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Full Length Research Paper

In Vivo Assessment of the Nutritional and Subchronic Toxicity of *Tacca leontopetaloides* (L.) Tubers

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Tacca leontopetaloides **tubers are largely used as food in sahelian arid zone during the periods of cereal shortages. The tubers are traditionally subject to post harvest treatments in order to eliminate the bitterness and toxicity. The present study evaluated the subchronic toxicity of processed and unprocessed tacca in rat models (*Rattus norvegicus* L.) one month old. Rats were fed for 7x7 days on aperitif (1.5 g) in the morning and standard food (no restriction) in the evening. The basic composition of aperitifs was 20% fish and 80% cassava. In the experimental design, the groups were formed by substitution of cassava with processed (100%) and unprocessed tacca (100%, 66% and 33%). The change in body weight and plasmatic biochemical parameters of rats groups were determined every week. The results revealed that while the consumption of processed tacca was 100%, the aperitif intake increasingly diminished as the level of unprocessed tacca increased. Rats fed unprocessed tacca excreted more lipids in feces as the intake level increased. Generally no significant difference was observed on the organ weight while rats groups fed unprocessed tacca presented high levels of plasmatic transaminases and high level of cholesterol. Beside no significant difference was observed on the hematological parameters.**

Key words: *Tacca leontopetaloides*, subchronic toxicity, food intake, biochemical parameters, hematological parameters.

INTRODUCTION

Food deficiency is a permanent problem in the soudano-sahelian countries of the world where efforts are continuously made by national and international authorities to assist the most stripped one. Food deficiency is generally associated with health problems and risks of food poisoning (Igor de Garine, 2002, Risinger et al., 2010, Seignobos, 1989). In fact during the long period of cereals shortage, populations often turn to nonconventional crop products in order to meet their daily food intake. This is more crucial in the soudano-sahelian dry zone where rainfall lasts less than 3 months. In this respect, *Tacca leontopetaloides* has been shown to play an important role in Central Africa, and particularly in Chad as a source of dietary starch (Igor de Garine, 2002, Ndouyang et al., 2003, Ruffo et al., 2002).

Tacca is an annual herb, which grows upright to a height of 30 cm and is widespread in the savanna zone of Central Africa including Chad, Nigeria and Cameroun (Manek et al., 2005). It produces an underground tuber which is subject to commercialization in local market for human consumption. As many non conventional tubers, the consumption of tacca is limited by the presence of toxic components (Rouers, 1996). In this respect, populations have developed traditional strategies to detoxify *T. leontopetaloides* tubers and nowadays, the detoxified tubers are not only consumed in households

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but are also commercialized in local market (Igor de Garine. 2002, Matsuura, 2001, Rouers, 1996). The traditionalmethod of detoxification consists of diluting in water the crushed fresh tubers followed by a step of decantation. The operation is repeated a number of time depending on the manufacturer (Igor de Garine. 2002, Matsuura, 2001). The fundamental question concerning the nutritional value and the toxicology of manufactured tacca needs to be answered. This question is pertinent in the way that multiple soakings are needed to remove the toxic while this significantly reduces the nutritional quality of the tubers.

The toxicity of the *Tacca* genus has been widely evocated (Kitjaroennirut et al., 2005, Liu et al., 2006, Tinley et al., 2003, Tripathi and Tiwari, 1981). Two alkaloids, taccalonolid E and A of *Tacca chantrieri,* have been identified and their activity on isolated cells in mitosis was determined. In this respect they possess a stabilizing effect of microtubules in interphase and an initiating activity of apoptosis (Tinley et al., 2003). Long time ago and more recently (Swanholm, 1959, Ukpabi et al., 2009), studies revealed that the bitterness of *T. leontopetaloides* is due to taccalin (3,5,7,4'-tetrahydroxy-flavylium-3-xyloside), a phenolic compound (Ukpabi et al., 2009). The question of the effect of consumption of processed and unprocessed tacca on the hematological and biochemical parameters of rat's blood is still to be answered since these parameters constitute the determinant variables conditioning their safety and health benefit. To our knowledge, very few if not such studies have been conducted.

