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PHARMACOLOGIC ACTIVITIES OF *PISTIA STRATIOTES*

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ABSTRACT

The pharmacologic activities of Pistia stratiotes *were studied. Calcium channel blocking activity of a methanol extract of the whole plant was demonstrated using isolated segments of rabbit jejunum and confirmed via inhibition by pretreatment with verapamil. Additionally, the plant extract exhibited dose-related bronchodilating activity on isolated guinea pig trachea and neuromuscular blocking action, which was also dose-related. The plant extract caused a decrease in blood pressure in anaesthetised rats. After a 10 μg dose of the extract, systolic and diastolic blood pressures fell by 18% and 10%, respectively. Further doses of the plant extract produced slight decreases in blood pressures in anaesthetised rats. The systolic, diastolic and mean blood pressures before the extract were all significantly higher (P < 0.001) than those following the administration of the extract.*

INTRODUCTION

Pistia stratiotes L. (Araceae), commonly known as the Nile cabbage, is a weed in all low-lying perennial fresh water, found in many parts of Kenya (Agnew, 1974). A decoction of the root extract is traditionally used for the treatment of earache and chest diseases (Watt and Brayer-Brandwijk, 1962). The ash of the whole plant is licked for the treatment of cough and, mixed with honey, it is taken for the treatment of tachycardia (Kokwaro, 1976). No pharmacologic activities have been reported for the plant extract. In our screening of potential herbal medicines in Kenya, we report here some pharmacologic activities of a 70% methanol whole plant extract of *P. stratiotes*.

Keywords: Araceae, bronchodilator, calcium channel blocker, guinea pig, hypotensive, neuromuscular blocker, *Pistia stratiotes*, rabbit, rat.

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MATERIAL AND METHODS

Plant Material

Plant material was collected in Kisumu, Nyanza Province, Kenya in September 1994. The identity of the plant was confirmed by the East African Herbarium, Nairobi and voucher specimens have been deposited in the Herbarium and in the Department of Pharmacology and Pharmacognosy, Faculty of Pharmacy, University of Nairobi, Kenya.

Plant Extraction

The whole plant was dried at room temperature (25°C), powdered and extracted with 70% methanol by cold percolation. The extract was filtered and evaporated *in vacuo* to yield 26 g from 500 g plant powder.

Animals

New Zealand white rabbits (2–2.5 kg), guinea pigs (300–450 g) and Wistar strain rats (200–300 g) of either sex were used. The animals were fed on normal rabbit pellets, vegetables, mice pencils and water. The animals were bred for research purposes at the National Public Health Laboratories, Nairobi. They were kept on a floor with saw dust and in cages when breeding.

Standard Solutions

Stock solution of the plant extract (200 mg/ml) was prepared in distilled water. Separate solutions of vera-

pamil (4 mg/ml) and calcium solution (10 mg/ml) were similarly prepared.

Isolated Rabbit Jejunum

Rabbits starved for 24 h were sacrificed by a blow at the back of the head. The abdomen was opened. Pieces of jejunum about 3 cm were mounted in a 20-ml double-walled tissue bath containing Krebs solution, aerated with 95% O_2 and 5% CO_2 at 37°C. The tissues were allowed to equilibrate for about 20 min, then the baseline tracings were recorded on a kymograph. The Krebs solution was replaced with Krebs without calcium. Calcium solution (10, 30 and 50 μM) was added to the tissue bath at about 2-min intervals to restore spontaneous contractions.

The experiment was repeated, after the baseline had been recorded and the solution was changed to calciumless Krebs as described above. The tissue was then challenged with the plant extract (1 mg/ml bath) for about 3 min. Calcium solution (30 and 50 μM) was then added to the tissue bath at about 2-min intervals and the result was recorded on a kymograph.

In a third experiment, the baseline was obtained and the tissue was challenged with verapamil (1 μM) for about 3 min. Calcium solution (30 and 50 μM) was added at about 2-min intervals while the tracing was obtained.

