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Hypotensive Effects of an Aqueous Extract of *Bambusa vulgaris* (Poaceae) Leaves in Rabbit *Oryctolagus cuniculus*

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Abstract

Plant of *Bambusa vulgaris* is used in traditional medicine practice for the management of many pathologies including hypertension. The effect of the aqueous extract of the leaves of *Bambusa vulgaris* on blood pressure was evaluated in normotensive male rabbits. Blood pressure was measured by the invasive method. Thus, aqueous extract of *Bambusa vulgaris* leaves had been injected intravenously at doses ranging from 1 mg/kg to 30 mg/kg in rabbits anesthetized with thiopental. The effects of this extract on blood pressure were also evaluated in rabbits having previously received different doses of atropine. The aqueous extract of *Bambusa vulgaris* leaves induced a dose-dependent hypotension which is not canceled in the presence of atropine. The results obtained show that the extract has blood pressure lowering effect which may be mediated by muscarinic-type cholinergic receptors.

Keywords

Bambusa vulgaris, Aqueous Extract, Hypotensive Effects, *Oryctolagus cuniculus* Rabbits, Atropine

1. Introduction

Hypertension is a cardiovascular disease that constitutes a real public health

problem due to the high rate of hypertensives and its cardiovascular and renal complications [1]. Each year, nearly 9.4 million deaths are recorded as a result of complications from hypertension [2]. Unfortunately, more than one and a half billion people will be affected in the world until 2025 [3]. There are several causes of hypertension. Hereditary predisposition is a risk factor for hypertension. More than 90% of people with hypertension have hypertensive parents in their genealogy [4]. Nutritional factors such as excessive and chronic consumption of salt, alcohol and saturated fatty acids are involved in the occurrence of hypertension [5] [6] [7]. Obesity is a malnutrition form that causes hypertension [8]. Tobacco consumption also leads to deterioration of the arteries and tachycardia causing an increase in blood pressure. Finally, renal, cardiac, vascular, hepatic, or gland dysfunction can be the cause of hypertension [9] [10].

The management of this disease is based on several parameters including lifestyle and dietary measures associated with taking medication. However, the treatment of hypertension is very expensive and the non-compliance with taking medication is an obstacle in the fight against this pathology. Also, the many adverse effects of anti-hypertensives, the inaccessibility of drugs and the socio-economic status of populations justify the uncontrollable progression of this disease [11] [12]. Therefore, people prefer to use medicinal plants to heal themselves [13]. Indeed, medicinal plants are accessible, inexpensive and very effective. They are widely used for preventive and curative purposes. The use of plants as alternatives in health care is encouraged by the WHO, which recommends that African countries conduct scientific research on medicinal plants in order to optimize their valuation [14]. Several studies on medicinal plants are therefore carried out in order to determine their properties and lead populations to more rational use.

Bambusa vulgaris is a plant belonging to the Poaceae family. Its leaves are widely used in traditional therapy to treat several diseases such as typhoid fever, malaria, diabetes and hypertension [15] [16]. The decoction of the leaves of this plant is recommended by Ivorian herbalists to treat hypertension [17] [18].

The present study evaluated the hypotensive effects of an aqueous extract of *Bambusa vulgaris* leaves on blood pressure in rabbits *Oryctolagus cuniculus* in the presence and absence of a cholinergic antagonist.

2. Material and Methods

2.1. Plant Material Extraction

The *Bambusa vulgaris* leaves were collected in Bingerville (Abidjan, Côte d'Ivoire) in February 2017. They have been authenticated at the national floristic center of Felix HOUPHOUET-BOIGNY University (Abidjan, Côte d'Ivoire) through the backing conserved in the herbarium (UCJ006786) of this center. The identification was made by late ASSI Yapo Jean, Botanist Technician.

The extraction was made according to [10] methods with some modifications. The fresh leaves are washed to remove impurities and then dried in the shade.

Then, they were cut and pulverized in a Reich-type electric shredder. 100 g of leaves powder was boiled in 1 L of distilled water for 10 min. After cooling, the decoction was filtered respectively on hydrophilic cotton and on wattman paper No 1. The filtrate was then dried in an oven (Memmert D-91126 Schwabach FRG, Germany) at 45˚C. The powder obtained was the aqueous extract of *Bambusa vulgaris* leaves (EABV).

