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Effects of Arabusta coffee on the cardiovascular and biochemical parameters in hypertensive rats

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Abstract

The objective of this investigation is to valorize Arabusta, an hybrid coffee, by testing it on the cardiac and biochemical parameters of rats made hypertensive to adrenaline. The present study was carried out on 32 rats divided into 2 lots: one control (4) and one test (28). After induction of adrenaline hypertension in the test batch, the curative effect of the coffee extract was evaluated at the different doses (200 and 400 mg / kg). At the end of the experiment, the cardiovascular parameters were measured and blood samples were taken for the determination of the various parameters. Our results showed that the treatment of hypertensive rats with the extract at the dose of 400 mg / kg exerted an antihypertensive effect by a significant decrease ($P < 0.05$) of the cardiovascular parameters (-31.2 mmHg for SBP and -31 mmHg for DBP). The beneficial effects of the extract on blood pressure were accompanied by a reduction in oxidative stress. Arabusta coffee could be recommended as a new antihypertensive food supplement because of its remarkable action on some risk factors for the onset of the disease.

Keywords: Oxidative stress; Blood pressure; Coffee.

1. Introduction

High blood pressure (hypertension) is a major and modifiable risk factor for cardiovascular (CVD) and renal [1]. It consists in a persistent increase in systolic and / or diastolic blood pressure above normal values and may be caused by genetic factors and / or environmental factors such as obesity, physical inactivity and poor [2,3].

Thus, the first way to treat high blood pressure is to significantly reduce these risk factors [4]. Different strategies help to maintain normal health among others, the intake of a diet low in saturated and total fats.

Thus, the efficacy of some of these foods and / or supplements like coffee has been shown to be promising. Coffee inhibits lipid peroxidation and thus inhibits the oxidation of LDL-c, thus promoting optimal cardiovascular health. It prevents the platelets from accumulating and allows improving the blood circulation throughout the body, thus preventing the hardening of the arteries. In this way, coffee extract is effective against hypertension [5,6], and enhances vasoreactivity [7].

This antihypertensive action of coffee is due to the presence of chlorogenic acid as a major phenolic compound which in turn contains ferulic acid [8] as a metabolic component which has been shown to act on nitric oxide of the vascular endothelium [5]. The vascular endothelium regulates vasoconstrictive and vasodilatory functions by producing and releasing various vasoactive factors, including nitric oxide [9, 10].

The objective of our work is to valorise Arabusta coffee, a new variety resulting from the hybridization of Robusta and Arabica by evaluating its effect on cardiovascular parameters and the oxidative stress of hypertensive rats.

2. Materials and methods

2.1. Plant material

The plant material consisted of commercial coffee packaging (Robusta and Arabusta). These samples were provided by the National Center for Agronomic Research of Côte d'Ivoire (CNRA-CI).

2.2. Animals

Rats (32) of the species *Rattus norvegicus*, Wistar strains of mean weight between 160 ± 0.03 and 220 ± 0.21 g of male and female, about 5 weeks old were used. They were provided by the breeding farms of the laboratory of animal physiology of the University Félix Houphouët Boigny of Cote d'Ivoire. They were reared in plastic cages that are lined with a litter of wood chips. The cages were cleaned and the litter changed every day until the end of the experiment. They were subjected to an adaptation period of about two weeks, under the conditions of the animal facility at 25 ° ± 2 ° C.

2.3. Preparation of coffee extracts

The coffee extracts were prepared according to the method described by Abdo *et al* [11]. Thus, 5 g of coffee powder was added to 100 mL of distilled water at 90 ° C contained in a filtered beaker and then on Wattman paper. The doses used are functions of the daily consumption of coffee for an adult. This consumption is 200 mg/kg b.w. for a person of 70 kg.

2.4. Induction of hypertension

The method described by Umang *et al* [12] was used for the induction of rat hypertension. The animals were divided into two lots. A control batch of 4 rats received 2 mL of the physiological fluid and a test batch of 28 rats received a dose of 1 mg / mL adrenaline by intravenous injection with an insulin syringe for 8 successive days.