In an effort to investigate this issue, this work was carried out with the objective to study the nutritional and sub chronic toxicity of processed and unprocessed tacca flour in rat models.

MATERIAL AND METHODS

Production of tacca flours

The plant materials, the fresh tubers of *T. leontopetaloides* were collected in the village of Binder, at the West of the region of Mayo-Kebbi in Chad. The sample was taken to the Laboratory of Biophysics, Food Biochemistry and Nutrition of ENSAI/University of Ngaoundere Cameroon for the production of flour according to Kunle et al. 2003 and Ukpabi *et al.2009*. The tubers were separated into two batches for the production of processed and unprocessed tacca flour. For the unprocessed tacca flour, the tubers were peeled, cleaned, grated, dried for 24h in an electrical convection dryer set at 50 °C. In the procedure of production of processed tacca, the second batch of samples was chopped in a Moulinex machine (France), mixed with water (1:3 w/v) for 30 min, left for 10 min for suspension to settle and the water discarded. Water was again added to the precipitate and the procedure redone twice. The precipitate presumably free of toxic was then spread out on aluminum clay and allowed to dry as described above. The dried processed and unprocessed dried chips were then finely milled to pass a 500 µm diameter sieve using an electrical harmer grinder (Cullati, France). The flours were packed in polyethylene bags and stored at 4°C for further studies.

Animal sampling

The animal material consisted of male rats (*Rattus norvegicus*) of 30 days old obtained by coupling 6 groups of 4 couples of rat male and female in the animal unit of the School of Agro-Industrial Sciences (ENSAI), Cameroon. The resulting rats 30 days after birth weighting 50 to 55 g were used for the experiment. They were housed in plastic cages, kept at room temperature (18-25°C), allowed free access to water and fed standard diet substituted or not with tacca powder.

Experimental design

Rats were randomized and divided into 6 groups of 6 animals each receiving specific diet according to Traore and Nebout, 1983 and Dzeufiet, 2005. The diets in all groups were composed of an aperitif diet of 1-1.5 g/rat served each morning in the form of paste to the animals, and in the afternoon an isoenergetic food served and left at their disposal all the day and withdrawn at the end of the day. Water was given to the animals in the morning and in the evening without restriction. The basic composition of aperitifs was 20% fish and 80% cassava. In the experiment, the groups were formed by substitution of cassava with tacca as followed: 0% substitution constituted group 1, group 2 was 100% substituted with processed tacca, 33% substitution with unprocessed tacca formed group 3, group 4 was fed diet 67% substituted with unprocessed tacca, group 5 was 100 substituted with unprocessed tacca, and finally group 0 received no aperitif. The isoenergetic food composition was as followed: 55% corn starch, 10% Fish meal, 10% corn flour, 20% groundnut paste, 0.5% cooking salt and 4.5% dried milk.

Food and rat weight measurements

When experiencing, the rats were weighed on the first day at the beginning, then weekly up to the end 6 weeks of the study. The initial and the final weights of rats were recorded and the daily food intake (aperitif and isoenergetic food) quantified weekly. The food intake was calculated as mass of food consumed daily per rat while the food efficiency ratio (FER) was expressed as the ratio

of total food intake to total increase in rat weight during the 6 weeks experiment. The specific growth rate (SGR) was calculated by the following formula (Dada, 2012).

$$SGR\ (\%\ .day^{-1}) = \frac{\ln(Wf) - \ln(Wi)}{t} * 100$$

where: *Wf* and *Wi* are respectively body weight of rats at the final and initial steps, et ***t*** represents the time of experimentation.

Hematologic and biochemical analyses of blood samples

At the end of the experimentation lasting 7x7 days, blood samples were collected in heparin tubes from rats by jugular vein puncture under chloroform anesthesia and used for the determination of serum hematological and biochemical parameters. Feces were also sampled at the end of the experiment.

