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Effect of Some Vegetable Extracts on Body Weight and Leptin Concentration

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Abstract

Background: The aim of our study was to evaluate the effect of some vegetable extracts, respectively *Telfairia occidentalis* and *Solanum macrocarpon* on body weight and leptin concentration in Wistar rats subjected to a diet rich in sugar and fat in order to reduce the rate of adipose fat as well as a preventive approach against diseases.

Methods: We performed the extraction is done by maceration of the powders in water. The phytochemical screening was carried out by colorimetric methods. The acute test was performed in single-dose rats of 2000mgkg / bw. In order to evaluate the effect of the extracts on the weight and the concentration of leptin, rats weighing 191 ± 10g were subjected to a diet enriched in sugar and fat; they received 1g extract/kg/bw every day for 21 days.

The extraction allowed us to obtain yields of 31.6% and 28.53% from *Telfairia occidentalis* and *Solanum macrocarpon* respectively. The extract screening revealed the presence of phenols, coumarins, tannins, saponins and flavonoids and the absence of anthocyanins. In addition, the diet enriched in sugar and fat induced in the animal a weight gains (from 194.75 ± 8.6g to 236.5 ± 2.8g), a high food intake (from 173.5g to 196, 0g), serum hypoleptinemia (0.34 ± 0.004g / l), elevated blood sugar (0.99 ± 0.018g / l) and hypercholesterolemia and triglyceridemia.

In conclusion, administration of the extracts prevented weight gain, reduced food intake, blood sugar Cholesterol, and triglyceride levels. On the other hand, an increase in leptinemia is observed in the treated rats. Thus, the use of aqueous extracts of *Telfairia occidentalis* and *Solanum macrocarpon* could be a better way to overcome the problem of overweight and hypoleptinemia. Moreover, we can consider these extracts as therapeutic alternatives in the treatment and prevention of obesity.

Keywords: *Telfairia Occidentalis*; *Solanum Macrocarpon*; Vegetables; Body Weight; Leptin

Introduction

Adipose tissue (AD) is an important organ because, in a lean person it can reach 15 to 25% of the total body weight, and this proportion can reach up to 50% in cases of morbid obesity. It plays a key role in the storage of lipids and the release of fatty acids, thus managing the body's energy reserves according to intake and needs. However, an individual's weight generally remains relatively constant throughout their adult life. There is therefore a fine regulation of the energy balance defined by the balance between food intake and energy expenditure (physical activity, basal metabolism and adaptive thermogenesis). Leptin is the first hormone secreted by white adipose tissue identified in 1994. It is produced in proportion to the degree of adiposity and its main effect is anorectic by its central action on the hypothalamus [1,2]. However, a leptin deficiency or hyperleptinemia will eventually lead to several metabolic disorders in both humans and rodents, due to overeating and inadequate metabolism. Aroused by the central nervous system, which perceives an energy deficiency in the presence of sufficient reserves [3]. To overcome these metabolic problems; the public health authorities have set up several solutions such as the injection of synthetic leptin; medicines like metreleptin, Relacore having satiety properties that are not always effective because they present side effects for some patients and resistance for others.

In view of these constraints around current treatments, the use of vegetables constitutes a new perspective for solving the problem of leptin insufficiency or hyper--leptinemia in order to reduce the rate of adipose fat, thus providing a preventive approach against metabolic diseases.

Vegetables are functional foods due to their nutritional and medicinal properties [3]. To date, they arouse particular interest and present, like medicinal plants, beneficial properties on health thanks to their richness in trace elements, vitamins and phytocompounds they are very important for solving many public health problems [4]. The vegetable species chosen for this study are among others; *Telfairia occidentalis* and *Solanum macrocarpon*. We selected these vegetables based on their availability, low cost and numerous properties. The study's goal is to advocate for the consumption of vegetables vis-à-vis metabolic diseases.