2.5. Treatment of animals

After eight days of induction of hypertension, the test batches were treated with coffee extracts (Arabusta and Robusta) and Nifedipine, a reference antihypertensive for fifteen days. Each lot was processed as follows:

C: Healthy control (untreated adrenaline (Adr))

Hyp: Hypertensive control treated with Adrenaline

UNH: Hypertensive untreated

Ara 1: Hypertensive treated with adr + Arabusta at the dose 200 mg / kg. pc;

Ara 2: Hypertensive treated with adr + Arabusta at the dose 400 mg / kg. pc;

Rob 1: Hypertensive treated with adr + Robusta at a dose of 200 mg / kg. pc;

Rob 2: Hypertensive treated with adr + Robusta at a dose of 400 mg / kg. pc;

Nife 1: Treated with Adr + Nifedipine at the dose 10 mg / kg bw;

Nife 2: Treated with Adr + Nifedipine at the dose 20 mg / kg bw;

After 15 days of treatment, the blood of all the animals was taken for the determination of the parameters mentioned.

2.6. Measuring Blood Pressure and Blood Collection

Blood pressure (BP) and heart rate (HR) were measured by the non-invasive method using a VISITECH BP 2000 system [13]. Samples were taken from the orbital sinus of the eye using a Pasteur pipette [14]. These collected blood samples will be used for the determination of the various biochemical parameters and the markers of oxidative stress.

2.7. Evaluation of oxidative stress markers

The determination of the activity of superoxide dismutase (SOD) was determined by the enzymatic method (Cayman Chemical Company kit), catalase by Aebi *et al* [15] and nitric oxide by of Fermor *et al* [16].

2.8. Statistical Analysis

Blood pressure data were presented as Mean ± SEM (standard error of mean). Data were analyzed using GraphPad Prism 5.0 software. Analysis of Variance (ANOVA) followed by Turkey's multiple comparisons test was used for comparison between groups. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Effect of coffee extracts on cardiac parameters of hypertensive rats

Table 1 shows the curative effect of aqueous coffee extracts on cardiac parameters in hypertensive rats. In normotensive animals, the systolic pressure (SBP), diastolic pressure (DBP) and heart rate (HR) values were determined to be respectively 123.3±1.16; 108.1±7.11 mmHg and 226.3±3.05 beat/ min. Induction of hypertension to animals resulted in an increase in these values of +43.8 mmHg for SBP, +39.6 mmHg for DBP and 294.7 ± 2.51 beat/min for HR. The administration of coffee extracts results in a significant reduction and dose dependent on the blood pressure of the rats. Thus, concomitant administration of the Arabusta extract at 400 mg / kg bw and adrenaline resulted in a significant reduction in SBP of -31.2 mmHg; the DBP of -31 mmHg and the HR of – 46.7 beat/min in relation to the Hypertensive batch. Under the same conditions, the administration of the Robusta extract decreases these parameters slightly (respectively -20 mmHg and -21.7 mmHg). Similarly, Nifedipine, a reference antihypertensive normalizes the blood pressure of hypertensive animals. In addition, these cardiac parameters remain very high in untreated hypertensive animals at the respective values of: 185.4 ± 3.47; 170.3 ± 0.18 mmHg and 314.0 ± 2.64 beat / min compared to the treated animals.

Table 1: curative effect of coffee extract on cardiac parameters of hypertensive rats