Hematological analyses were performed on blood samples using an automated hematology analyzer (Humacount; Human, Weisbaden, Germany). The recorded parameters were white blood cells, lymphocytes, granulocytes, red blood cells, hemoglobin, hematocrit and platelets. Alanine aminotransferase (ALAT), Aspartate aminotransferase (ASAT) and Gamma-glutamyltransferase (GGT or γ-GT) of blood samples expressed in international unit per liter (IU/L) were assayed using kit on a programmed spectrophotometer (Spectrophotometer 3000 revolution, International Business Technology Medical IBT) following Henry, 1974.

Glycemia expressed as mg glucose dL^{-1} was evaluated using a glucometer (One Touch Ultra 2) provided with a reader of glycemia and strips.Total cholesterol and triglycerides of blood samples were proportioned using a kit of enzymatic colorimetric quantification by the method of Allain *et al.* 1974 and Ter Welle *et al.* 1984 respectively. The HDL cholesterol level was determined after quantitative precipitation of the low density lipoproteins (VLDL and LDL) and the fractions of chylomicrons by addition of buffer PEG6000 (Burstein et al. 1980). The reading wavelength of the optical densities was 510 nm. The fraction of LDL cholesterol (LDL-C) was proportioned by difference between total Cholesterol (TC) and HDL Cholesterol (HDL-C) and triglycerides (TG) using Friedewald *et al.* 1972: LDL-C=TC-(HDL-C+TG/5). The Atherogenic Index was calculated based on the classical method, AI1 (ratio of total cholesterol to HDL cholesterol), and the new approach, AI2 (ratio of the LDL cholesterol to HDL cholesterol) according to Orekhov *et al. 1991*.

The plasmatic proteins were quantified according to the method of Gornall *et al*. 1949. The fecal proteins were first extracted according to the method of Bottomley and Popineau, 1984 and proportioned according to the method of Gornall *et al. 1949*. The fecal lipids were quantified by the method of Folch *et al.* 1957.

Statistical analysis

Means and standard deviations (±SD) were calculated from 6 individual values. One way analysis of variance was tested to detect the effect of diet on the blood and feces parameters. When effect was significant ($p<0.05$), the duncan multiple test range was used to compare two means. The software Statgraphics Plus 5.0 was used for the statistical analysis.

RESULTS

Food intake and nutritional properties of the diets

The effect of tacca served as aperitif on the food intake and the growth parameters of rats are given in table 1 and figure 1. Generally no significant difference was observed on the initial and final weights of the rats. This suggested similar food intake as confirmed by the non significant variation of the isoenergetic food intake. Consequently the weight gain and feed efficiency ratio did not vary significantly with diet regime. However the aperitif intake significantly ($p<0.01$) varied from one diet regime to another. In fact the groups fed cassava and processed tacca completely consumed their aperitif while aperitifs made of unprocessed tacca were less consumed and the level of consumption increasingly diminished as the substitution level of cassava by unprocessed tacca increased. In this respect aperitif 100% cassava substituted with unprocessed tacca was consumed at 24%, while 67% and 33% substituted cassava were consumed at 31% and 60% respectively. This clearly demonstrated that the unprocessed tacca was rejected by rats, as a consequence of toxic compound as suggested in literature. Some toxic components were determined in tacca and in this respect the unprocessed tacca flours were significantly higher in phytates and saponins. One could have expected to observe a decrease in weight gain at the end of the experiment as the aperitif intake differed from one group of rats to another. But this was not the case (figure 1), and might reflect the low contribution of the aperitif to the overall food intake (isoenergetic + aperitif). In fact the ratio of isoenergetic food intake to tacca intake varied from 1.05 to 4.56. This could be explained by the compensation with the isoenergetic food intake.