Material and Methods

Preparation of Extracts and Qualitative Phytochemical Screening

The biological material comprised two varieties of vegetables purchased at the local market (Douala): Solanum Marcrocarpon (sm) and Telfairia occidentalis (To) commonly called "Keya" and "Ikon-Ubong" (in the Douala language). Once sampled, they were transported to the biochemistry laboratory at the University of Douala where they were oven-dried for 4 days at 37°C and then ground using an electric grinder (brand of the grinder). The ground material obtained was used for the preparation of the aqueous extracts by maceration of the powders in distilled water in proportions of 1: 8. Then we performed a qualitative phytochemical screening (colorimetric method) to highlight some secondary metabolites (phenols, flavonoids, tannins, coumarin terpenes, saponins, and anthocyanins) present in our extract samples. Phenols were treated with 1ml of 1% FeCl3, according to the method used by Rasool et al., 2010, Flavonoids with a few drops of 1% AlCl3 according to the method used by Bekro et al., 2007, Tannins with a few drops of 2% FeCl3 according to Bennehdi et al., 2012. As regards Terpenes, to 5ml of each extract , were carefully added 2ml of chloroform and 3ml H2SO4 according to Edeoga

et al., 2005, coumarins were treated with 10% NaOH according to Békro et al., 2007 and anthocyanins with sulfuric acid (H2SO4) and ammonium hydroxide (NH4OH).

Study of the Acute Toxicity of the Extracts

Test protocol proposed by the OECD (Organization for Economic Cooperation and Development) in 2008 was used to assess the acute toxicity of extracts of vegetables according to test No. 425: acute oral depression, dose adjustment method. This protocol recommends the administration of a single dose (2000 mg/kg of body weight: BW) of the substance to a first experimental animal (rodent) followed by observation of the physiological variations of the animal for 48 hours. If it survives, 04 additional animals are added and given a dose of the substance at 2000 mg/kg of body weight. The observation of physiological variations in the animal was carried out over two weeks **(OECD, 2008)**. At the end of the study, after 12 hours of fasting, the rats were weighed, anesthetized with ketamine (50 mg/kg of body weight), and then sacrificed. Blood was drawn from the arterial trachea, collected in dry tubes, and centrifuged at 3000 rpm for 15 min. The sera were collected to assess some biochemical parameters (ALT, ASAT, Urea, Creatinine, and Protein). The liver, kidneys, lungs, spleens, and heart were removed, rinsed with physiological water observed, and then photographed.

Effect of Different Extracts on Changes in Body Weight and Leptin Concentration

We used for our study 20 rats of 2 months of age weighing 190 ± 10g breed at the animal facility of the Biochemistry laboratory at the University of Douala at room temperature. They were divided into 6 groups: Group 1 or negative controls (TN) who had received only the standard laboratory diet (RSL); Group 2 or positive controls (TP) who received a standard diet enriched in fat and sugar (peanut, biscuit, chocolate and egg yolk), Group 3 (Sm), Group 4 (To) and Group 5 (Ref) who had all received in addition to the standard diet enriched in fat and sugar (peanut, dry biscuit, chocolate, and egg yolk), the extract of *Solanum melongena*, the extract of *Telfairia occidentalis* and the drug of RELACORE reference respectively at a dose of 1g/day/kg of body weight for 21 days. The diet enriched with fat and sugar was chosen because its excessive consumption for a long time would lead to metabolic diseases like obesity. During the study, the rats were weighed each morning before the administration of the extracts, and the food intake was also monitored. At the end of the study, after 12 h of fasting, the rats were weighed, anesthetized with ketamine (50 mg / Kg of body weight), and then sacrificed. Blood was collected in dry tubes and centrifuged at 3000 rpm for 15 min to obtain serum. A few target organs (the liver, kidneys, lungs, and heart) were removed, rinsed with 0.9% NaCl, weighed, and observed.

Biochemical Analyzes of some Parameters

We determined total cholesterols (CT), HDL (C-HDL), LDL (C-LDL), triglycerides (TG), glucose, Leptin, ASAT, ALT, creatinine, urea and total proteins in the sera by enzymatic and colorimetric methods using kits (Autospan Liquid Gold; SGM Italia, Hospitex diagnostics; Nanjing Duly Biotech C.) according to the methods described by Young 2001.

