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Phytochemical profile and toxicity assessment of phytomedicines for hemorrhoids and sexual disorders sold in public transport in Côte d'Ivoire

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Abstract

The sale of herbal medicines is increasing in public transport vehicles in Côte d'Ivoire. Many of these products are promoted as treatments for hemorrhoids or as remedies for sexual and/or reproductive disorders, without any certainty regarding their efficacy and safety. This study aimed to determine the phytochemical profile and assess the acute toxicity of aqueous extracts of plant powders sold in public transport vehicles along three main routes in Côte d'Ivoire. Phytochemical screening and quantification of phenolic compounds were performed using colorimetric and spectrophotometric techniques, respectively, on aqueous extracts from samples purchased on public transport buses. Acute toxicity of the extracts was then evaluated according to OECD 423 guidelines in Wistar rats. Phytochemical analysis revealed that all extracts contained total polyphenols, flavonoids, catecholic tannins, and anthraquinones, but lacked alkaloids, saponins, terpenes, and sterols. Quantitative analysis of phenolic compounds showed low levels ranging from 53 to 438 ± 0.7 mg GAE/g, 11.66 to 698.33 ± 2 mg QE/g, and 0.009 to 0.28 ± 0.8 mg EAT/g of dry extract, for total polyphenols, flavonoids, and tannins, respectively. Furthermore, toxicity tests indicated that none of the extracts were toxic in rats. These findings suggest that these products may be safe for humans, but their effectiveness could be limited due to the absence of certain metabolites known to be useful in the treatment of hemorrhoidal and sexual disorders.

Keywords: Herbal Medicines; Hemorrhoids; Sexual Disorders; Phytochemical Profile; Toxicity

1. Introduction

A medicine is any substance or product used, or intended to be used, to modify a physiological system for the benefit of the subject to whom it is administered [1]. The inappropriate use of different types of medicines, together with their cost, accessibility, toxicity, and the ineffectiveness of some products against emerging diseases, has generated increasing interest in traditional medicine. In order to be closer to the population, several naturopaths have emerged, employing communication and marketing strategies in public spaces, including public transport vehicles in Côte d'Ivoire [2]. Herbal medicines are often the first line of defense for treating illnesses and relieving pain in public transport along various intercity routes. Most of these products are offered by vendors for numerous ailments, particularly those related to hemorrhoids, the sexual system, and reproduction, which are now considered public health issues. The growth of this trade is strongly linked to accessibility, low cost, and testimonials regarding the effectiveness of these products in treating hemorrhoids and sexual disorders. Indeed, certain phytomolecules, such as polyphenols, are believed to have

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beneficial effects in relieving hemorrhoidal pain [3]. However, these herbal remedies often escape formal health control. The sale of medicines in public transport has become a worrying situation for healthcare professionals, as the toxicity and safety of these products remain to be verified [4]. Moreover, the lack of regulation in this sector exposes users to major public health risks, especially since they have no way of knowing the chemical composition of these products. The WHO (2024) reported dangers related to side effects, incorrect dosage, and the hygienic quality of these medicinal products [1]. For these reasons, the present study was initiated to evaluate the phytochemical profile and safety level of traditional medicines sold in public transport in Côte d'Ivoire.

2. Material and methods

3. Plant material

The plant material consisted of nine samples of plant powders sold in public transport vehicles in Côte d'Ivoire. These samples were collected in August 2024 from buses operating along the following intercity routes: Abidjan–Abengourou (AA), Korhogo–Abidjan (KA), and Yamoussoukro–Abidjan (YA). The powders were packaged by vendors in plastic bags and accompanied by instructions for use (Figure 1). For each route, three samples were purchased and transported to the laboratory for the preparation of aqueous dry extracts.

Figure 1 Samples of packaged powders, purchased on public transport

3.1. Animal material

Wistar strain rats, both male and female, with an average body weight of 109.32 ± 0.2 g and aged two months, were used to evaluate the acute toxicity of the plant extracts. The animals were protected from stress and sleep disturbances by maintaining optimized hygiene and feeding conditions [6].

3.2. Preparation of dry extracts of samples

For each sample, aqueous extraction was carried out by maceration following the method described by Kamagaté et al. (2017) [7]. One hundred grams (100 g) of each sample were macerated in one liter (1 L) of distilled water under magnetic stirring for 24 hours. After maceration, each extract was first filtered through a square of white cloth and then double-filtered using absorbent cotton. Finally, the filtrates were oven-dried at 50 °C to obtain the aqueous dry extracts of the different samples.