Fecal losses and Organs weight

The variation in fecal proteins, ashes and lipids, plasma-

Table 1: Effect of tacca served as aperitif on the nutritional properties of rats

Parameters	Level of substitution of cassava (%)						Level of significance P*
	No aperitif	0% substituted	100% PT	33% UT	66% UT	100% UT	
Isoenergetic food (g/rat/day)	13.4±0.69[a]	15.2±0.61[a]	13.8±0.71[a]	13.3±0.68[a]	13.4±0.53[a]	13.4±0.38[a]	0.23
Aperitif (g.DW/rat/day)		0.93±0.021[c]	0.8±0.02[c]	0.5±0.07[b]	0.28±0.071 [a]	0.20±0.061[a]	0.01
Aperitif (%)		100[c]	100[c]	60.1±7.91[b]	30.6±6.69[a]	23.9±7.54[a]	0.01
Tacca (g.DW/rat/day)			0.6±0.01[b]	0.14±0.022[a]	0.15±0.042[a]	0.16±0.050[a]	0.01
Initial weight(g)	49.5±3.60[a]	56.0±4.41[ab]	61.5±3.89[b]	56.5±3.58[ab]	57.5±3.29[ab]	57.0±2.20[ab]	0.33
Final weight (g)	171.0±10.38[a]	178.0±11.28[a]	174.0±8.42[a]	153.8±12.37[a]	167.8±7.69[a]	162.0±7.75[a]	0.52
Weight gain (g)	121.5±10.98[a]	122.0±9.80[a]	112.5±7.66[a]	97.2±11.76[a]	110.2±6.72[a]	105.0±6.82[a]	0.36
Feed efficiency ratio	0.11±0.011[a]	0.13±0.012[ab]	0.12±0.013[a]	0.15±0.021[ab]	0.13±0.011[ab]	0.13±0.012[ab]	0.24
Tacca/isoenergetic (%)	0	0	4.56	1.05	1.12	1.20	-

*P is level of significance following the ANOVA test; Means ± SD followed by different letters (a–c) in the same line are significantly different ($p < 0.05$). *PT* processed tacca; *UT* unprocessed tacca.

