

EVALUATION OF THE EFFECT OF "WAKOUBA " ON THE LIPID PROFILE, SYSTOLIC BLOOD PRESSURE (SBP) DIASTOLIC (DBP) AND BLOOD GLUCOSE IN HYPERTENSIVE RABBITS

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ABSTRACT

Aim: This study aims at evaluating the effects of *Wakouba*, an extract of the fronds of oil palm tree *Elaeis guineensis* (Jacq) traditionally used in the treatment of high blood pressure, on lipid profile, urea, creatinine, blood glucose, systolic blood pressure (SBP), diastolic (DBP) and heart rate (HR) in hypertensive rabbits. **Methods:** Twenty four rabbits (24) divided into six (06) groups of four rabbits each weighing between 1.5 ± 3.0 to 2 ± 1.5 kg were used. Group 1 served as witness, group 2 sick and untreated control, groups 3, 4, 5, and 6 were used as experimental groups (sick+treatment). Throughout the experiment the witness group received distilled water; adrenaline was administered to the sick control group. After 10 days of adrenaline injection, hypertension has been stabilized in sick groups (group 2 to 6) and blood was taken for the determination of urea, creatinine, and lipids. Four (04) of the five (05) groups of hypertensive rabbits were treated with two (2) doses of "Wakouba" 950 and 2500 mg / kg bw and two (02) doses of tenordate 10 and 20 mg / kg BW, two(2) group by two(2) group. After ten (10) days of treatment, the SBP and DBP and HR were measured, blood was collected for determination of the same biochemical parameters. **Results:** The study of the effect of *Wakouba* and tenordate on the changes in systolic blood pressure SBP, DBP and heart rate (HR) showed a significant decrease ($P < 0.05$) up to normalization of these parameters after 10 days of treatment. Similarly, the measurement of serum lipid profile in hypertensive rabbits treated with *Wakouba* (950mg / kg bw) and tenordate (20 mg / kg bw) showed a significant reduction in ($P < 0.05$) values of total cholesterol, LDL cholesterol and triglycerides in contrast to HDL cholesterol which has increased significantly compared to the control group. Same doses also normalize serum glucose, urea and creatinine. Histological sections performed on the kidney and the heart of hypertensive rabbit showed congestion of blood in the kidney and cardiomyopathy. **Conclusion:** *Wakouba* at dose (950 mg / kg bw) as well as tenordate decreases and normalizes systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) in hypertension induced rabbit. Furthermore *Wakouba* (950 mg / kg BW) and tenordate (20mg/kg BW) increases HDL cholesterol and decrease LDL cholesterol. *Wakouba* would have the same mechanism of action as tenordate (ATENOLOL + NIFEDIPINE) a reference anti hypertensive product, thus anti hypertensive and cardioprotective properties, which justifies its use in traditional medicine in Cote d'Ivoire as an anti hypertensive.

Key words: *Wakouba*, Tenordate, hypertension, lipid profile, systolic and diastolic pressure.

INTRODUCTION

Hypertension is an elevation of blood pressure in the arteries (Messerli et al, 2007). This is a major cardiovascular risk factor by its correlation with dyslipidemia, diabetes, and renal failure (Zabsonré et al, 2001. Meguid and Bello, 2005; Soraya and Soda, 2009; Kpahe et al, 2012) which are the main causes of death in the world (Rabarijaona et al, 2009. WHO, 2011; WHO, 2011; WHO, 2013).

Testing for high blood pressure should not be limited only to BP criterion but must be extended to a complete lipid profile and serum markers of kidney failure and diabetes (WHO, 1999, O'Brien, 2001) to help guide treatment. So the best way to treat high blood pressure will be first; significantly reduce all risk factors known in hypertensive patients (Dickinson et al. 2006). To do so, several classes of antihypertensive drugs are available in pharmacies (Koffi, 2007). But the expensive cost of these drugs make people turn to medicinal plants mainly natural antihypertensive and use them for their health problem (Yomalan et al, 2008. Souza et al, 2011 Abrogoua et al, 2012). Among these natural antihypertensive we have *Wakouba*, a salt extract of *Elaeis guineensis* (Jacq) or oil palm tree. The objective of this study was to evaluate the effect of *Wakouba* compared to that of Tenordate ,a reference antihypertensive substance on systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), serum markers of renal failure , diabetes, and myocardial infarction in rabbit having adrenaline induced hypertension.