3.3. Phytochemical screening of extracts

Phytochemical screening of the plant extracts was performed using colorimetric and precipitation tests in test tubes, following the method described by Walid et al. (2016) [8]. The secondary metabolites investigated included total polyphenols, flavonoids, tannins, anthraquinones, alkaloids, saponins, as well as terpenes and sterols.

3.4. Determination of phenolic constituents in extracts

The spectrophotometric method, using specific reagents and reference solutions, was employed to determine total polyphenols (760 nm), flavonoids (510 nm), and tannins (550 nm) (Table I).

Table 1 Spectrophotometric techniques for the determination of phenolic compounds

Metabolites	Reagents	Reference standard molecules	References
Polyphenols Totals	Folin-Ciocalteu Sodium carbonate	Gallic acid	Ruiz-Vasquez *et al* . (2023) [8]
Flavonoids	sodium nitrite aluminum chloride	Quercetin	Shetti *et al.* (2024) [9]
Tannins	vanillin in methanol and hydrochloric acid	Tannic acid	Haroun *et al.* (2023) [10]

3.5. Evaluation of the acute toxicity of the extracts

Acute toxicity of the extracts was evaluated according to OECD guideline no. 423 (2001), using both male and female rats [11]. Ten groups of three rats each were formed, including one control group and nine experimental groups. The groups were treated as follows:

- Batch1 (control): tap water;
- Batch 2, 3, 4: aqueous extracts of the three samples from the aa route;
- Batch 5, 6, 7 : aqueous extracts of the three samples from the ka route;
- Batch 8, 9, 10: aqueous extracts of the three samples from the ya route.

The treatment consisted of fasting the rats for 12 hours, followed by administration of a single dose of 2000 mg/kg body weight of each extract by gavage, using a 5 mL gastric tube. Afterwards, the rats were hydrated and fed dry bread, then monitored every four hours after gavage on the first day, and daily for 14 days, to record the following symptoms: ptosis, piloerection, urinary excretion, response to external stimuli, stool condition, general animal behavior (aggression, mobility, vocalization, convulsions, etc.), as well as mortality.

3.6. Statistical analyses

Graphs were generated using Excel software. Analysis of variance (one-way ANOVA) was performed with Statistica software, version 7.1, followed by the Newman–Keuls test, applied to compare means showing significant differences at the 5% level.

4. Results

4.1. Phytochemical composition of powder extracts

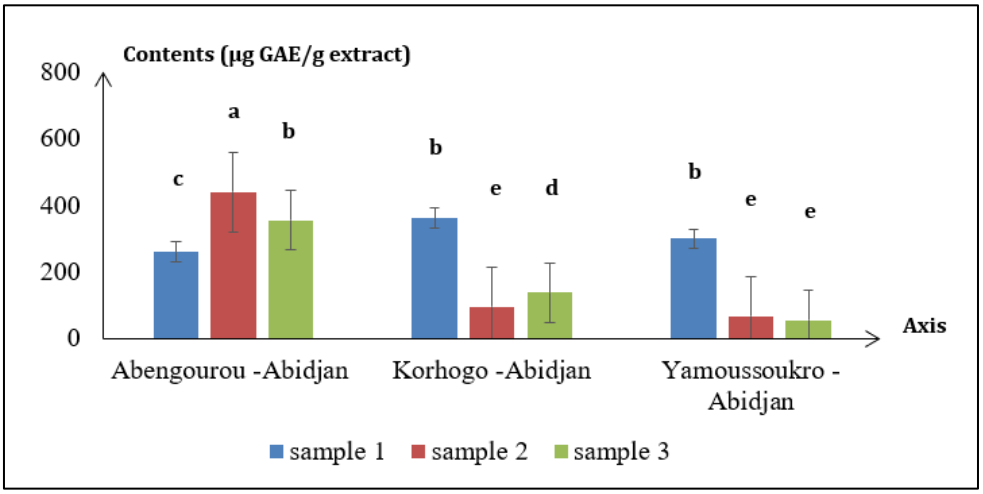
Table II this study presents the secondary metabolites of plant powder extracts. Analysis of the results revealed that all extracts contained the following compounds: total polyphenols, flavonoids, catechins, and anthraquinones. However, the extracts did not contain alkaloids, gallic tannins, saponins, terpenes, or sterols.

