Aqueous Extract of *Zingiber officinale* Roscoe Rhizomes Sold in Ouagadougou Markets: Phytochemical Constituents, Effect on Arterial Pressure and Blood Biochemical Parameters of Wistar Rats

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**Authors’ contributions**

This work was carried out in collaboration among all authors. Author LCT designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors YO and AAS managed the analyses of the study. Author LB managed the literature searches. All authors read and approved the final manuscript.

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**ABSTRACT**

The aim of this study was to exhibit cardiovascular effects of aqueous extract of *Zingiber officinale* rhizome sold in Ouagadougou markets (Burkina Faso). Phytochemical constituents and some blood biochemical parameters were also investigated. Colorimetric method was used for phytochemical screening. Extract was prepared and orally administered on Wistar rats. Arterial pressure and cardiac rhythm were measured using Ugo Basile Blood Pressure Recorder 58500.

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Biochemical parameters were performed using Mindray BA-88A, Semi-auto Chemistry Analyzer. Triterpenes and/or sterols, and saponosides were present in aqueous extract of the plant. We also found very significative hypotension effect on rat mean arterial pressure, when plant extract was administered at 400 mg/kg bw (p < 0.01). When extract was administered after a hypertension induced by L-NAME, we observed a high significative antihypertensive effect (p < 0.001) at 200 and 400 mg/kg bw. This effect was comparable to captopril inhibition of L-NAME induced hypertension. However, in all cases, we did not observe any significative variation of heart rate. For biochemical parameters, we did not find any effect, excepted a significant increase of phosphoremia at 400 mg/kg bw and after L-NAME administration (highly significant). Our results confirm literature data and corroborate traditional uses of *Z. officinale* sold in Ouagadougou markets. They suggest that antihypertensive effect of AEZO is mainly supported by vascular physiology components.

**Keywords:** *Zingiber officinale*; L-NAME; phytochemical constituents; antihypertensive effect; biochemical parameters.

1. **INTRODUCTION**

Since the early 2000s, there was renewed interest in ginger, *Zingiber officinale* Roscoe (*Zingiberaceae*). Many studies aimed identification of its active constituents. They attempted to verify its pharmacological actions, and to explain its utilization against several diseases [1]. Indeed, more than twenty sanitary and nutritional properties were reported in literature about ginger. Among them anti-hypertensive, nephroprotective, analgesic anti-inflammatory antioxidant, hepatoprotective, anticancer, anti-diabetic, etc. [2]. More than hundred chemical components were identified, and most are bioactive. Constituents or their level in plant vary according to area of cultivation, conservation, and storage conditions [3,4].

In West African countries, mainly Côte d’Ivoire, Mali and Burkina Faso, this plant rhizomes were consumed directly or after infusion or decoction as drink, named gnamakoudji. Ginger rhizomes sold in Ouagadougou markets, mainly, come from the southwest of the Burkina Faso. In previous paper [5], we studied plant toxicity and its antihypertensive effects on norepinephrine induced hypertension on Wistar rats. Present study is to complete that last one. Phytochemical screening, anti-hypertensive activity study using L-NAME as hypertensive agent, and measure of some blood biochemical parameters were done.

2. **MATERIALS AND METHODS**

2.1 Materials

2.1.1 Plant

Fresh rhizomes of *Zingiber officinale* were bought at the local market at Ouagadougou (Burkina Faso, West Africa). It was identified at Biodiversity Laboratory of Plant Biology Department, University Joseph Ki-Zerbo. Specimen was deposited in Herbarium of this Laboratory under identification number 16874 and Specie number, 6822.

2.1.2 Animals

Male Wistar rats (250 – 300 g) were used. Animals were fed with standard diet and kept in Laboratory at 24 ± 2°C, with 60 ± 10% humidity. They were submitted to a 12 h light/dark cycle with free access to food and water.