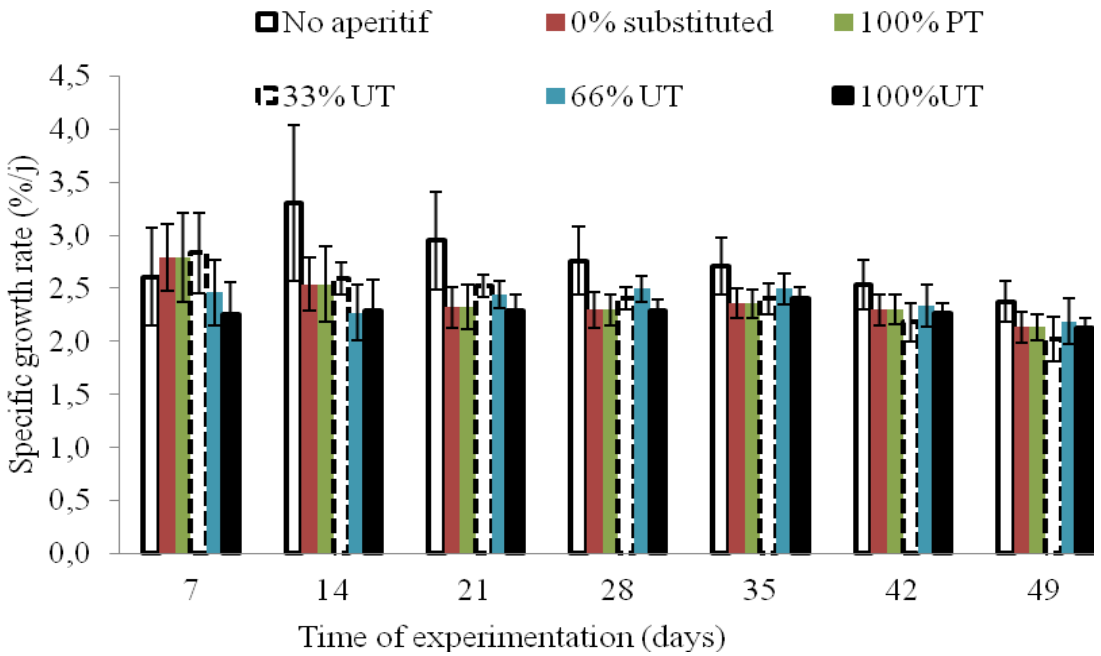

Figure 1: Rats specific growth rate as affected by aperitif and the level of tacca in aperitif. *PT* processed tacca; *UT* unprocessed tacca

Table 2: Fecal and plasmatic biochemical parameters and WG/IW ratio.

Group	Fecal Proteins (%)	Fecal ashes (%)	Fecal Lipids (%)	plasmatic proteins (g/L)	WG/IW
No aperitif	25.14±0.72^{ab}	15.46±0.41^{a}	7.37±0.40^{ab}	82.28±1.88^{c}	2.57±0.3^{b}
0% Substituted	23.45±2.26^{a}	17.75±0.67^{b}	6.61±0.55^{a}	85.48±7.17^{c}	2.26±0.2^{ab}
100% PT	24.80±1.04^{ab}	17.38±0.16^{b}	8.46±0.73^{bc}	73.31±3.64^{c}	1.88±0.2^{a}
33% UT	31.11±1.98^{c}	15.57±0.43^{a}	7.49±0.59^{ab}	60.11±2.20^{a}	1.79±0.3^{a}
66% UT	30.13±2.00^{bc}	15.74±0.57^{a}	9.57±0.49^{c}	64.40±5.31^{ab}	1.96±0.2^{ab}
100% UT	25.26±1.94^{c}	16.61±0.27^{ab}	9.62±0.54^{c}	75.56±1.70^{bc}	1.85±0.1^{a}

*P is level of significance following the ANOVA test; Means ± SD followed by different letters (a–c) in the same column are significantly different at P (p< 0.05). *PT* processed tacca; *UT* unprocessed tacca; *WG/IW* Weight Gain/Initial Weight.

Table 3: Weight of the organs of the rats having received various aperitifs.

	Weight of organs of experienced rats (in grams, g)					
Groups	**Heart**	**Lungs**	**Stomach**	**Liver**	**Kidneys**	**Brain**
No aperitif	0.61±0.04^{a}	1.52±0.14^{a}	1.12±0.05^{a}	6.64±0.40^{a}	1.62±0.12^{a}	1.51±0.06^{a}
0%substituted	0.66±0.04^{a}	1.51±0.07^{a}	1.27±0.07^{a}	6.78±0.52^{a}	1.63±0.08^{a}	1.52±0.09^{a}
100% PT	0.63±0.04^{a}	1.57±0.08^{a}	1.17±0.05^{a}	6.62±0.35^{a}	1.50±0.09^{a}	1.52±0.04^{a}
33% UT	0.55±0.03^{a}	1.60±0.09^{a}	1.20±0.05^{a}	6.56±0.43^{a}	1.53±0.09^{a}	1.53±0.04^{a}
66% UT	0.66±0.03^{a}	1.42±0.08^{a}	1.08±0.06^{a}	6.49±0.35^{a}	1.49±0.03^{a}	1.59±0.04^{a}
100% UT	0.63±0.03^{a}	1.39±0.06^{a}	1.00±0.01^{a}	6.64±0.42^{a}	1.50±0.09^{a}	1.48±0.03^{a}

*P is level of significance following the ANOVA test; Means ± SD followed by different letters (a–c) in the same column are significantly different at P (p< 0.05). *PT* processed tacca; *UT* unprocessed tacca.