Table 2 Secondary metabolites of plant powder extracts

Secondary metabolites	Abengourou -Abidjan axis			Korhogo – Abidjan axis			Yamoussoukro-Abidjan axis		
	sample 1	sample 2	sample 3	Sample 1	Sample 2	sample 3	Sample 1	sample 2	Sample 3
Alkaloids	-	-	-	-	-	-	-	-	-
Total polyphenols	+	+	+	+	+	+	+	+	+
Flavonoids	+	+	+	+	+	+	+	+	+
Catechetical tannins	+	+	+	+	+	+	+	+	+
Gallic tannins	-	-	-	-	-	-	-	-	-
Anthraquinone	+	+	+	+	+	+	+	+	+
Terpenes and sterols	-	-	-	-	-	-	-	-	-
Saponosides	-	-	-	-	-	-	-	-	-

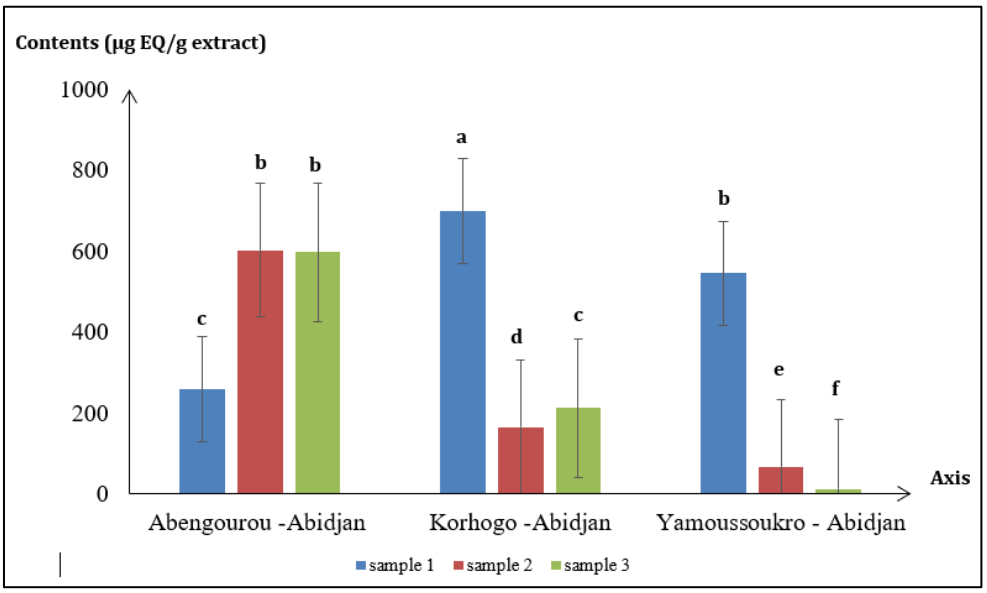
+ : Presence; **-** : Absence

4.2. Phenolic compound content of the extracts



Bands bearing different letters are statistically different ($p \leq 0.05$).

Figure 2 Total polyphenol contents of the extracts

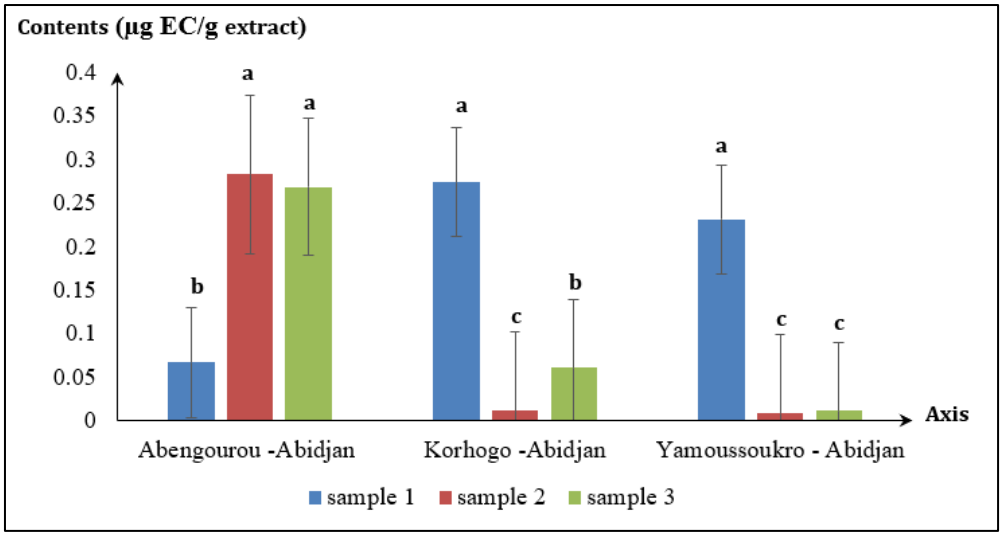


Bands bearing different letters are statistically different ($p \leq 0.05$)