2.1.3 Technical material

The material used was the Blood Pressure Recorder 58500, a “Riva Rocci sphygmomanometer” conceived to provide an accurate recording of the systolic and diastolic blood pressure, and cardiac rhythm. It combines pressure generation-pressure monitoring system; pulse amplifier and thermal array analog and digital recording unit with two auxiliary systems for pulse rate measuring and recording; micro-pressor controlled functions to self-diagnosis, calibration, signal filtering and storage.

2.1.4 Reagents

N-nitro-L-arginine (L-NAME) was purchased at Enzo Life Sciences (Villeurbanne, France). NaCl (0.9 %) and captopril were purchased from Ouagadougou pharmaceutical office (Burkina Faso).

2.2 Methods

Administrations of substances in solution were orally done using a probe connected to a syringe.
All administration volumes were adjusted to 1 mL per 100 grams of animal body weight (bw). Previously, all animals were habituated to experimental and manutention conditions for two weeks.

Seven lots of six rats each were constituted as follows:

Group 1 received only NaCl 0.9% (normal or negative control);
Group 2 received AEZO at 200 mg/kg of body weight (bw);
Group 3 received AEZO at 400 mg/kg bw;
Group 4 received L-NAME at 40 mg/kg bw;
Group 5 received L-NAME and 5 mg/kg bw captopril (positive control);
Group 6 received L-NAME and AEZO at 200 mg/kg bw;
Group 7 received L-NAME and AEZO at 400 mg/kg bw.

2.2.1 Cardiovascular parameters measurements

Arterial pressure and cardiac frequency studies were performed by non-invasive method [6]: vigil animals were put in closed cage keeping tail out; systolic arterial pressure (SAP), diastolic arterial pressure (DAP) and cardiac frequency were measured through caudal artery, using Blood Pressure Recorder 58500.

2.2.2 Phytochemical study

Phytochemical study consisted to search some important chemicals groups in aqueous extract. Method used was based on phytochemicals groups reactivity with reagent that give characteristics colored compounds [7].

2.2.3 Biochemical parameters measurements

At the 28th day, blood samples were collected by heart puncture for biochemical parameters measurements, performed using Mindray BA-88A, Semi-auto Chemistry Analyzer.

2.3 Statistical Analysis

Database software used was Excel to keyboard data and Graph Pad Prism 5 for analysis. ANOVA one factor with Newman-keuls test was used for data comparison. Differences are significative when p < 0.05, very significative when p < 0.01 and highly significative when p < 0.001.

3. RESULTS AND DISCUSSION

3.1 Phytochemical Compounds

Phytochemicals screening revealed presence of triterpenes and/or sterols, and saponosides. But anthracenosides and its derivates, coumarins, polyphenols and alkaloids were not found (Table 1).

Z. officinale phytochemistry has been widely studied in many others cultivation and storage contexts. The major phytochemical groups found were phenolic compounds, flavonoids, alkaloids, glycosides, saponins, steroids, terpenoids and tannin [2]. Our results confirm that plant constituents vary from area of cultivation to another, as reported in literature [3,4].

3.2 Effects of AEZO on L-NAME Induced Hypertension

For mean arterial pressure (MAP) results, baseline value found was 93.77 ± 1.66 mmHg. AEZO at 400 mg/kg bw induced a very significative hypotension (p < 0.01). L-NAME triggered a highly significative hypertension (p < 0.001) as expected. But this L-NAME induced hypertension was suppressed when AEZO was administered at 200 and 400 mg/kg bw. Similar result was observed when captopril at 5 mg/kg bw was administered after L-AME (Fig. 1).

For systolic arterial pressure (SAP), baseline value found was 119.63 ± 2.16 mmHg. We found that AEZO administration had no effect (compared to normal control) while L-NAME triggered a highly significative increase of SAP (Fig. 2). In presence of AEZO, like the captopril, the hypertension induced by L-NAME was not observed.