MATERIAL AND METHODS

Preparation of Wakouba

Fronde of *Elaeis guineensis* (Jacq) or oil palm tree were collected between August and September 2013 in Sassandra city (South - West Côte d' Ivoire) , cut into small pieces and dried away from sunlight at room temperature (25-30°C) . Four (04) weeks after drying, these fronds were incinerated in a muffle furnace at 400 ° C until ashes were obtained. One hundred grams (100g) of ashes of *Elaeis guineensis* (Jacq) were taken and dissolved in one liter (1 L) distilled water and then homogenized for two (02) hours at room temperature using a magnetic stirrer IKAMAG. The homogenate was filtered and the filtrate evaporated by heating at 60 ° C. The sediment at the bottom of the container is the *Wakouba* salt.

Treatment of Animals

Twenty four (24) rabbits of the species *Oryctolagus cuniculus* of both sexes, aged 8 weeks with an average weight of 1 ± 2.2 to 1.5 ± 3.01 kg were used. These animals were brought from a poultry farm in Bingerville (South-east of Abidjan) , were acclimated for three weeks at the Animal unit of the National Agricultural Research Centre (NARC) , IRO LA ME station then divided into 6 lots of 4 rabbits (Lot1to 6) . Lot 1 or witness lot received throughout the duration of the experiment distilled water; Lot 2-6 or experimental lots were intravenously injected with an insulin syringe, adrenaline dosed at 1 mg / ml to cause elevated blood pressure or hypertension, which was later stabilized after 10 days of treatment.

Direct or noninvasive measurement of blood pressure of rabbit

Blood pressure of rabbits was taken with an electric manometer which cuff was adapted to the leg of rabbit. The cuff was wrapped around the left hind leg of the animal and its inflation gauge enabled with the ON button. The cuff inflates to the maximum to tighten up the leg of the animal and deflates immediately. It appears on the manometer screen, systolic pressure, diastolic pressure and the heart rate of rabbit. These three cardiovascular parameters of rabbits were then compared to the witness group.

Antihypertensive treatment

10 days after induction of hypertension in animals, they were treated with *Wakouba*, a salt extract of *Elaeis guineensis* and Ténordate a reference antihypertensive sold in the market. Each lot was treated as follows:

LOT 1: Witness + distilled water

LOT 2: Witness treated with adrenaline (Adr)

LOT 3: Treated with Adr + Ténordate (Atenolol + Nifedipine) (10mg/kg bw)

LOT 4: Treated with Adr + Wakouba (950mg/kg bw)

LOT 5: Treated with Adr + Tenordate (20mg/kg bw)

LOT 6 :Treated with Adr + Wakouba (2500 mg / kg bw)

Sampling of blood and organs.

Blood of the animals were collected for testing, taken from the orbital sinus of the eye using a pasteur pipette. The blood was collected in red and gray tubes and centrifuged at 10,000 rpm for 10 minutes. The supernatant was collected and used for the determination of total cholesterol (CHOL T), triglycerides (TG), the HDLch, LDLch, creatine, urea, LDH and blood sugar. Kidneys and hearts of animals in the lot sick not treated (Lot SNT) and kidneys of animals treated with *Wakouba* (2500mg/kg.Bw) were immediately removed and put in formalin 5% to carry out the histological sections.

Treatment of results

All values presented are (mean \pm SEM), with n representing the number of different separate experiments. Statistical significance of the values was analyzed using an analysis of variance (ANOVA) followed by multiple comparison tests by Tukey -Kramer. P values less than 0.05 were considered significant.