Figure 1 Total flavonoid contents of the extracts

Figures 2, 3, and 4 illustrate the phenolic compound contents of the plant powder extracts. These values were determined from the calibration curves of gallic acid ($Y = 0.6484X - 0.0025$; $R^2 = 0.995$), quercetin ($Y = 0.6455X - 0.0079$; $R^2 = 0.9983$), and tannic acid ($Y = 0.0004X + 0.0062$; $R^2 = 0.9933$), corresponding respectively to total polyphenols, total flavonoids, and total tannins. Overall, the concentrations varied, ranging from 53.33 to 438.66 ± 0.7 mg GAE/g, 11.66 to 698 ± 2 mg QE/g, and 0.009 to 0.28 ± 0.8 mg EAT/g of dry extract for total polyphenols, flavonoids, and tannins. Across the three axes studied, the Abidjan–Abengourou (AA) axis samples exhibited the highest concentrations of polyphenols, flavonoids, and tannins, particularly sample 2. Statistical analysis confirmed significant differences between the concentrations of the different samples ($p \leq 0.05$).

The highest levels of all three metabolites were consistently recorded in the same samples. For total polyphenols, these included sample 1 of the KA axis (360 ± 0.2 mg GAE/g), sample 1 of the YA axis (298 ± 1.2 mg GAE/g), as well as sample 2 (438 ± 0.7 mg GAE/g) and sample 3 (353 ± 2.1 mg GAE/g) of the AA axis. Regarding total flavonoids and tannins, similar trends were observed: sample 1 of the KA axis (698.33 ± 2 mg QE/g and 0.27 ± 1.2 mg EAT/g), sample 1 of the YA axis (545 ± 1.3 mg QE/g and 0.23 ± 0.2 mg EAT/g), and samples 2 (601.66 ± 0.2 mg QE/g and 0.28 ± 0.8 mg EAT/g) and 3 (596.66 ± 0.6 mg QE/g and 0.26 ± 0.8 mg EAT/g) of the AA axis.



Bands bearing different letters are statistically different ($p \leq 0.05$).

Figure 4 Total tannin contents of the extracts

4.3. Acute toxicity of plant powder extracts

Administration of a single dose of 2000 mg/kg body weight of each extract to different groups of rats produced no observable changes compared to the control group four hours after treatment, indicating that the extracts were not toxic. Moreover, no alterations in mobility or behavior were observed during the 14-day post-treatment period. The rats' general physical appearance and somatomotor function also remained unchanged throughout the observation period. Finally, no signs of salivation, diarrhea, coma, or mortality were recorded. Thus, according to the OECD classification, the median lethal dose (LD_{50}) of the extracts is greater than 2000 mg/kg body weight.

5. Discussion

In this study, samples of herbal medicines sold on public transport were purchased along several routes in Côte d'Ivoire. These products, sold in powder form, were advertised by vendors for the treatment of hemorrhoidal and sexual disorders, as well as for stimulating fertility. The samples underwent aqueous extraction to obtain dry extracts. The use of water for this extraction is justified by its common use in traditional medicine. Phytochemical screening of the extracts revealed the presence of total polyphenols, flavonoids, catecholic tannins, and anthraquinones. However, alkaloids, gallic tannins, saponins, as well as terpenes and sterols were absent. This absence could be explained by the choice of an aqueous solvent, which may not have allowed for their extraction [12,13] . The presence of total polyphenols, including flavonoids, tannins, and anthraquinones, could give these herbal remedies important biological properties. Indeed, several studies have shown that flavonoids have beneficial effects in the treatment of hemorrhoidal disorders. These molecules relieve the symptoms associated with hemorrhoidal flare-ups by strengthening the walls of blood vessels, thus reducing pain, swelling, and bleeding. [14] It has also been reported that tannins increase the resistance of blood vessels, ensuring better blood flow to the hemorrhoids. Tannins and flavonoids are also known for their laxative properties, recommended for constipation, a source of hemorrhoidal inflammation [15] . As for anthraquinones, they have a dual action: a motor action by stimulating nerve endings and a direct irritant action on the mucosa. This latter action, however, requires some caution and limits the use of these substances to stubborn constipation, often associated with hemorrhoids [16] .