Statistical Analysis

The results are expressed as the mean ± standard error (M ± ES) of four rats per group (n = 4). We applied the ANOVA test to compare the means between the different groups using the Statgraphics software (Version of software). Fisher's Protected Least Significant Difference (PLSD) test (post hoc comparison test) was used to make pairwise comparisons when the ANOVA p-value was significant.

Results

Extraction Performance

The means indicated by different letters (a, b, c) are significantly different at $p^{<} 0.05$.

We assessed the extraction yield after the maceration (Figure 1). The harvest was different from the two material plants used and the type of samples. The Solanum macrocarpon produced the highest amount of extract (31.6%) compared to Telfairia occidentalis (28.53%) based on the total dry matter weight.

Figure 1 shows the extraction yield from the pow-

ders of our 2 samples. It can be seen from this figure that the yields vary not only according to the plant material used but also according to the type of sample. In addition, the yield based on the total dry matter weight of the samples shows that Solanum macrocarpon produced the highest amount of extract (31.6%) compared to Telfairia occidentalis (28.53%).

Phytochemical Screening

Table 1 shows the results of the phytochemical screening of the plant extracts.

Table 1 shows the results of the phytochemical screening of plant extracts. The results obtained reveal the presence of flavonoids and tannins which give our extract antioxidant activity, total phenols, coumarin which give them anti-edematous activity, saponins giving hemolytic activity to our extracts, an absence of anthocyanins, with a preponderance of secondary metabolites in leafy vegetables Sm compared to time To.

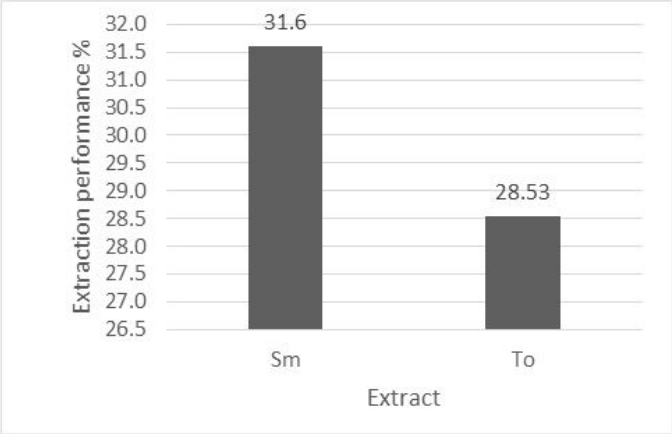

Figure 1: Extraction yield for the different samples.

Sm: Solanum marcrocarpon; To: Telfairia occidentalis

Table 1: Summary of phytochemical screening

Metabolites/extracts	Sm	To
Flavonoid	+ + +	++
Total phenols	+ + +	+ ++
Coumarin	+ + +	+ + +
Anthocyanin	-	-
Saponin	+	+ + +
Tannins	+ + +	+ + +

Sm: Extract of Solanum marcrocarpon; To: Extract of Telfairia occidentalis;

- = absence; +: low presence; ++: Moderate presence; +++: abundant presence

3- Toxicity study

Toxicity Study

Effect of Extracts on some Biochemical Parameters after Toxicity Study

We evaluated the toxicity of the extracts of the material plant by screening some essential biochemical parameters (Table 2).

Table 2: Summary of biochemical parameters after the toxicity study

Test/lot	TN	Sm	To
ASAT	32.36 ± 1,06[a]	31.55 ± 0,70[a]	30.37 ± 1,61[a]
ALAT	38.9 ± 0,54[a]	38.70 ± 1,37[a]	39.1 ± 0,56[a]
Urea	0.67 ± 0,003[a]	0.67 ± 0,01[a]	0.68 ± 0,003[a]
Creatinin	1.70 ± 0,17[a]	1.68 ± 0,27[a]	1.32 ± 0,19[a]
Protein	62.10 ± 1,65[a]	68.5 ± 1,62[b]	65.9 ± 1,36[a]

TN: rat having received no extract; Sm: rat treated with Solanum marcrocarpon extract; To: rat treated with Telfairia occidentalis extract.