RESULTS

Effect of *Wakouba* on cardiovascular parameters SBP, DBP and HR

Table I shows the values of cardiovascular parameters SBP, DBP and HR of animals of the control lots, sick not treated and treated with *Wakouba* and Tenordate (ATENOLOL NIFEDIPINE +). Cardiovascular parameters values for animals in witness lot, systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were respectively 122.3 ± 0.33 mmHg for SBP; 80.33 ± 0.11 mmHg for DBP and 226 ± 3.51 beat / min for HR. These values increased significantly ($p < 0.001$) after the induction of hypertension in rabbits respectively to 197.3 ± 1.45 mmHg for SBP, 170.00 ± 0.57 mmHg for DBP and $363.66 \pm 3, 62$ beat / min for HR that is a percentages increase of 38.43 %, 74.26 %, 28.57% respectively. These parameters (SBP, DBP and HR) decreased significantly ($p < 0.001$) up to their normalization with the treatment of Tenordate (10mg/kg and 20mg/kg. Bw) and *Wakouba*, at doses of 950mg/kg.Bw and 2500 mg / kg .bw. The SBP values change from 197.3 ± 1.45 mmHg to 125.70 ± 1.76 mmHg with 950mg/kg bw and from 197.3 ± 1.45 mmHg to 95.33 ± 0.66 mmHg with 2500 mg / kg.bw. *Wakouba* at the dose of 2500mg/kg,bw after ten days of treatment induced hypotension. With Tenordate (20 mg / kg.bw), the values obtained are 136.3 ± 0.88 mmHg, 78.33 ± 1.50 mmHg and 226.3 ± 2.10 mmHg for SBP, DBP and HR respectively

Table 1: Values of SBP, DBP, and HR in rabbits treated and not treated with Adrenaline, the Tenordate and *Wakouba* after 10 days of treatment.

Cardiovascular parameters	Lot C	lot SNT	Lot Adr+ ten	Lot Adr+lten	LotAdr+W	Lot Adr+w
			10mg/kg	(20mg/kg)	(950mg/kg)	(2500mg/kg)
SBP (mmHg)	122,30±0,33	197,3±1,45***	154±01,73***	136,3±0,88**	125,7±1,76***	95,33±0,66***
DBP (mmHg)	80,33±0.11	170,0±0,57***	93,33±0,88*	78,33±1,50***	76±1,52***	50,00±0,57***
HR	226±3,51	363,66±3,62***	230,7±2,73ns	226,3±2,10***	223,0±5,29***	210,3±1,45***

Each value represents the mean \pm SEM, n = 3; Significant (* $p < 0.05$); ** $p < 0.01$; *** $p < 0.001$); ns (not significant). Adrenaline (Adr), WAKOUBA (w) Tenordate (Ten), Sick control (SC), Sick not treated (SNT), systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR)

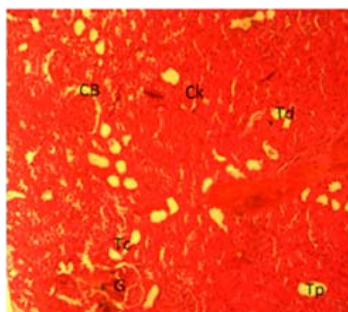
Effect of *Wakouba* on lipid profile and serum markers of kidney and heart.