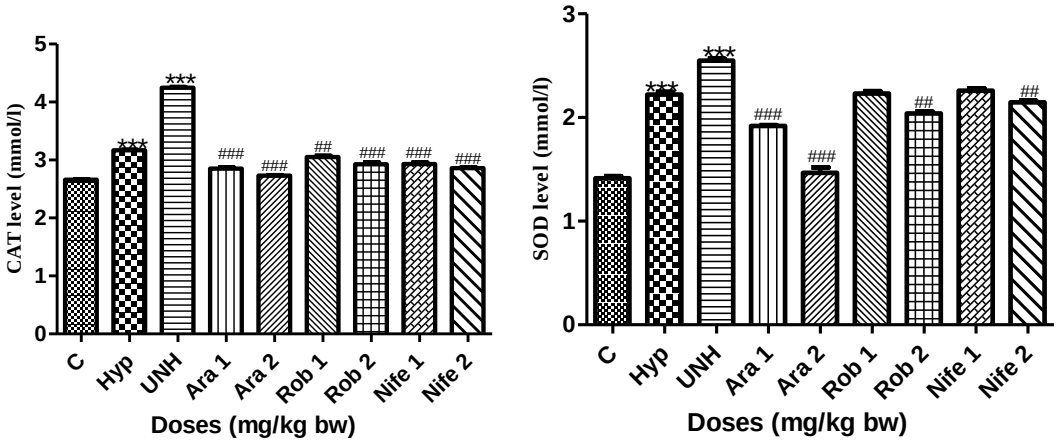
Cardiac parameters	Control			Hypertension			Treatment		
		HYP	UNH	ARA 1	ARA 2	ROB I	ROB II	NIFE 1	NIFE 2
SBP (mmHg)	123.3± 1.16	167.1± 11.48***	185.4± 3.47***	155.7 ±2.21^{ns}	135.9± 0.72$^{###}$	162.5 ± 2.65^{ns}	147.1 ±1.90$^{###}$	145.0 ±2.60$^{##}$	124.2 ±1.43$^{###}$
DBP (mmHg)	108.1± 7.11	147.7± 7.12***	170.3± 0.18***	137.0± 1.00$^{##}$	116.7 ±2.31$^{###}$	142.71± 0.57$^{##}$	126.0± 3.00$^{##}$	123.5± 1.3$^{###}$	110.0± 2.64$^{###}$
HR (beats /min)	226.3± 3.05	294.7± 2.51***	314.0± 2.64***	266.7± 3.51$^{##}$	248.0± 1.73$^{###}$	281.3± 1.51 ^{ns}	268.0± 1.00$^{###}$	226.7± 1.52$^{###}$	226.0± 1.00$^{###}$

**** p <0.05) significant difference from normotensive control; ns: no significant; ### p <0.05) significant difference from the hypertensive batch;*

4.2. Effect of coffee extracts on oxidative stress markers of hypertensive rats

Figure 1 (A, B, C) shows the curative effect of coffee extracts on the oxidative stress markers of rats rendered hypertensive by adrenaline.

Induction of hypertension to animals resulted in a significant increase in the oxidative stress markers of the rats as compared to the control batch. SOD and CAT rates increased by 29.55 % and 15.82 %, respectively. As for NO, the rate decreases by 48.52%. Treatment with Arabusta at the 400 mg/kg of hypertensive rats showed a significant decrease in SOD activity of 24.74 %; of CAT 12.97% and an increase of NO of 76 %. At the same dose, the curative effect of Robusta is lower with SOD reduction rates at 12.37 %; of CAT at 7.59 % and an increase of NO at 52 %.



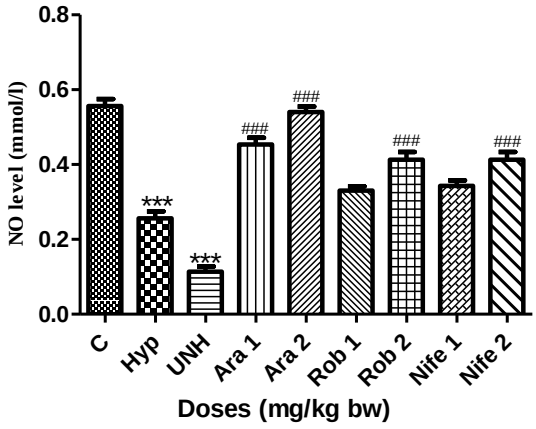


Figure 1: Effect of coffee extracts on stress oxidative parameters of Hypertensive rats

A: serum SOD levels, B: serum CAT levels, C: serum NO levels

*. ***, significant difference from the normotensive control batch at p <0.05; ###, significant difference from hypertensive at p <0.05*

5. Discussion

The influence of diet on blood pressure is topical since some data have shown that a change in diet could slow down the development of hypertension and improve the control of blood pressure in hypertensive patients. Individuals with pre-high blood pressure, also with a higher cardiovascular risk, require first-line non-pharmacological management [17]. Thus, the change in eating behavior of the population would be an interesting option of prevention.