Each value represents the mean ± Standard deviation, the number of rats per batch (N) = 4.

The result reveal that, the evaluation of the biochemical parameters does not show any significant difference between the different groups of rats; these results allow to say that these extracts would not present toxicity at the dose of 2000mg / kg of body weight.

Evaluation of the Effect of Extracts on Body Weight and Leptin Concentration

Food Intake of Rats

The food intake of the rats receiving the extracts of Telfairia occidentalis and Solanum melongena is shown in Figure 2.

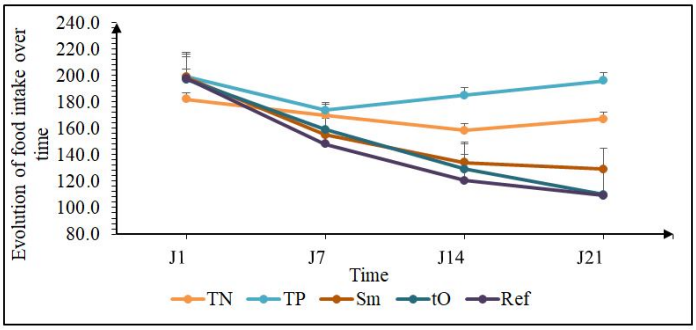

Figure 2: Evolution of the food intake of rats as a function of time

TN: rat having received no extract; TP: rat not having received any extract but consuming a diet enriched in sugar and fat; Sm: rat treated with Solanum marcrocarpon extract; To: rat treated with Telfairia occidentalis extract; Ref: rat receiving the reference drug.

The results show us a progressive decrease in food intake in the test rats compared to the positive and negative control batches. In fact, during the first week of the study, food intake showed no significant difference in all groups of rats. From the second week, a significant difference in food intake is noted between the animals subjected to a diet supplemented with sugar and fat and those receiving extracts of Sm, To and Relacore reference drug (Ref). In fact, food intake decreases significantly in the latter; it goes from 198.0 (J1) to 92.0 (j21) for Sm, from 197.0 (J1) to 80.0 (j21) for To and from 197.0 (J1) to 79.0 (j21) for Ref compared to TN animals (from 182.0 (D1) to 167.0 (d21)).

Evolution of the Body Weight of the Rats During the Study

The change in weight of rats receiving the aqueous extracts Telfairia occidentalis and Solanum melangena during the study is recorded in Figure 3 below.

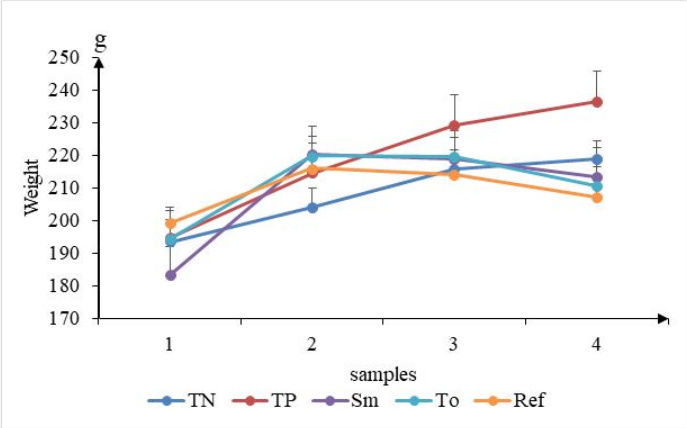

Figure 3: Evolution of the body weight of rats as a function of time

TN: rat having received no extract; TP: rat not having received any extract but consuming a diet enriched in sugar and fat; Sm: rat treated with Solanum marcrocarpon extract; To: rat treated with Telfairia occidentalis extract; Ref: rat receiving the reference drug.