Table 1. Summary of chemical characterization tests in tubes

| Chemical constituent                  | Detected |
|---------------------------------------|----------|
| Triterpenes and/or sterols            | Yes      |
| Saponosides                           | Yes      |
| Anthracenosides and its derivates     | No       |
| coumarins                             | No       |
| Tanins                                | No       |
| Flavonoids                            | No       |
| Alkaloids                             | No       |
**Fig. 1. Hypotensive and antihypertensive effect of AEZO on mean arterial pressure**

AEZO: significant from normal control, \(^a\)P < 0.05; \(^{aa}\)P < 0.01; \(^{aaa}\)P < 0.001

AEZO: significant from L-NAME, \(^b\)P < 0.05; \(^{bb}\)P < 0.01; \(^{bbb}\)P < 0.001

AEZO: significant from positive control (L-NAME + captopril), \(^c\)P < 0.05

Mean ± S.E.M = Mean values ± Standard error of means of six experiments

**Fig. 2. Effect of EAZO, L-NAME and captopril on systolic arterial pressure**

AEZO: significant from normal control, \(^a\)P < 0.05; \(^{aa}\)P < 0.01; \(^{aaa}\)P < 0.001

AEZO: significant from L-NAME, \(^b\)P < 0.05; \(^{bb}\)P < 0.01; \(^{bbb}\)P < 0.001

Mean ± S.E.M = Mean values ± Standard error of means of six experiments
For diastolic arterial pressure (DAP), baseline value found was 80.20 ± 1.14 mmHg. Our results showed a significative difference between AEZO (400 mg/kg bw) and L-NAME. But L-NAME had no significant effect compared to normal control (Fig. 3). L-NAME + AEZO administration had no effect on DAP compared to positive control (L-NAME + captopril). But positive control induced significant DAP decrease, compared to normal control and compared to L-NAME alone.

Hypertension mechanism is complex and implicate renin-angiotensin and autonomous nervous system. The more proximal and systemic hormone is angiotensin II (AngII). It is obtained after Angiotensin I conversion by angiotensin converter enzyme (ACE). Ang II stimulates sympathetic system, induces vasoconstriction, liberation of antidiuretic hormone, aldosterone secretion, and renal water and sodium retention. All this tends to raise the blood pressure. The inhibition of ACE deprive organism of AngII and tends to decrease blood pressure. Nitric oxide (NO) is one of the ACE inhibitors. It is the best characterized endothelium derived relaxing factor and its release by the endothelial cell can be regulated [8]. The downregulation of NO triggers among other effects, arterial hypertension. Indeed, NO promotes relaxation of smooth muscle fibers [9] and maintains adequate vascular tone by opposing to vasoconstrictor effect of AngII and endothelin-1 [10,11].

Z. officinale is known for its blood pressure lowering effects in traditional medicine. Our results with Z. officinale sold in Ouagadougou markets confirm these effects and corroborate those of another author who showed significative dose-dependent decrease of the SAP (and DAP) after Z. officinale administration [12]. Antihypertensive effect of ginger was also reported [13]. We confirm previous hypotensive and antihypertensive effects obtained with invasive method and using norepinephrine as hypertensive agent [5].

Our investigation model focused and compared two interactions effects. In one hand, AEZO interaction with L-NAME, and, in the other hand, captopril interaction with L-NAME. Vasoconstriction induced by L-NAME administration plays an important role in triggering and duration of hypertension [8,14]. L-NAME is a NO synthase inhibitor. It downregulates NO release and induces hypertension. This impaired NO signaling is improved after the cessation of L-NAME administration (restoration of NO synthase activity). However, it can persist arterial structural alterations and deceleration of enhanced NO formation [14,15]. Captopril is one of the better angiotensine converter inhibitor. Its chronic administration increases the liberation of prostaglandins (vasodilator) that contributes to antihypertensive mechanism in renin-dependent hypertension [15,16].