Isolated Guinea Pig Trachea

Guinea pigs were sacrificed by a blow at the back of the head. Isolated trachea was placed in Krebs Henseleit (KH) solution. About 3 cm of the trachea was mounted in one side of a U-shaped capillary tube. The other side was connected to a graduated 0.1-ml pipette. The capillary terminal was joined to a 5-ml syringe containing KH solution. The tissue was then immersed in KH solution in a double-walled 20-ml tissue bath aerated with 95% O_2 and 5% CO_2 at 37°C. The tissue was equilibrated for 30 min. Doses of the plant extract (0.25 and 0.5 μg/ml bath) were investigated against histamine (0.5 μg/ml bath) and a 35-min tissue-drug contact time cycle. Changes in fluid volume inside the pipette were recorded initially after every min for the first 5 min, then after every 5 min for a total of 35 min (Achola *et al.*, 1995b, 1996).

Rat Phrenic Nerve Diaphragm

Rats of either sex were killed by a blow at the back of the head. The chest wall was opened to remove phrenic nerve diaphragm, and placed in a Petri dish containing (KH) solution. The tissue was then attached to an electrode and placed in a 50-ml double-walled tissue bath containing KH solution aerated with 95% O_2 and 5% CO_2 at 37°C. The tissue was allowed to stabilize for about 30 min (Achola and Munenge, 1996).

Blood Pressure in Anaesthetised Rats

The rats were anaesthetised with 50% urethane (0.3 ml/100 g rat weight i.p). The trachea was incised to insert a wind pipe. The carotid artery was cannulated and attached to the Gould P23 ID transducer connected to Hellige recorder for blood pressure recordings. The femoral vein was cannulated for the administration of the plant extract (Achola *et al.*, 1995a,b, 1996).

RESULTS AND DISCUSSION

Intrinsic contractions of rabbit jejunum were abolished when exposed to calcium-free Krebs solution, and were restored by calcium in about 2 min (Fig. 1). When the tissues were pretreated with the plant extract, calcium did not restore spontaneous movement of rabbit jejunum: however, after 5 min intrinsic movements started to appear (Fig. 1). Similarly, calcium did not restore spontaneous contractions of rabbit jejunum when the tissues were pretreated with verapamil (Fig. 1). The plant extract and verapamil inhibited activity of calcium on the tissues. Their action may be due to interference either with the depolarization process or with the calcium influx through voltage dependent calcium channels (Gilani *et al.*, 1994).

Smooth muscles are dependent on transmembrane calcium influx for normal resting tone and contraction responses. Calcium influx inhibitors can cause relaxation of smooth muscles. This has been demonstrated for bronchial, gastrointestinal and uterine smooth muscles. Those calcium blockers can reduce blood pressure through reduction in peripheral vascular resistance (Katzung, 1987).

The plant extract was found to be a bronchodilator on isolated guinea pig trachea. The bronchodilation was dose-dependent (Fig. 2). A 0.5 μg/ml bath concentration was significantly more efficacious ($P < 0.01$) than a 0.25 μg/ml bath concentration (Fig. 2). Additionally the plant extract was found to possess dose-dependent neuromuscular blockade on the rat phrenic nerve system. The time of the onset of neuromuscular blockade of an 8-mg/ml bath concentration of the plant extract was approximately half that of a 4-mg/ml bath concentration (Fig. 3).