The results obtained show weight gain in all groups of rats during the first two weeks of the study. It should also be noted that, unlike the TN group, whose weight change was almost constant throughout the study, the Sm, To and Ref groups showed a decrease in body weight between the second and the third week of the compared study. to the PT group whose body weight increased throughout the study ranging from 194.75 ± 8.6 to 236.5 ± 2.8).

Evolution of the Evaluated Biochemical Parameters

Table 3: Summary of biochemical results

Parameter / lots	TN	TP	Sm	To	Ref
ASAT	26.46±1,62^{a}	55,65± 0,94^{c}	29,70±0,86^{b}	40,76±1 ,01^{b}	35,97±1,18^{a}
ALAT	37.01±1,93$^{a'b'}$	61,62±2,91$^{c'}$	39,80±2,33$^{b'}$	39,14±2,51$^{b'}$	34,94±2,63$^{a'}$
UREE	0,17±0,007^{a}	0,26±0,007^{b}	0,15±0,008^{c}	0,142±0,007^{c}	0,17±0,008^{a}
Créatinin	0,50±0,03^{ab}	0,59±0,02^{b}	0,43±0,01^{ab}	0,47±0,01^{ab}	0,43±0,01^{a}
Protein	118,22±1.57^{e}	80,88±1.01^{a}	109,74±3.34^{d}	90,65±2,89^{b}	104,98±2,64^{c}
TG	0,89±0,008^{ab}	1,07±0,007^{a}	0,93±0,005^{b}	0,93±0,007^{ab}	0,88±0,005^{b}
HDL-C	0,58±0,008^{d}	0,47±0,005^{a}	0,56±0,008^{c}	0,54±0,006^{d}	0,53±0,003^{b}
LDL-C	0,12±0,008^{a}	0,34±0,004^{d}	0,18±0,009^{c}	0,20±0,013^{c}	0,15±0,018^{b}
CT	0,91±0,003^{b}	1,01±0,006^{e}	0,95±0,007^{d}	0,94±0,006^{cd}	0,89±0,006^{a}
Glucose	0,79±0.011^{a}	0,99±0,018^{b}	0,81±0,013^{a}	0,80±0,019^{a}	0,791±0,012a
Leptin	5,99± 0,27^{a}	3,470±0,44^{b}	5,99±0,23^{a}	5,55±0,44^{a}	5,60±0,32^{a}

TN: rats that did not receive any extract; TP: rats having received no extras but co-consuming a diet enriched in fat and sugar; Sm: rats treated with Solanum marcrocarpon extract; To: rats treated with Telfairia occidentalis extract; Ref: rats receiving the reference drug

From Table 4 it Emerges that

The result obtained during the statistical analysis reveals a significantly lower concentration (3.470 ± 0.442ng / ml) of leptin in PTs compared to the TN group (5.996 ± 0.265ng / ml) and to the other test groups (Sm, To and Ref). In addition, no significant difference was noted between the To, Ref and Sm groups compared to the TN group.

We note a significantly high concentration of total cholesterol, LDL cholesterol and Triglyceride in the TP group compared to the TN, Ref groups and to the To and

Sm treated groups. In contrast, the To and Sm groups, although they consumed the diet supplemented with sugar and fat, showed a significantly low value compared to the TP group. Regarding HDL cholesterol, we observed a significant difference ($p < 0.0000$) within the different groups; with PT significantly lower compared to the other groups.

Blood glucose was significantly ($p < 0.0000$) higher (0.99 ± 0.018g / l) in the PT group compared to the other groups. As regards the Sm, To and Ref groups, they show no significant difference compared to the TN groups.

Transaminases (ALAT and ASAT) are enzymes that reflect cell damage, statistical analysis reveals a significant difference between the concentrations of the different groups compared to significantly higher TP. In fact, the concentrations of ASAT and ALAT in the TN and Ref groups do not show any significant difference ($p < 0.0000$), the same for Sm and To. On the other hand, Sm and To are significantly different from the TN and Ref groups and also from TP.

