at doses of 300 and 600 mg/kg.

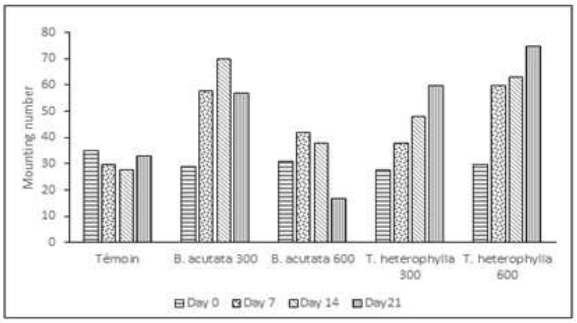


Fig. 4. Effect of extracts on the frequency of mounts

Effect of aqueous plant extracts on the frequency of mounting

In general, an increase in mounting behavior was observed in animals receiving plant extracts during this study (Fig. 4). Regarding the aqueous extract of *Buxus acutata* root, at a dose of 300 mg/kg BW, the number of mounts increased significantly ($p<0.001$) on days 7, 14, and 21 ($p<0.0001$). At a dose of 600 mg/kg BW, a non-significant increase ($p>0.05$) was observed on days 7 and 14 compared to the control. Then, on day 21, a significant decrease in the number of mounts was observed. This decrease (17 ± 0.7) was highly significant ($p < 0.001$) compared to the control (33 ± 1.84). With *Turraea heterophylla*, the number of mounts in rats increased with each weekly observation. At a dose of 300 mg/kg PC, the increase was significant ($p < 0.001$) from day 14 (48 ± 3.7) and highly significant ($p < 0.0001$) on day 21 (60 ± 2.23). At a dose of 600 mg/Kg of BW, from the first week of treatment, a significant increase ($p<0.0001$) is observed and this continues until the 21st day compared to the control.

DISCUSSION

The ten (10) identified aphrodisiac plants belong to nine (9) genera distributed across nine (9) distinct botanical families. This study reveals that *Buxus acutata* and *Turraea heterophylla* have the highest citation frequencies. This suggests that these plants are the most accepted by the population of Oumé. Some of the ten identified plants have already been the subject of previous studies.

This is the case with *Turraea heterophylla*. Mentioned as an aphrodisiac plant by Tra Bi (1997) and Opa (2001). As for Fah *et al.* (2019), *Euadenia trifoliolata* possesses stimulant and androgenic effects. These results justify the traditional use of these aphrodisiac species. *Buxus acutata* is cited as an aphrodisiac plant for the first time. Regarding plant parts, roots and stems are the most commonly used because they are most often used in toothpicks or in alcoholic preparations called bitters. Several scientific studies have confirmed that alcoholic bitters are generally prepared from plant parts such as roots, stems, or bark. Indeed, these parts concentrate the majority of the bioactive compounds. The results obtained in the present study partly agree with those of Erhabor and Idu (2017), who showed that the roots of *Aloe barbadensis* are traditionally used as an aphrodisiac. Also, the studies of Azonbakin *et al.* (2021) on aphrodisiac plants shows that the roots are the most used organs after the leaves.

The acute toxicity assessment of the aqueous extract of *Turraea heterophylla* showed that at doses up to 5000 mg/kg body weight, no mortality was observed in the tested animals. The LD_{50} is therefore estimated to be greater than 5000 mg/kg, which allows the extract to be considered non-toxic, in accordance with the OECD (2001) criteria stipulating that a substance with an LD_{50} exceeding this threshold is classified as non-toxic. In contrast, administration of the aqueous extract of *Buxus acutata* at a dose of 2000 mg/kg BW induced signs of respiratory distress, agitation, and paralysis of the hind legs, preceding the death of the mice. These observations could be due to the extract's effect on the animal's central nervous system.

The observed mortality could be attributed to respiratory and cardiac arrest. Further investigations showed that the LD_{50} of the aqueous extract of *Buxus acutata,* administered orally, is estimated at 1182 mg/kg body weight. According to the criteria proposed by Hodge and Sterner (1943), this extract can be classified as a slightly toxic substance.

Phytochemical screening of *Buxus acutata* and *Turraea heterophylla* shows that these plants contain polyphenols (tannins and flavonoids), steroids (saponins, sterols, and polyterpenes), and alkaloids. These compounds are important pharmacodynamic groups capable of stimulating male sexual activity (Watcho *et al.,* 2007). Like flavonoids and saponins, alkaloids possess androgenic activities. Indeed, these compounds were identified in the work of Boua *et al.* (2013) on *Turraea heterophylla* and Moyabi (2015) on *Buxus acutata* (Buxaceae).

The phytochemical composition of these two plants supports their possible mechanism of action. Oral administration of aqueous extracts of *Buxus acutata* root and *Turraea heterophylla* stem resulted in a significant increase in sexual parameters, including the number of mounts and the number of anogenital sniffs. Furthermore, these extracts stimulated endogenous serum testosterone production in treated rats. The increasing number of mounts could be attributed to flavonoids and sterols present in plant extracts. Indeed, these chemical compounds would induce changes in the levels of neurotransmitters involved in erectile function and modulate their action at the level of target cells in order to increase the level of androgens (Suresh *et al.*, 2000; Chauhan *et al.*, 2014). Other phytochemical compounds may contribute to endogenously increasing testosterone levels and stimulating sexual behavior in rats. This is the case for alkaloids. which act by dilating blood vessels in the penis, while flavonoids, tannins, and polyphenols are known for their erectile potential (Sofidiya *et al.*, 2016). These substances stimulate the formation of androstenedione, a precursor steroid hormone in testosterone biosynthesis (Rukundo, 2007). The various results from this study confirm the traditional use of *Buxus acutata* and *Turraea heterophylla* in the treatment of erectile dysfunction.

CONCLUSION

The ethnobotanical survey conducted in this study identified ten medicinal plants traditionally used in the treatment of erectile dysfunction. Among these, *Buxus acutata* (Buxaceae) and *Turraea heterophylla* (Meliaceae) were the most frequently cited. Phytochemical analyses revealed the presence of phytocompounds known for their androgenic properties. Furthermore, the pharmacological evaluation highlighted the androgenic potential of the aqueous extract of these two species, which manifested as an increase in testosterone levels, the number of anogenital sniffs, and the number of mounts. These results confirm the relevance of the traditional use of these plants to improve male erections. However, subacute toxicity studies are still needed to guarantee the safety of these remedies, which are widely used by the populations of the Oumé region.

RECOMMENDATION(S)

Aqueous extracts of both plants significantly increased the aphrodisiac parameters studied. For better utilization of these plants, subacute and chronic toxicity studies should be conducted.

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