-tic proteins are presented in table 2. The consumption of tacca as aperitif had no significant effect on fecal proteins while significant variation (p<0.01) was observed on the fecal ashes which were much higher in group fed cassava and processed tacca aperitif. In addition the fecal lipids level was significantly (p<0.05) affected by introduction of tacca in the food. In this respect rats group fed tacca excreted more lipids in feces than group having no aperitif and rats fed cassava as aperitif. Rats fed unprocessed tacca excreted more lipids as the intake level increased. The result suggested a disturbance of the metabolism of rats which might reflect the changes in metabolism of organs (table 2). The weights of organs as affected by the feed regime are shown in table 3. Generally no significant difference was observed on the organ weight.

Plasmatic concentrations in transaminases

The variations in some plasmatic enzyme ALAT, ASAT, GGT, as well as glycemia on empty stomach are presented in table 4. Compared to rats groups without aperitif and those fed cassava and processed tacca, the level of transaminases were significantly (p<0.05) higher in group fed unprocessed tacca. The high levels of plasmatic transaminases generally reflect liver damage (Etuk et al., 2009b, Etuk et al., 2009a, Otimenyin and Sabo, 2011) and in this respect suggests a toxicity of unprocessed tacca. Besides, glycemia did not varied significantly with diet regime.

Blood cholesterol content (Total, HDL and LDL-Cholesterol).

The cholesterol levels (table 5) varied significantly (p<0.05) with diet. Generally groups fed unprocessed tacca had high level of cholesterol, and this increased as the level of substitution increased. In addition the rat groups fed tacca and no aperitif exhibited high level of HDL-cholesterol and low level of LDL compared to rats

Table 4: Plasmatic concentrations in transaminases and glycemia of rats groups fed different tacca regimes.

Level of substitution of cassava (%)	ALAT (UI/L)	ASAT (UI/L)	GGT (UI/L)	Glycemia (g/L)
No aperitif	38.0±1.73^{a}	33.4±1.55^{a}	37.0±3.45^{a}	0.98±0.05^{a}
0% substituted	50.2±1.91^{b}	47.9±3.03^{b}	37.3±1.45^{a}	0.81±0.08^{a}
100% PT	60.5±3.31^{bc}	48.9±4.43^{b}	38.0±1.73^{a}	0.85±0.04^{a}
33% UT	62.3±4.94^{bc}	80.3±3.50^{c}	51.4±3.33^{b}	0.89±0.03^{a}
66% UT	62.1±3.81^{c}	78.3±5.52^{c}	66.5±2.75^{c}	0.88±0.04^{a}
100% UT	61.3±4.27^{c}	86.8±2.97^{c}	70.1±0.49^{c}	0.85±0.05^{a}
Level of significance P*	<0.01	<0.01	<0.01	<0.676

ALAT Amino Transferase Alanine; *ASAT* Aspartate Amino Transferase; *GGT* Transpeptidase Gamma-Glutamyl; *PT* processed tacca; *UT* unprocessed tacca; values are expressed as mean ± SD, n= 6 in each group. Means followed by different letters (a–b) in the same raw are significantly different (α< 0.05).

Table 5: Lipids profile (Triglycérides; total, HDL & LDL- Cholesterol) of rats groups fed tacca different tacca regimes.

Groups	Tot Chol (mg/L)	HDL Chol (mg/L)	Triglycérides (mg/L)	LDL Chol (mg/L)	IA1 (%)	IA2 (%)
No aperitif	560±40^{a}	270±24^{abc}	939±49^{a}	102±20^{a}	213±15^{ab}	113±15^{ab}
0% substituted	607±44^{a}	234±15^{a}	1055±67^{a}	162±28^{ab}	264±21^{c}	164±21^{c}
100% PT	573±34^{a}	241±196^{ab}	993±57^{a}	134±26^{ab}	246±21^{bc}	146±21^{bc}
33% UT	567±49^{a}	284±24^{bc}	933±64^{a}	96±25^{a}	204±16^{ab}	104±16^{ab}
66% UT	639±37^{a}	322±22^{c}	977±53^{a}	104±21^{a}	200±9^{ab}	100±9^{ab}
100% UT	633±55^{a}	335±15^{c}	980±81^{a}	102±34^{a}	189±14^{a}	89±14^{a}

*P is level of significance following the ANOVA test; Means ± SD followed by different letters (a–c) in the same column are significantly different at P (p< 0.05). *PT* processed tacca; *UT* unprocessed tacca.

fed cassava. As consequence the atherogenic indices of rat groups fed unprocessed tacca were systematically lower compared to others.