There is a significant increase (0.26 ± 0.007g / l) in the serum urea content in the TP rats compared to the other groups of rats. Furthermore, the enrichment of the diet of rats with To, Sm extracts and the intake of the drug significantly reduced ($p < 0.0000$) these concentrations which are respectively 0.142 ± 0.007g / l; 0.15 ± 0.008g / l; 0.17 ± 0.008g / l compared to rats on a diet enriched in fat and TP sugar.

Statistical analysis shows a significant increase (0.59 ± 0.02 mg / dl) in serum creatinine levels in TP rats compared to other groups of rats. In fact, the enrichment of the diet rich in sugar and fat with To and Sm extracts and the drug significantly reduced ($p < 0.3043$) these concentrations 0.47 ± 0.02 mg / l; 0.47 ± 0.01mg / l; 0.43 ± 0.01 mg / l compared to TP rats.

Our results indicate that the protein concentration is significantly different ($p < 0.0089$) between the TP which is significantly higher ($80.88 \pm$ g / l) and the other groups of rats. Furthermore, there is no significant difference between Sm (109.74 ± 3.34g / l) and Ref (104.98 ± 2.64g / l), however, they are significantly different from TN and To.

Discussion

After extraction from the powders of *Solanum macrocarpon* and *Telfairia occidentalis* the yields were respectively 31.6% and 28.53%. The extraction was carried out with water as the solvent. The difference in yield between the two extracts could be attributed to the nature of the compound studied and to the chemical composition which differs from one plant to another. Indeed, the chemical effect of the solvent on the plant material induces better penetration of the solvent into the cells depending on the composition of each compound, which thus improves mass transfer and increases the extraction efficiency.

The results of the phytochemical screening revealed the presence of Flavonoids, tannins, phenols, coumarins, and saponins in all the extracts. But the absence of anthocyanins in both extracts. These results are similar to those obtained by the team from [8], which found the same compounds in the leaves of *Telfairia occidentalis*. The same is true for [9] with regard to *Solanum macrocarpon.*

In order to determine the degree or the harmful nature of the various extracts, their toxicity was evaluated in the rats at a dose of 2000 mg/kg of body weight. The extracts did not cause any deaths throughout the study: these extracts would have a toxicity index equivalent to 5, according to the toxicity scale of a chemical substance according to the LD50 and the route of administration. [10]; they are not toxic substances. In addition, the evaluation of the biochemical parameters does not show any significant difference between the different groups of rats; these results allow to say that these extracts would not present toxicity at the dose of 2000 mg/kg of body weight on the hepatic and renal functions of the animals because according to [11] the serum transaminase level increases during hepatic impairment, which is the same for urea and creatinine levels in impaired renal function [12] Which is not the case in this study.

The results reveal a progressive decrease in food intake in the Sm, To, and Ref test rats compared to the TN and TP groups. On the other hand, the TP group presents a progressive increase in food intake compared to the TN group in which the food intake is almost constant. This high value of food intake would be due to the diet rich in

fats and sugars which would induce a leptin deficiency in these animals and consequently a decrease in satiety. It is well established that a diet with a high energy density, rich in lipids decreases satiety, increases the feeling of hunger and body weight [13]. However, the administration of the extracts in the test groups results in a decrease in food intake compared to PT. This suggests that the extracts would promote a sufficient synthesis of leptin which would participate in the establishment of the satiety signal in these groups of rats, thus leading to a decrease in food intake. The same is true for the reference drug used in this study. This is in agreement with the studies carried out by [14] which affirms that in the event of leptin deficiency, the administration of this cytokine is remarkably effective.