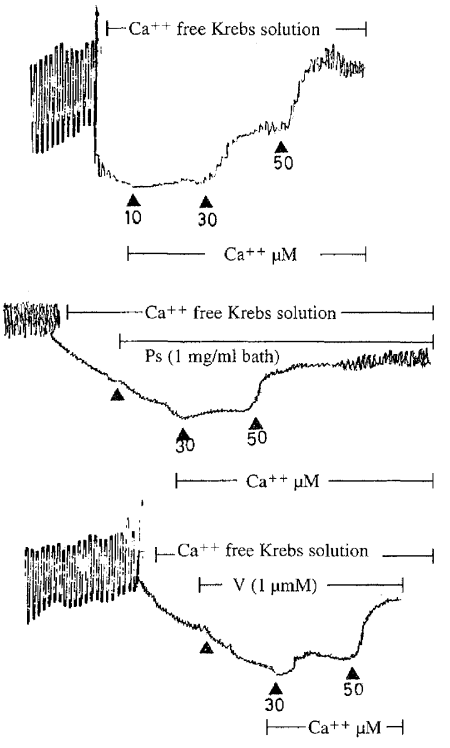

Fig. 1. Effect of calcium supplementation of isolated rabbit jejunum in calcium free Krebs solution. Effect of pretreatment with *Pistia stratiotes* extract (Ps) or verapamil (V) on calcium supplementation (n = 7).

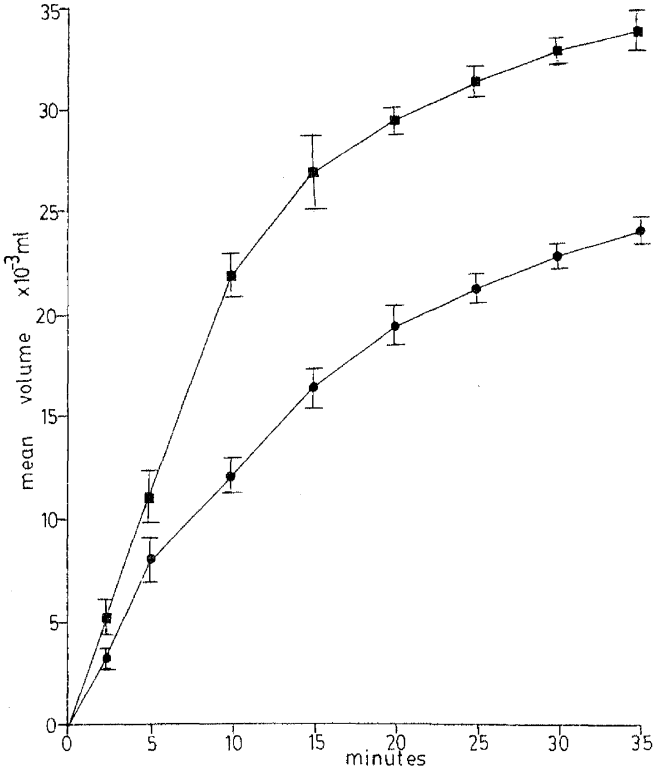

Fig. 2. Bronchodilating activity of *Pistia stratiotes* extract on isolated guinea pig trachea (n = 7; mean ± SEM). —●— = 0.25 µg/ml bath concentration; —■— = 0.50 µg/ml bath concentration.

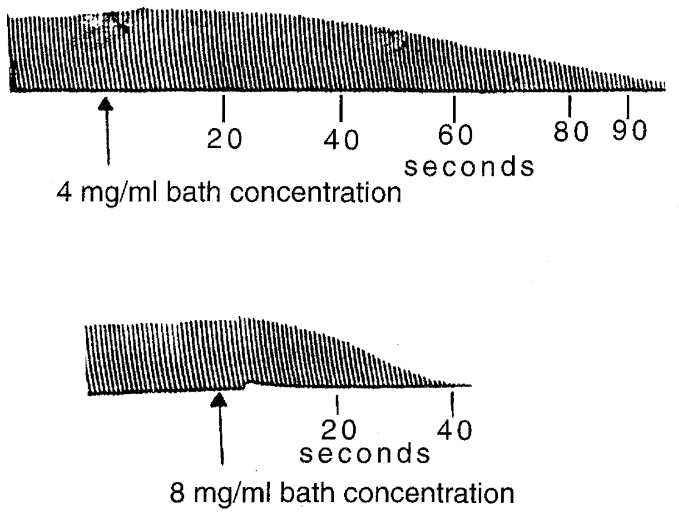

Fig. 3. Neuromuscular blockade of *Pistia stratiotes* extract on isolated rat phrenic nerve diaphragm (n = 7).