The values of lipid profile (T Chol, TG, HDLch, LDLch) and serum markers of kidney (urea and creatinine) and heart (LDH) of the control Lot, Sick not treated and treated are presented in Table II. Normal values of lipid parameters are: CHOL T (1.11 ± 0.01 mmol / l) TG; (0.63 ± 0.13 mmol / l); HDL (0.56 ± 0.02 mmol / L), LDL (0.45 ± 0.05 mmol / l). These values CHOL, TG and LDL significantly increased after the induction of hypertension in rabbits. They change from 1.11 ± 0.21 mmol / l to 2.30 ± 0.16 mm for CHOLT; 0.63 ± 0.13 mmol / l to 1.20 ± 0.05 mmol / l for the TG and 0.45 ± 0.05 mmol / l to 1.02 ± 0.03 mmol / l for the LDL, that is a percentages increased of 14.41%; 17.46% and 91.11 % respectively. HDL, on the contrary decreased significantly from 0.56 ± 0.02 mmol / l to 0.10 ± 0.06 mmol / l, a percentage decrease of 42.28 %. In control rabbit urea, creatinine, LDH and glucose values are respectively 0.33 ± 0.01 g / l; 13.31 ± 0.46 g / l; ± 234.00 g / l and 0.86 ± 0.05 g / l which increased significantly with the increase in blood pressure to attain the respective values of 84.33 ± 4.37 g / l urea; 32.33 ± 4.66 g / l for creatinine; 250.0 ± 9.23 g / l for LDH and 0.96 ± 0.03 g / l glucose. Treatment of hypertensive rabbits with *Wakouba* (950 and 2500 mg / kg bw) and Tenordate (10 and 20 mg / kg bw) causes a significant decrease in values of T CHOL, TG and LDL to normalize within 10 days of treatment to 1.11 ± 0.4 mmol / l for T CHOL and 0.63 ± 0.03 mmol / l for TG. The LDLch significantly decreased even after 10 days of treatment, HDLch on the contrary significantly increases from 0.10 ± 0.19 mmol / l for Sick not treated lots to 0.67 ± 0.09 mmol / l in lots treated with *Wakouba* (950mg/kg bw and tenordate (20mg/kg bw). Values of urea, creatinine, glucose and LDH decreased significantly to reach normal values when compared to control lot (0.34 ± 0.08 g / l. 13.51 ± 0.64 g / l. 236.00 ± 6.42 g / l. All serum parameters in Sick not treated lot increased significantly compare to the control batch except HDLch which decreases significantly. HDLch values vary from 0.32 ± 0.0 mmol / l in the control group (Lot C) to 0.10 ± 0.19 mmol / l for the sick not treated lot (lot SNT) a percentage decrease of 68.75% compared to the control lot.

Table 2: Effect of Wakouba on lipid profile, blood glucose, and serum markers of kidney and heart of hypertensive rats

Serum parameters	LOT C	L SNT	Lot Adr+Ten	Lot Adr+Ten	Lot Adr+W	Lot Adr+ W
			(10mg/kg)	(20mg/kg)	(950mg/kg)	(2500mg/kg)
UREE (g/l)	0,33±0,01	84,33±4,37*	0,39±0,07 ^{ns}	0,34±0,06*	0,34±0,09 ^{ns}	0,55±0,08**
CREAT (g/l)	13,31±0,46	32,33±4,66*	15,70±0,47 ^{ns}	14,71±0,29***	13,51±0,64 ^{ns}	22,48±0,21*
LDH (g/l)	234,00±1,52	250,0±9,23**	239,00±7,50 ^{ns}	234,30±8,81*	236,00±6,42**	230,00±6,42***
GLY (g/l)	0,86±0,05	0,96±0,03*	0,85±0,01 ^{ns}	0,88±0,07 ^{ns}	0,84±0,07 ^{ns}	0,82±0,04 ^{ns}
CHOLT (mmol/l)	1,11±0,12	2,30±0,16**	1,15±0,05 ^{ns}	1,12±0,07***	1,11±0,04***	1,10±0,01*
TG (mmol/l)	0,63±0,13	1,20±0,05 ^{ns}	0,63±0,01 ^{ns}	0,62±0,04**	0,63±0,03*	0,60±0,24*
HDL (mmol/l)	0,56±0,02	0,10±0,19***	0,68±0,04 ^{ns}	0,66±0,20*	0,67±0,09**	0,68±0,19 ^{ns}
LDL (mmol/l)	0,45±0,05	1,02±0,03***	0,50±0,05**	0,33±0,07***	0,34±0,11***	0,31±0,06**