2.2. Animals

All animal experiments have been carried out in accordance with EU guidelines (2007/526/CE). *Orictolagus cuniculus* rabbits (1.8 ± 0.2 kg) were used for blood pressure study. These animals were fed in the vivarium of *Ecole Nationale Supérieure* (ENS, Côte d'Ivoire).

2.3. Blood Pressure Measure

Blood pressure was measured using the method described by [19] and improved by [20]. The rabbit was anesthetized by intraperitoneal injection of thiopental (1 g/kg). The saphenous vein and carotid artery were dissected and intubated using a catheter containing heparinized physiological solution. The various test substances (EABV and atropine) were administered through the saphenous vein using a syringe. The carotid artery was connected to the Ludwid manometer, a device that records blood pressure. Rabbit's blood pressure was registered on the black smoked paper covering the recording cylinder.

In this test, the rabbit's normal blood pressure was recorded and then doses ranging from 1mg/kg to 30 mg/kg of EABV were administered intravenously (i.v). Then, the dose of 15 mg/kg of EABV was injected (i.v) into the rabbits having previously received a range of increasing doses of atropine (Atr) from 6.7×10^{-7} mg/kg to 6.7×10^{-4} mg/kg.

3. Data Analysis

The data written on the black-coated paper was fixed with cellulose varnish. Then, they were digitized and processed using paint software. Data were presented as mean ± standard error of the mean of four experiments (mean ± SEM). GraphPad Prism 7 software (Microsoft, San Diego, California, USA) was used for statistical data analysis and graphical representations. The significance of differences between treatments was determined using the variance analysis (ANOVA) of the Tukey Kramer multiple comparison test. The difference was considered statistically significant when $p < 0.05$.

4. Results

4.1. Dose-Response Effects of EABV on Arterial Blood Pressure in Rabbits

EABV, administered (i.v) in increasing doses induced a decrease in blood arterial pressure in rabbits. This hypotension increased with the dose and appears ra-

pidly (less than 10 seconds) after injection of EABV in rabbits.

EABV injected at doses of 1 mg/kg and 2.5 mg/kg did not significantly modify ($P > 0.05$) blood pressure. On the other hand, doses greater than or equal to 5 mg/kg caused significant hypotension compared to the initial blood pressure in rabbits. It is explained by a dose-dependent drop in blood pressure ranging from 8.83% ± 2.41% (for the dose of 5 mg/kg) to 21.71% ± 2.69% (for the dose of 15 mg/kg). At these doses, the effects of EABV on blood pressure are rapid and fully reversible. EABV, administered at doses ranging from 20 mg/kg to 30 mg/kg caused less rapid and sustained hypotension. It corresponds to a drop in blood pressure from 27 ± 2.89 mmHg ($P < 0.001$) to 32 ± 2.31 mmHg ($P < 0.0001$), either a respective decrease of 22.63% ± 2.44% at 26.79% ± 2.63% (**Figure 1**).

The ED50, obtained from the dose-effect curve of EABV on arterial blood pressure in rabbits was 12.15 ± 5 mg/kg (**Figure 2**).

4.2. Interaction EABV-Atropine

EABV, administered (i.v) at a dose of 15 mg/kg caused hypotension of 36 ± 1.68 mm Hg (100%) in the absence of atropine (Atr). On the other hand, this hypotension was reduced with increasing doses of Atr.