Effect of tacca served as aperitif on the hematological parameters of rats

The results of tacca served as aperitif on the hematological parameters of rats are presented in table 6. No significant difference was observed between the groups. The amount of processed tacca (PT) and unprocessed tacca (UT) consumed as aperitif was without effect on white blood cell count (WBC), lymphocytes, granulocytes, red blood cells (RBC), hemoglobin (Hb), hematocrit (Ht) or platelets (Plt).

DISCUSSION

Our previous studies revealed that tacca is essentially composed of carbohydrate (90-92%) with low level of proteins (2-3%), ash (2.5%) and lipids (2.1%) (Ndouyang et al., 2003). This makes tacca an energy source for populations producing them. However the tubers also contained appreciable amount of antinutrients among which saponins, phytic acid and polyphenols were most represented (Ukpabi et al., 2009, Ubwa et al., 20094). These antinutrients also called antimetabolic/antiphysiological substances naturally occurr in plants and interfere with utilization of nutrients. It has been shown that polyphenols and tannins inhibited the hydrolytic action of enzymes in the intestine, complexed dietary proteins and reduced their hydrolysis by enzymes (Allain et al., 1974). In addition, phytic acid lowers the bioavailability of minerals and inhibits proteases and amylases actions in the intestine. Saponins occur widely in plants and are the best-known toxic constituents in fishing poisons. The toxicity of saponin has been associated to its structure similar to that of cholesterol which allowed its insertion in the cell membrane (Francis et al., 2002). They induce bitterness to food Wszelaki et al., 2005 and they would also lower cardiovascular diseases (Matsuura H. 2001). On one

Table 6: Effect of tacca served as aperitif on the hematological parameters of rats

Parameters	Level of substitution of cassava (%)						Probability P (α=0.05)
	No aperitif	0%Substituted	100% PT	33% UT	66% UT	100% UT	
WBC (*10^9/L)	3.8±0.57^a	5.1±1.99^a	3.9±0.30^a	4.5±0.56^a	4.0±0.79^a	4.3±0.36^a	0.94
RBC (*10^{12}/L)	7.7±0.79^b	6.9±0.33^{ab}	6.8±0.30^{ab}	6.9±0.23^{ab}	5.0±0.83^a	6.4±0.26^{ab}	0.22
Hb (g/dL)	14.9±1.80^b	13.1±0.74^{ab}	13.0±0.67^{ab}	13.2±0.35^{ab}	9.2±1.82^a	12.0±0.54^{ab}	0.31
Ht (%)	37.9±0.93^{ab}	37.2±1.88^{ab}	37.1±1.85^{ab}	38.2±0.90^b	23.9±5.66^a	34.8±1.53^{ab}	0.24
Plt (*10^9/L)	197.6±21.88^a	258.7±56.06^a	155.3±20.67^a	186.2±78.68^a	242.9±114.0^a	185.9±24.25^a	0.70

WBC: white blood cell count; Lym: lymphocytes; Gra: granulocytes; RBC: red blood cells; Hb: hemoglobin; Ht: hematocrit; Plt: platelets; values are expressed as mean ± SD, n= 6 in each group. Means followed by different letters (a–b) in the same line are significantly different.
PT processed tacca; *UT* unprocessed tacca

hand, positive nutritional effects of specific saponins such as hypocholesterolemic effects and improvement of growth in various animal species have also been reported (Makkar et al., 2007). On (Abdel-Aziz et al., 1990, Risinger et al., 2010, Yokosuka et al., 2002).