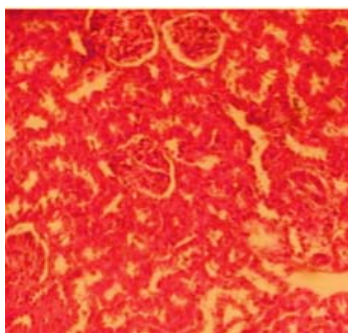
Each value represents the mean ± SEM , n = 3 ; Significant (* p < 0.05) ; ** p < 0.01 ; *** p < 0.001) ; ns (not significant). Values are expressed as mean ± SEM (n = 5). ; Significant (* p < 0.05); ** p < 0.01; *** p < 0.001); ns (not significant). Urea (mg / l) ; Creatinine (g / l) ; LDH (lactate dehydrogenase) (g / l) ; Glucose (g / l) ; CHOLT (Total Cholesterol) (g / l) TG (Triglyceride) (g / l) ; HDL (high density lipoprotein) (mmol / l) ; Low density lipoprotein (mmol / l). Adrenaline (Adr). Wakouba (WA) Tenordate (Ten), Sick not treated (SNT)



A: Cross section of kidney of control rabbit

This section presents the glomeruli (G) , Bowman's capsule (Cb) , the distal convoluted tubules (dct) , the proximal convoluted tubules (Tp) and the collector tube (Tc) all having a normal appearance..

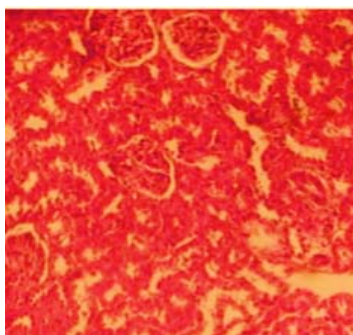
Figure 1: cut section of kidney treated with wakouba at' (2500mg/kg .bw)



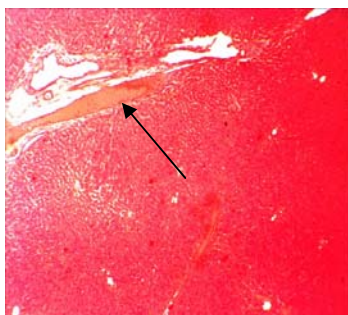
B: Cross section of kidney of rabbit treated with wakouba at dose of 2500 g/kg.

The kidney is not damaged. It contains Bowman's capsule surrounding the glomerulus (G), distal convoluted tubule (Td) and proximal tubules (Tp) all in the state of normal kidney architecture compared to that of control rat.

Figure 2 : Cut section of kidney of animals of Lot sick untreated(SNT) 20 days of experiment(HE X 400) A: Control rabbit treated with wakouba (2500mg /kg bw) B: rabbit Sick untreated with wakouba



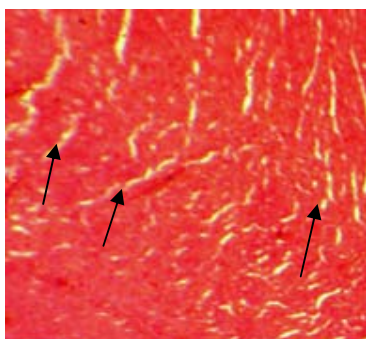
C: Cut section of kidney of rabbit treated with wakouba at dose of 2500 g/kg. No damage was found in this kidney. It contains Bowman's capsule surrounding the glomerulus (G), distal convoluted tubule (Td) and proximal tubules (Tp) all in the state of normal kidney architecture compared to that of control rat.



D: Cut section of kidney of sick rabbit not treated (SNT) with wakouba.

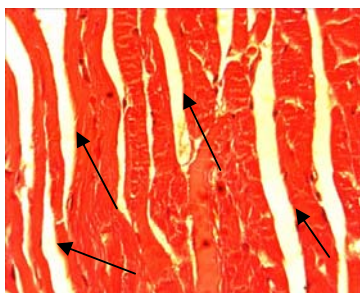
The arrow indicates the vascular congestion of the kidney. The observed congestion is due to the pressure of an abnormal blood flow in the renal vessels.