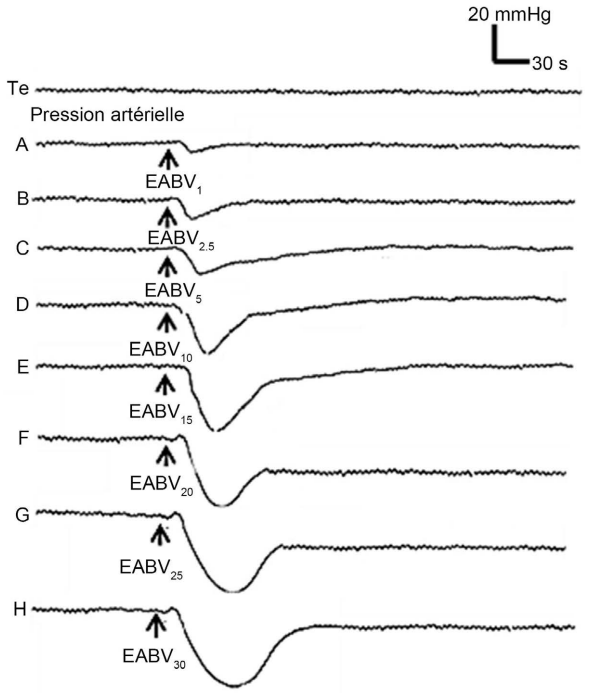

Figure 1. Dose-response effect of an aqueous extract of *Bambusa vulgaris* (Poaceae) leaves on blood pressure in rabbits. Intravenous injection of increasing doses of the aqueous extract of *Bambusa vulgaris* leaves caused dose-dependent hypotension in rabbits. The arrows indicate the time of administration of the different doses of the extract. A: 1 mg/kg; B: 2.5 mg/kg; C: 5 mg/kg; D: 10 mg/kg; E: 15 mg/kg; F: 20 mg/kg; G: 25 mg/kg; H: 30 mg/kg. EABV: aqueous extract of *Bambusa vulgaris* leaves.

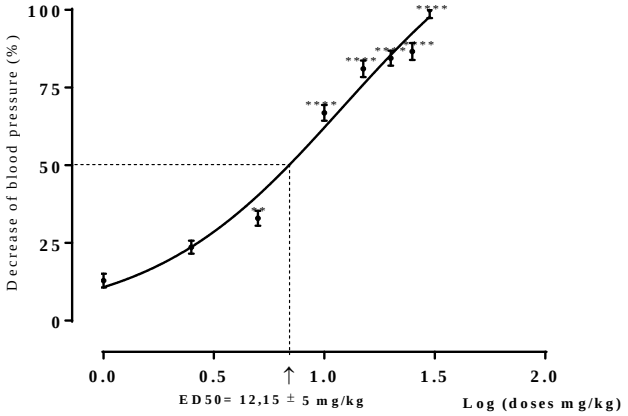

Figure 2. Dose-effect curve of an aqueous extract of *Bambusa vulgaris* leaves on arterial blood pressure in rabbits and determination of ED50. Data were presented as mean ± standard error of the mean (mean ± SEM); n = 4; ( ) P > 0.05: not significant; (***) P < 0.001, (****) P < 0.0001: significant compared to initial blood pressure.

Atropine, injected (i.v) at a dose of 6.7×10^{-7} mg/kg did not significantly modify the hypotensive effect of EABV. However, the hypotensive effect of EABV is reduced (P < 0.001) in the presence of the dose of 6.7×10^{-6} mg/kg of Atr. This hypotension is 25 ± 1.78 mmHg, either a hypotension reduction of 30.56% ± 1.84%. At a dose of 6.7×10^{-5} mg/kg of Atr, the hypotension induced by EABV is 20 ± 1.47 mmHg (44.45% ± 1.36%, P < 0.0001). EABV, injected in the presence of a dose of 6.7×10^{-4} mg/kg of Atr induced a drop in arterial pressure of 12 ± 1.08 mmHg (P < 0.0001). At this dose, the hypotensive effect of EABV is reduced by 66.67% ± 1.41% (**Figure 3** and **Figure 4**).

The arrows indicate the time of administration of the substances. Atr: atropine; EABV: Aqueous Extract of *Bambusa vulgaris* leaves.

5. Discussion

This study evaluated the hypotensive effects of an aqueous extract of *Bambusa vulgaris* leaves on blood pressure in rabbits in the presence and absence of atropine, a muscarinic-type cholinergic antagonist.

Aqueous *Bambusa vulgaris* leaves extract (EABV), administered (i.v) in increasing doses resulted in an immediate drop in blood pressure. This hypotension is gradual and reversible at doses ranging from 1 mg/kg to 15 mg/kg, corresponding to a concentration range varying from 1.8 mg/ml to 27 mg/ml. On the other hand, EABV administered at doses ranging from 20 mg/kg to 30 mg/kg (36 mg/ml to 54 mg/ml) induced permanent hypotension. The effective dose 50 (ED50), obtained from the sigmoid curve is 12.15 ± 5 mg/kg. These results are partly confirmed by [21] who showed the hypotensive effect of macerated *Bambusa vulgaris* leaves. However, in their work, the hypotension caused by the maceration of *Bambusa vulgaris* leaves is irreversible. This difference could be explained by the type of extraction used for the leaves of *Bambusa vulgaris*. Furthermore, the hypotensive effects of *Bambusa vulgaris* leaves are shown in