In this study, the antihypertensive effects of the Arabusta extract were evaluated in experimentally hypertensive rats by adrenaline. Indeed, administration of adrenaline for 8 days resulted in a significant increase in SBP and DBP of +43.8 mmHg and +39.6 mmHg, respectively. This increase in pressure explains the effect of adrenaline which once in the intracellular medium increases the contraction force by positive inotropic effect and the heart rate by positive chronotropic effect thus leading to an increase in cardiac output and blood pressure [18]. According to Salvador and Amar [19], elevation of DBP is due to increased vascular resistance in small arteries and arterioles, and sustained distention of the aorta and large arterial trunks. Concomitant administration of the Arabusta extract at a dose of 400 mg / kg and adrenaline kept the blood pressure around the normal value. Our results showed that the Arabusta extract was able to inhibit the rise in DBP and SBP adrenaline-induced. This reduction in the pressure caused by the Arabusta extract is due to the vasodilatory action of this extract. The Arabusta extract therefore antagonizes the hypertensive effect induced by adrenaline. These results are consistent with those obtained by Suzuki *et al* [20] who found a decrease in blood pressure after administration of 720 mg / kg of coffee extract to hypertensive rats. [21,22] demonstrated in vitro and in vivo that CGAs in coffee as major phenolic compounds could interact with the renin-angiotensin aldosterone system by inhibiting the activity of the angiotensin-converting enzyme. In rats treated with Arabusta extract, mean HR decreased significantly ($P < 0.05$) compared to hypertensive rats with adrenaline. The effect of the extract could have a direct action on the cardiac muscle causing a negative chronotropic effect, also contributing to the antihypertensive activity of the Arabusta extract. These effects are similar to those observed with nifedipine, a predominant vascular calcium channel blocker, belonging to the dihydropyridine family [23,24].

It is well known that the predominantly vascular calcium channel blockers selectively inhibit the entry of calcium into the vascular smooth muscle cell through slow or voltage-dependent calcium channels or L-type channels [24]; muscle relaxation and decreased peripheral resistances, resulting in vasodilatation and a drop in blood pressure [23-25]. The Arabusta extract therefore behaves as a calcium channel blocker. This study also showed that induction of adrenaline leads a disturbance of the prooxidant / antioxidant balance. Thus, the results showed a significant increase in SOD and Catalase (CAT) activity compared to normotensive rats. This increase in SOD activity would be indicative of the increase in the production of the superoxide anion (O_2-) and therefore the oxidative stress. It is known that the increase in superoxide anion production is involved in the pathogenesis of hypertension [26].

Treatment of hypertensive rats with Arabusta extract had a beneficial effect on the tissue parameters of oxidative stress by reducing the concentrations of SOD and CAT. These results suggest that this extract would be capable of preventing adrenaline-induced lipid peroxidation in rats. The induction of adrenaline also decreased the NO level available. Thus, during hypertension, endothelial dysfunction is observed when the expression of endothelial-derived NO synthase (eNOS) and the production of the superoxide anion (O_2^-) are simultaneously increased, leading to the formation of peroxynitrite [27]. The Arabusta extract normalizes this rate at 76% increase over Hypertensive rats. These results show that Arabusta has a protective role against adrenaline-induced endothelial dysfunction. This antihypertensive effect of Arabusta is due to the vasodilating action of chlorogenic acid which contains ferulic acid [8] as a metabolic component which has been shown to act on nitric oxide of the vascular endothelium [5].

The vascular endothelium regulates the vasoconstrictive and vasodilating functions by producing and releasing various vasoactive factors, including nitric oxide [9,10]. Indeed, chlorogenic acids inhibit the expression and activity of NADPH oxidase, which has the direct consequence of reducing the production of free radicals, direct neutralization of free radicals, stimulation of nitric oxide production allowing improvement of endothelial function, inhibition of the angiotensin-converting enzyme in plasma, and also in peripheral organs[28].

6. Conclusion

This work was devoted to the study of Arabusta coffee extract, a new variety resulting from the hybridization of Arabica and Robusta, in order to best mimic the conditions of its supplementation in the therapeutic treatment of hypertension. Our results demonstrated the dose-dependent antihypertensive efficacy of coffee extract and beneficial effects on oxidative stress and endothelial dysfunction. At the end of our study, we note that all this antihypertensive potential noted by

Arabusta could justify and encourage the consumption of this coffee.

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