The present study revealed high levels of saponins, alkaloids and phytates in fresh tacca tubers, but the post harvest treatment generally applied to them seem to lower their concentrations to a non toxic level. In the present study we limited the consumption of tacca to 1-1.5 g/rat/day in order to give a choice to the animal to either reject it or not. As expected the rats fed cassava and processed tacca as aperitif consumed totally their food while those fed unprocessed did not. As the level of unprocessed tacca increased in the aperitif from 33% to 100% substitution, the consumed quantity of aperitif diminished from 24% to 60% respectively. The rats then ate the quantity of food according to their preference. As a result the levels of tacca ingested in the present study were low enough to induce metabolic disorders, but rather biological activities. In fact phytates represented 0.004 % to 0.008 % dry food while saponins varied from 0.003 to 0.05 % dry food. Although the levels of phytates and saponins were low in the isoenergetic food, the rats did not accept them either due to the bitterness or the toxicity they induced. Whatever the case, all the rats groups exhibited similar increase in weight, similar organs weights, synonym of no acute toxicity. According to (Francis et al., 2002) levels of saponins lower than 1% do not cause cellular lesions. We equally observed no significant change in the hematological parameters.

ASAT and ALAT are two biomarkers associated with myocardial infarction and hepatic lesions [29]. GGT is an enzyme abundant in liver, kidneys, pancreas and lung which catalyses the transfer of γ-glutamyl groups from one peptide to another (Connell and Serum, 1973). The high levels of GGT are associated to hepatic, pancreatic and bile disorders or cardiac dysfunction (Connell and Serum, 1973). Generally consumption of drugs or ingested chemical compounds induce lipid peroxidation and damage the membranes of hepatic cells and organelles, and consequently cause inflammation and necroses in hepatocytes from where cytosolic transaminases such as ASAT, ALAT, GGT, alkaline phosphatase are released in the blood circulation (Etuk et al., 2009, Venukumar and Latha, 2002). In the present study, the levels of ASAT, ALAT and GGT in the blood of animal groups fed aperitif either made of cassava or tacca were not significantly different to the group which did not consume aperitif, although those fed unprocessed tacca were a little high.

Saponins have been shown to affect cholesterolemia. The primary mechanism of action of saponin is interference with absorption of nutrients such as lipids especially cholesterol, and minerals * Chunmei et al., 2006, Shi et al., 2004). This consequently increases the quantity of fecal lipids. In concordance with Gorinstein *et al. 2006*, the present study revealed no significant change in the total cholesterol which could have diminished with the increase of tacca in the feed. These authors reported that in groups of rats fed cholesterol-free diets, the rats synthesized more total cholesterol, and the level of HDL-cholesterol stayed higher than the LDL. So, the phenomenon of complexation of lipid in digestive gut confers to the diet a lipid-free diet character. The hypocholesterolemic effect of saponins has been demonstrated elsewhere (Matsuura, 2001). Unprocessed tacca seems then to possess edical values if used in adequate conditions while processed tacca may be used as food.

The levels of tacca ingested in groups fed unprocessed tacca were similar with a mean value of 0.15g/rat/day. This quantity is probably the quantity than can induce a benefit to consumers. Taken in account the mean weight of a rat equal to 104 g, the quantity with benefit biological effect was calculated to 1.3 g unprocessed tacca per per day and kg of rat.

CONCLUSION

Although *T. leontopetaloides* is recognized toxic, its toxicity depends on the quantity ingested. At low levels in the diet, ingestion of unprocessed tacca reduced the level of LDL-cholesterol and limit digestion of lipids by increasing the fecal lipids. No abnormality in biochemical markers of toxicity was observed in rats fed unprocessed tacca. Unprocessed tacca can then be recommended for ingestion a day at a quantity not higher than 1.34 g unprocessed tacca per kg body weight of rat and per day. Ingestion of unprocessed tacca in low quantities seems to have positive effect on the lipid metabolism, but this need to be investigated.

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