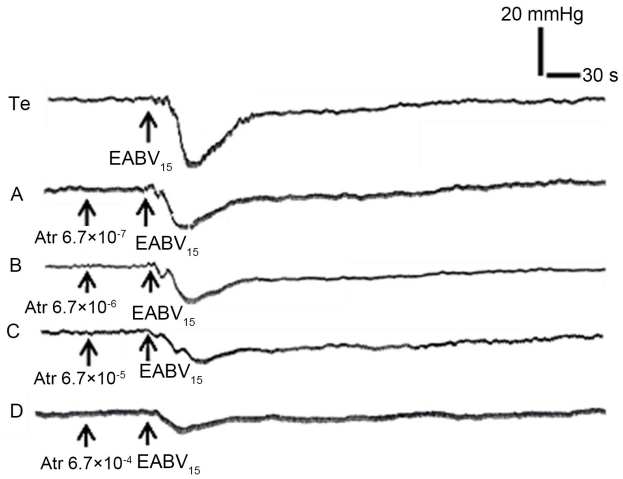

Figure 3. Effects of an aqueous extract of leaves of Bambusa vulgaris (Poaceae) on blood pressure in rabbits in the presence of different doses of atropine. EABV (15 mg/kg) was administered in the presence of increasing doses of Atr (A = 6.7×10^{-7} mg/kg; B = 6.7×10^{-6} mg/kg; C = 6.7×10^{-5} mg/kg; D = 6.7×10^{-4} mg/kg). The hypotensive effect of EABV.

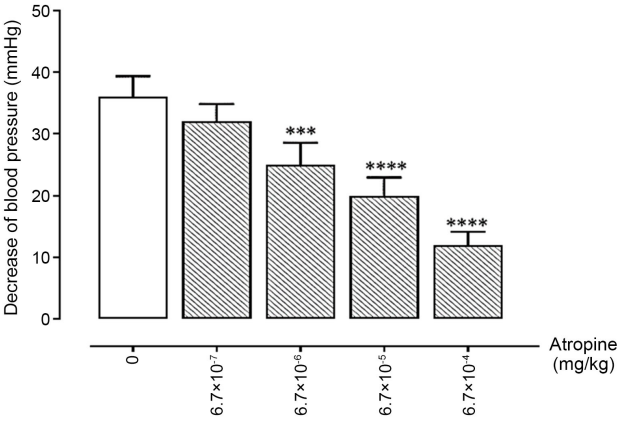

Figure 4. Variations of EABV-induced hypotension in the presence of different doses of atropine. EABV (15 mg/kg) was administered in the presence of increasing doses of atropine. mean ± esm; n = 4; ( ) $P > 0.05$: not significant; (***) $P < 0.001$; (****) $P < 0.0001$: significant compared to initial blood pressure.

the present study is similar to those of [22]. These authors revealed that the administration of the aqueous extract of leaves of *Urtica dioica* (Urticaceae) caused reversible hypotension at a dose of 4 mg/kg but permanent hypotension at 24 mg/kg in anesthetized male rats. The leaf decoction of *Lophira lanceolata* (Ochnaceae) injected at doses of 0.5 mg/kg to 40 mg/kg significantly reduced blood pressure from 7.17% ± 1.34% to 38.66% ± 1.85% [23]. This study found that injection of increasing doses of atropine significantly reduced the hypotensive effect of EABV. This indicates that this extract contains muscarinic-type cholinergic receptor agonists. These results are similar to those obtained by several au-

thors in the study of the interaction of atropine with many plant extracts including *Ficus exasperata*, *Lophira lanceolata* et *Blighia unijugata* used in the traditional medicine of Côte d'Ivoire to treat Hypertension [20] [23] [24]. The hypotensive effect of EABV would be due to the presence of secondary metabolites such as alkaloids, catechics tanins, flavonoids and polyphenols in this extract. These molecules were also determined in the fractions of *Ficus exasperata* and *Bidens pilosa* leaves known for their hypotensive effect in rabbits [20] [25]. The effect of EABV on blood pressure would be similar to that of acetylcholine. Indeed, the administration of this molecule causes an immediate and transient drop in blood pressure which results from cardiac slowing and vasodilation [26].

6. Conclusions

The present study showed the hypotensive effect of the aqueous extract of *Bambusa vulgaris* leaves in rabbits. This extract contains muscarinic-type cholinergic receptor agonists. However, the determination of the molecule responsible for its hypotensive effect is necessary.

This property justifies the use of this plant in the management of hypertension in traditional medicine.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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