Figure 2: Cut section of heart of animals in the Lot Sick not treated after 20 days of experiment (HE X 400). C: Control rabbits treated with ‘Wakouba’ (2500mg/kg. bw). D: Rabbits sick not treated with ‘Wakouba’



E: Cut section of heart of rabbit treated with wakouba at (2500mg/kg bw).

The heart present a normal architecture .Arrows indicate the levels of branching of cardiac cells connected to each other by a system of cell junction. All forms bundle of smooth muscle cells of the (FML) heart.



F : Cut section of heart of rabbit sick not treated (SNT).

This heart has a hypertensive dilated cardiomyopathy characterized by the breakdown of systems that link cell junctions FML. The arrows indicate the breaking levels between FML.

DISCUSSION

High blood pressure (HBP) is a permanent and sustained elevation in blood pressure, resulting from the contraction of blood vessels due to a rise in intracellular calcium (Neef and Maier, 2007; Cheng and Lederer, 2008, George , 2008, Reece and Moss , 2008; Kpahe et al, 2012). The adrenaline induced Hypertension is an appropriate experimental model for study of hypertension (Umang, 2012). Adrenaline indeed exerts its hypertensive effect by intracellular calcium mobilization in three principal mechanisms: (1) Activation of phosphoinositol triphosphate (IP3) pathway, with the formation of diacylglycerol in the presence of ATP (Alexander et al, 1985. Lassegue *et al* ; Griendling et al, 1985. Lassegue et al, 1993. Venema et al, 1998).