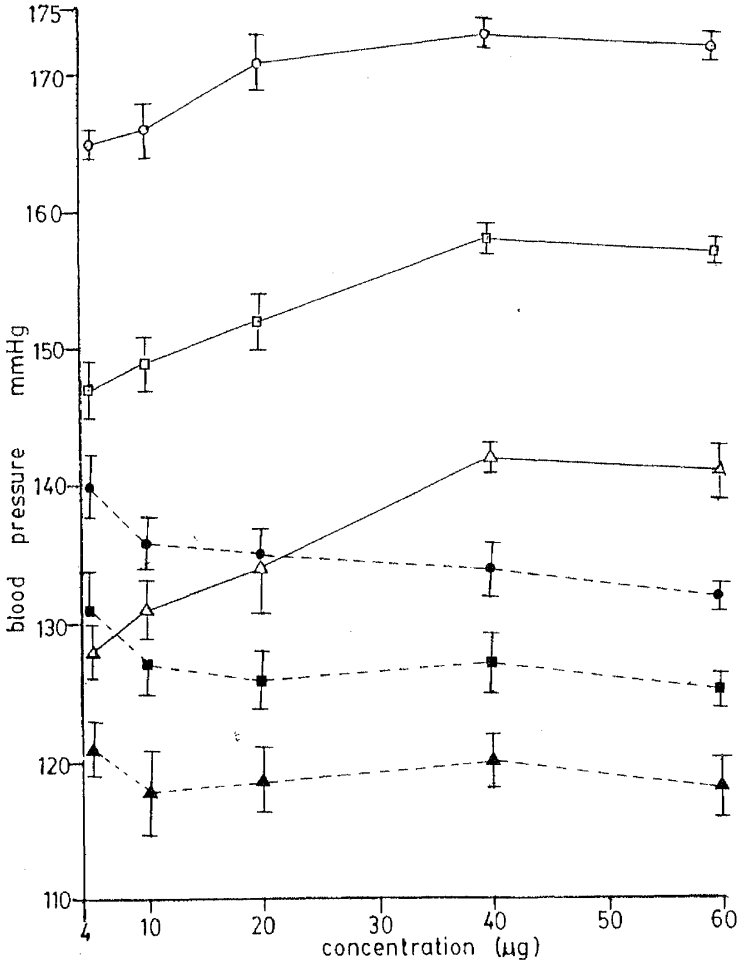

Fig. 4. Changes in blood pressure in anaesthetised rats before and after administration of *Pistia stratiotes* extract (n = 7; mean ± SEM). —○— = systolic blood pressure before drug; —□— = mean blood pressure before drug; —Δ— = diastolic blood pressure before drug; - - -●- - - = systolic blood pressure after drug; - - -■- - - = mean blood pressure after drug; - - -▲- - - = diastolic blood pressure after drug.

The plant extract (5–60 μg) lowered blood pressure in anaesthetised rats. After a 10 μg dose of the plant extract, systolic, diastolic and mean blood pressure fell by 18%, 10% and 15%, respectively, below the pre-drug levels. These decreases were significant ($P < 0.001$) (Fig. 4). Higher doses of the plant extract produced marginal further decreases in blood pressure. The lowest decreases in systolic, diastolic and mean blood pressures, 23%, 15% and 20%, respectively, were observed after the 40 μg dose of the plant extract. There was no further decrease in blood pressure after the 60 μg dose (Fig. 4).

In conclusion, these preliminary studies suggest that the aqueous solution of the dried residue of a 70% methanol extract of *P. stratiotes* contains a muscle relaxing principal for both smooth (vascular, intestinal and bronchiolar) and skeletal muscle, and this principal appeared to operate via calcium channel blockade.

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