The results obtained after the evaluation of the effect of the different extracts on the evolution of the body weight and the leptin concentration of the rats revealed a weight gain in all groups of rats during the first two weeks of the studies. It should also be noted that, unlike the TN group, whose weight change was almost constant throughout the study, the Sm, To, and Ref groups showed a decrease in body weight between the second and the third week of the compared study. To the TP group whose body weight increases during the study. This weight loss in the Sm, To, and Ref groups could be due to the fact that the extracts used and our reference medicine increase satiety. In addition, these would have favored the sufficient synthesis of leptin, which is the benchmark satiety hormone, the action of which reduces food intake and increases energy expenditure. This increase in energy expenditure thus leads to a loss of fat mass in animals, hence the decrease in body weight, which is in agreement with the study carried out by [15] where taking the Recombinant leptin by patients improved metabolic parameters and allowed weight loss. On the other hand, the weight gain in the TP group would be due to the lipid content of the diet. This is justified by the work of [16] which indicated that a high-fat diet in Wistar rats would induce an increase in food intake and body weight with an accumulation of lipids in the adipose tissue. This would also be due to the variety of foods chosen, foods that are highly tasty and with high proportions of lipids, making it possible to increase appetite and cause overeating in animals, inducing an increase in the energy absorbed, thus leading to a rapid weight gain [17].

The leptin assay reveals a significantly lower concentration in the PTs compared to the TN group and the other test groups. The significantly low leptin concentration observed in the TP group could be attributed to adipose tissue atrophy. The latter could be caused by major dyslipidaemia, hyperglycaemia as well as hepatic and muscle lipid deposits leading to a major leptin deficiency in this group of rats [18] This could also be justified by the proposals of Arner, 2003 which said that dietary fats have a higher energy value than other macronutrients, a low satietogenic power and a high energy density which leads to an increase in energy intake, resulting in the long term an increase in body fat. The leptin concentrations referenced in the To, Sc, and Sm groups would be due to the administration of the extracts. Indeed, contrary to the TP group which only consumes a diet enriched in fats and sugars, the leptin concentration is significantly higher. The extracts are said to have improved the condition of the animals by improving the synthesis of leptin. This is in agreement with the work of (Foster et al., 2006) who affirm that in the event of leptin deficiency, the administration of this cytokine would be remarkably effective. From the foregoing, it appears that our extracts possess secondary metabolites playing the role of exogenous leptin which, brought to the body, would regulate the level of leptin in the serum of rats thus their use in cases of insufficiency in the leptin.

The evaluation of the lipid profile shows us a significantly high concentration of total cholesterol, LDL cholesterol, and Triglyceride in the TP group compared to the TN group and to the Ref, To, and Sm treated groups, unlike HDL which is higher for the test groups. and TN compared to TP. The hyperlipidemia observed in TP rats could be explained by the high content of lipids in the diet. Several authors like [19] have found that an increase in the lipid content of foods causes an increase in the plasma cholesterol concentration and modifies the composition of plasma lipoproteins, in particular by increasing the portion of cholesterol esters in VLDL and LDL. In addition, fat accumulation is regulated by the lipolysis, lipogenesis cycle [20], which explains the significantly elevated level of triglycerides and cholesterols in adipose tissue in rats receiving the diet enriched in fats and sugars compared to rats given a standard diet. For the To, Ref, and Sm groups, the decrease in these parameters could be a consequence of the consumption of

the extracts, their composition in essential omega-6 fatty acids makes them excellent foods for reducing the level of bad cholesterol (LDL-C) in the blood In addition, the flavonoids and phenolic compounds contained in the various extracts allow the activation of lipoxygenase. These biomolecules have the power to change the plasma level of leptin thus achieving a decrease in the lipid profile [21]. The decrease in triglyceride levels could be associated with weight loss because triglycerides are the fatty tissues that constitute the most important energy reserve of the body. Fiber in the diet can reduce LDL-C levels, which dilutes gastrointestinal contents leading to digestion and absorption of dietary fat [22], for example therefore, the release of cholesterol in the liver from chylomicron remnants will decrease, with decreased secretion of lipoproteins to maintain cholesterol homeostasis in the liver [23].