In this study, samples of herbal medicines sold on public transport were collected along several routes in Côte d'Ivoire. These products, marketed in powder form, were promoted by vendors for the treatment of hemorrhoidal and sexual disorders, as well as for enhancing fertility. The samples underwent aqueous extraction to obtain dry extracts, a choice justified by the widespread use of water in traditional medicine. Phytochemical screening of the extracts revealed the presence of total polyphenols, flavonoids, catecholic tannins, and anthraquinones. In contrast, alkaloids, gallic tannins, saponins, terpenes, and sterols were absent. This absence may be explained by the use of an aqueous solvent, which might not have facilitated their extraction [12,13]. The presence of total polyphenols, including flavonoids, tannins, and anthraquinones, suggests that these herbal remedies may possess important biological properties. Indeed, several studies have demonstrated that flavonoids exert beneficial effects in the management of hemorrhoidal disorders. These molecules alleviate symptoms associated with hemorrhoidal flare-ups by strengthening blood vessel walls, thereby

reducing pain, swelling, and bleeding [14]. Tannins have also been reported to increase vascular resistance, ensuring improved blood flow to hemorrhoidal tissues. Moreover, tannins and flavonoids are recognized for their laxative properties, which are recommended in cases of constipation—a common cause of hemorrhoidal inflammation [15]. Anthraquinones, for their part, exhibit a dual mechanism of action: a motor effect through stimulation of nerve endings and a direct irritant effect on the mucosa. The latter, however, requires caution and restricts the use of these compounds to cases of refractory constipation, often associated with hemorrhoids [16].

Regarding aphrodisiac properties, several plant extracts have been reported to enhance sexual pleasure by promoting sustained erection. This is the case with *Rauvolfia obscura*, which has been shown to increase blood flow in erectile and ejaculatory structures, as described by Ondélé *et al*. (2015) [17]. According to these authors, the aphrodisiac properties of this plant are partly attributed to flavonoids. Indeed, flavonoids modulate neurotransmitter levels involved in erectile function and influence the activity of these structures at their target cells. Furthermore, these metabolites facilitate increased androgen secretion and may play an important role in reproductive processes [18]. The presence of total polyphenols, including flavonoids, tannins, and anthraquinones, in the extracts of products sold in buses could therefore confer aphrodisiac properties. However, phytochemical analysis revealed the absence of alkaloids, saponins, and particularly terpenes and sterols, which are known precursors of reproductive hormones and are associated with aphrodisiac effects [18, 19]. This absence may limit the effectiveness claimed by vendors. This limitation is further highlighted by the quantitative analysis of phenolic compounds in the extracts. Indeed, the total polyphenol, tannin, and flavonoid contents appear relatively low, although these compounds are known to confer important antioxidant, antibacterial, and anti-inflammatory properties. Several researchers have established a correlation between phenolic compound content and the antioxidant, antibacterial, and anti-inflammatory potential of plant extracts [20]. These properties contribute to combating cellular aging, promoting the healing of hemorrhoidal lesions, and improving blood circulation, particularly within the reproductive system [21,22]. Moreover, many phenolic compounds exhibit estrogenic effects on the reproductive system and are used in the treatment of certain cases of infertility [23].

Beyond questions concerning the efficacy and dosage of the products sold, concerns frequently arise regarding their potential toxicity. In this study, administration of a single oral dose of 2000 mg/kg body weight of each extract to rats produced no signs of toxicity or mortality during the 14-day observation period, indicating that all tested herbal remedies were non-toxic according to OECD guideline 423. These findings are consistent with those reported by Mikolo *et al.* (2020) and Sone *et al.* (2021) [24, 25]. Indeed, these authors demonstrated that extracts of *Tetracera potatoria, Gnetum africanum*, and *Gnetum buchholzianum* plants known for their anti-hemorrhoidal effects administered orally, were not toxic.

6. Conclusion

The objective of this study was to evaluate the safety of traditional medicines sold on public transport in Côte d'Ivoire. The results demonstrated that all samples contained medicinally relevant secondary metabolites, including total polyphenols, flavonoids, tannins, and anthraquinones. The presence of these compounds may explain the anti-hemorrhoidal, aphrodisiac, and laxative properties attributed to the herbal medicines marketed by vendors.

However, these properties may be limited by the relatively low levels of these metabolites and the absence of certain key compounds such as alkaloids, terpenes, and sterols. Furthermore, aqueous extracts of the sampled powders proved harmless to rats. Therefore, these products appear to be safe for human use and could be more effectively valorized.

Compliance with ethical standards

Acknowledgments

We express our sincere gratitude to the managers of the various Ivorian transport companies for their valuable collaboration, which greatly contributed to the successful completion of this research.

Disclosure of conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Statement of ethical approval

In Côte d'Ivoire, an ethics committee exists and issues certificates for research involving the human species. However, no certification is provided for experiments conducted on animal species.

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