3.3 Effects of AEZO and L-NAME on Heart Rate

We found that AEZO had no effect on heart rate, compared to normal control. At 400 mg/kg bw of AEZO, we observed a very significative increase of heart rate, compared to L-NAME. For all other administered substances, we did not observe any significant change (Fig. 4).

This result suggested that main effect on AEZO on arterial pressure is mainly mediated by vasomotricity as previously found [5]. Its effect on heart rate is not determinant.

3.4 Effects on Biochemical Parameters

AEZO did not induce significative variation of biochemical parameters excepted a significant increase of phosphoremia at 400 mg/kg bw (Table 2). Phosphoremia was also highly significantly increase after L-NAME administration. This increase did not disappear in presence of captopril, but in presence of AEZO at 200 and 400 400 mg/kg bw.

Generally, phosphoremia is determined by interactions between intestinal absorption, renal excretion and exchanges with bone and intracellular compartment [17]. These interactions implicate catecholamines, precursor of isochinolic alkaloids [18] diuretics and glucocorticoids [19,20]. Many studies of minerals constituent on ginger reported that phosphorus is present in plants [2,21,22]. Phosphoremia increase could be explained by this datum. But related results obtained by L-NAME + AEZO administration must be deepened. AEZO could have a regulation effect in phosphoremia and consequently on phospho-calcic equilibrium. This equilibrium is implicated in bone mineralization and other physiological functions [23].
**Fig. 1. Effect of EAZO and L-NAME on diastolic arterial pressure**

*AEZO: significant from normal control, *P < 0.05*

*AEZO: significant from L-NAME, *P < 0.05*

*Mean ± S.E.M = Mean values ± Standard error of means of six experiments*

**Fig. 4. Effect of EAZO, L-NAME and captopril on heart rate**

*AEZO: significant from L-NAME, *P < 0.05; **P < 0.01*

*Mean ± S.E.M = Mean values ± Standard error of means of six experiments*
| Biochemicals Parameters | ALAT (UI/L)       | Creatinine (Mmol/L) | Chloride (Mmol/L) | Phosphorus (Mmol/L) |
|------------------------|-------------------|---------------------|-------------------|--------------------|
| NaCl 0.9%              | 49.66 ± 15.39     | 64.50 ± 3.80        | 99.33 ± 1.63      | 3.07 ± 0.45        |
| L-NAME 40              | 108.83 ± 19.73 aa | 75.28 ± 10.83       | 99.00 ± 5.65      | 4.90 ± 0.90 aaa    |
| AEZO 200               | 86.25 ± 16.80     | 72.60 ± 5.20        | 103.00 ± 2.82     | 3.61 ± 0.89        |
| AEZO 400               | 68.00 ± 10.81     | 66.23 ± 5.91        | 105.33 ± 3.78     | 4.61 ± 1.02 a      |
| L-NAME + Captopril     | 66.00 ± 15.86     | 67.81 ± 5.16        | 102.16 ± 3.76     | 5.03 ± 0.56 aaa    |
| L-NAME + AEZO 200      | 74.60 ± 18.01     | 71.40 ± 7.04        | 107.80 ± 2.94 aa bb | 3.81 ± 0.34 bc    |
| L-NAME + AEZO 400      | 88.75 ± 68.65     | 58.25 ± 5.74 bb     | 104.25 ± 3.09     | 3.27 ± 0.16 bb cc |

AEZO: significant from normal control, aP < 0.05; aaP < 0.01; aaaP < 0.001
AEZO: significant from L-NAME, bP < 0.05; bbP < 0.01; bbbP < 0.001
Mean ± S.E.M = Mean values ± Standard error of means of six experiments
4. CONCLUSION

Our results, obtained with *Z. officinale* sold in Ouagadougou markets, fit into those of literature. Phytochemistry constituents, biochemical parameters and mostly, antihypertensive effects, corroborate plant utilization in nutrition and in traditional medicine.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All animals’ procedures were strictly within national laws and guidelines. The protocol approval number was CE-UJKZ/2020-04.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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