The serum glucose concentration for each group of rats was assessed. In view of the results obtained for TP, this very high blood sugar value could be due to the sugar content of the diet consumed by this group of rats. This diet enriched in fat and sugar would induce an increase in serum glucose levels in rats, [24] which showed that rats subjected to a diet rich in fat develop hyperglycemia. On the other hand, the decrease in blood sugar levels by the effect of aqueous extracts of *Solanum melongena* and *Telfairia occidentalis* may be due to several mechanisms that involve multiple factors. This could be the result of the influence of bioactive molecules as well. Numerous studies have reported that certain flavonoids have an effect on glucose metabolism enzymes and the presence of aromatic hydroxyl groups in several types of flavonoids is associated with antioxidant properties, that also protect pancreatic islet cells from oxidative stress [25]. According to Coskun O et al., 2005 [26], Flavonoids can also help regenerate β cells. It should be noted that the extracts by improving the synthesis of leptin would have allowed to regulate the glycemia, because according to the studies carried out by Perry et al., 2014[28], the treatment with leptin would correct the hyperglycemia.

Transaminases are enzymes found in the liver, but also in muscle, kidneys, pancreas, and other tissues. They are synthesized in the cytoplasm of the cells of these organs and released into circulation when these cells are damaged [29]. ALT is more specific for liver damage, and ASAT is slightly more sensitive. Their activity has been studied. The results from our study reveal a difference between the concentrations of the different groups compared to significantly higher TP. This variation in concentration between TN and TP on the one hand could be due to the difference between the diets of the two groups of rats. Indeed, the fatty and sweet diet induces an increase in the activity of transaminases. This increase could result in cell damage like hepatic [30], the increase in ALT in animals would indicate a sign of cytolysis mainly of hepatic origin. The lower transaminase activity in animals given the extracts could be explained by the effect of the different active ingredients contained in the extracts. These extracts improved cell functions in rats by regulating the synthesis of transaminases. This reveals to us the hepato-protective function of the different extracts. [31], which showed that the decrease in the levels of transaminases would indicate the stabilization of the plasma membrane and the protection of the hepatocytes against the damage caused by glucotoxicity and lipotoxicity. This protective action could be due to the improvement in the accumulation of fat in the liver [32].

Urea and serum creatinine are considered to be the main markers of nephrotoxicity, although serum urea is often considered a more reliable predictor of renal function than serum creatinine [33]. Evaluation of urea and creatinine levels revealed that rats on a diet high in fat and sugar showed a significant increase compared to other groups of rats. These results could be due to the lipid content of the diet consumed, which agrees with the work of Hejazi (2016), who highlighted a relationship between kidney disease and an increase in cholesterol in the diet. The increase in serum creatinine could be a sign of kidney toxicity which is a very specific marker of kidney damage and a significant increase in urea levels [34], as glomerular filtration (renal function) decreases, urinary excretion of urea and creatinine is also reduced, which is reflected in the blood concentration of these two parameters which are increased. In addition, the decrease in creatinemia in To, Sm, and Ref could be the consequence of the administration of the vegetable extracts, and the taking of the drug. However, the extracts would therefore have secondary metabolites with beneficial effects on health, which would allow the improvement of kidney functions. These results are consistent with Ramachandran and

Baojun (2015) who found that the hypoglycemic effects of plants may be associated with their nephroprotective effect. Additionally, it was observed that flavonoids would have a protective effect on renal dysfunction in rats fed a diet rich in sugars, by modulating the pathological pathways induced.

Limites of your study?

Conclusion

The aqueous extraction from the powders of *Solanum macrocarpon* and *Telfairia occH%identalis* allowed us to obtain two extracts with very different yields which are respectively 31.6% and 28.53%. Moreover, the phytochemical analysis of the plants shows that the aqueous extracts of *Solanum macrocarpon* and *Telfairia occidentalis* are poor in anthocyanins and very rich in phenols, flavonoids, coumarins, tannins and saponins.

The toxicity study revealed that the different extracts used were not toxic at the dose of 2000 mg/kg / bw.

It was also noted that the consumption of the extracts for 21 days induces a decrease in food intake and prevents the gain in body weight. In addition, we have found that the extracts have a preventive effect against hyperglycemia and hyperlipidemia, liver and kidney damage. They would also increase the synthesis of leptin by adipose tissue.

In general, the results obtained show that the use of *Solanum macrocarpon* and *Telfairia occidentalis* could be a better way to overcome the problem of overweight and hypoleptinemia, assets that can be exploited in the management of obesity.

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