This leads to the rapid mobilization of intracellular calcium responsible for increasing the amplitude of the heart rate and therefore a rise in blood pressure. (2) Adrenaline activate the secretion of peptide natri uretic directly in the heart and in the blood vessels and vasopressin which in turn activate the dependent calcium channel in the endothelium and causes the release of calcium into the intracellular medium. This leads to vasoconstriction and increase in blood pressure (Metrich, 2008). (3) The adrenaline binds to β_1 receptors present in the juxtaglomerular apparatus of the kidney and activates adenylyl cyclase (AC) - cAMP resulting in the release of renin to yield angiotensin I, which converted to angiotensin II causes vasoconstriction thus an increase in blood pressure (Van et al , 2005. Sucharov, 2007 vernier, 2008). The cardiovascular parameters values (SBP, DBP and HR) measured in control rabbits in this study are consistent with those proposed by (Dewre and Drion , 2006) in their study on rabbits. The induction of hypertension in rabbits causes a rise in glucose level higher than in normal rabbits. Our results are in agreement with those of Sowers, (2001); Guo et al, (2005). ; De Jongh (2004). For these authors, the vasoconstriction observed in the heart during hypertension prevents the movement of glucose into the target cells to be placed in reserve thus causing hyperglycemia observed in hypertensive patients. Lipid profile in hypertensive patient allows the determination of LDL- cholesterol, HDL- cholesterol and triglycerides, 3 parameters associated with the risk of developing cardiovascular disease (Ugawa, 2000; Brown, 2001. Law et al, 2003). Hyperlipidemia observed in hypertensive rats are in agreement with the results of the study of Oyedepo (2013) carried out on rats rendered diabetic with alloxan .Hyperlipidemia correlated to hyperglycemia would be due to the mobilization of fat from under-utilization of glucose in adipose tissues (Nimenibo - Uadia , 2003). The high level of creatinine and urea in hypertensive rabbits corroborate to those obtained by Torres et al (2007). ; Chapman et al, (2003). ; Risk et al, (2009). ; and Chapman et al. , (2010) in their study on kidney disease. These authors reported that hypertension increases renal bloodstream due to a decrease in glomerular filtration. Creatinine and urea are substantially removed from the blood by glomerular filtration (Dombia, et al. 2007). The decrease in the filtration results in elevation of these two parameters in the blood and implies a failure of the kidney. Significant elevation of LDH in hypertensive rabbits implies myopathy because LDH has a diagnostic value with infarction (Coulibaly et al, 2010). Our results are in agreement with those of (Rasekh et al. (2008) who observed heart disease diagnosed by significantly increased blood LDH in rats treated with an extract of *Galela officinalis*. Treatment of hypertensive rabbits with Wakouba (950mg/kg.bw) causes a decrease in blood pressure and high levels of all markers of hypertension until full normalization. Wakouba (2500mg/kg.bw) induce a pronounced hypotension characterized by high levels of urea and creatinine compare to witness lot. Used at high concentrations, Wakouba could present adverse effects to the body. *Wakouba* is a salt extract obtained from fronds of *Elaeis guineensis* or *oil palm tree*. This salt is used by the peoples of southwestern Côte d'Ivoire to treat high blood pressure. This salt reduces both systolic blood pressure (SBP) and diastolic blood pressure (DBP) and heart rate (HR). These effects are similar to those of Tenordate (ATENOLOL + NIFEDIPINE), reference antihypertensive product available in the market. The Tenordate contains two molecules, nifedipine, a calcium antagonist and Atenolol, a β -blocker. The Tenordate act either by inhibition of calcium channels , preventing the entry of calcium into the contracting structures , resulting in the decrease of above mentioned parameters, or by fixing to the β adrenergic receptors, thus preventing massive release of calcium into the intracellular medium , which causes vasodilation and a decrease in SBP , DBP and HR . *Wakouba* which has the same effect as Tenordate could act by the same mechanism as the latter. *Wakouba* would contain calcium antagonist compounds and β -blockers. The calcium antagonist compound of *Wakouba* inhibit calcium channels and β -blockers, would bind β adrenergic receptors to block the binding of adrenaline and prevent the massive release of calcium into the intracellular medium , resulting in vasodilation and thus a normalization of blood pressure (Van Gestle et al, 2008 ; . Short et al, 2011). The significant increase in the level of urea in the lot treated with *Wakouba* (2500mg/kg.bw) does not signifies renal failure but the hypotensive effect of *Wakouba*. In fact, the creatinine and urea are substantially eliminated from the blood by glomerular filtration, which also depend on the blood pressure in the glomerular capillaries, which is about 30 mm Hg, drop in blood pressure may therefore cause a decrease of glomerular pressure of about 10 mmHg (Dombia et al, 2007) and lead to a decrease in the volume of plasma filtered through the glomerulus. The non-pathological state of the kidney is confirmed by observation of the histological section of rabbit kidney of the concerned lot which has a normal appearance compared to the control lot. The very high level of urea, creatinine and LDH in the lot SNT confirms the damage done to kidney and heart due to a permanent and sustained hypertension. Vascular congestion levels observed in the kidney (section B) can be explained by abnormal blood flow in the renal vessels (Damman et al, 2007. Damman et al, 2009, Mullens et al, 2009) in the heart, there is a dilated cardiomyopathy hypertensive (section D) characterized by the breakdown of junction system that bind smooth muscle of the heart. (Schonberger and Seidman, 2001; Ross, 2001; Aylor et al, 2006. Hilfiker - Kleiner, 2008, Jefferies 2010). This breakdown is due to the uncontrolled hypertension resulting in high pressure and high heart rate.

CONCLUSION

Our study on the effect of *Wakouba* on SBP, DBP, HR, lipid profile, blood glucose and serum markers of kidney and heart showed a significant decrease followed by a normalization of the above parameters in the lot sick and treated with *Wakouba*. *Wakouba* significantly reduces cholesterol, triglycerides and LDL while increasing HDL serum. *Wakouba* has the same effect as the Tenordate, an antihypertensive compound, on the same parameters. *Wakouba* is an antihypertensive substance; this justifies its uses in Ivorian traditional medicine in the treatment of hypertension. *Wakouba*, in addition to its antihypertensive properties, would possess a great cardioprotective properties and may prevent diabetes and kidney failure. *Wakouba* may be used in the treatment of cardiovascular diseases. *Wakouba* at doses above 1000 to 1500 mg / kg.bw could be harmful and the best dose is 950mg/kg. bw.

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