Potential effect antidiabetic of a medicamentous receipt made up of *Parquetina nigrescens* (Periplocaceae) and *Erythrina senegalensis* (Fabaceae) and effects on the lipidic profile and the glycation of hemoglobin in rats diabetics

EKISSI Yapi Hugues Romaric, EHOUE Adjoumani Placide, KAHOU Bi Gohi Parfait and ABO Kouakou Jean-Claude

**DOI:** [https://doi.org/10.22271/phyto.2021.v10.i5a.14242](https://doi.org/10.22271/phyto.2021.v10.i5a.14242)

**Abstract**

The medicinal recipe composed of *Parquetina nigrescens* (Periplocaceae) and *Erythrina senegalensis* (Fabaceae) is a remedy used in traditional medicine in Côte d'Ivoire to treat diabetes. This study aims to assess the potential anti-diabetic effect of the drug recipe (RPNES) and its effect on the lipidic profile and hemoglobin glycation in diabetic rats. Diabetes mellitus is induced by an intraperitoneal injection of streptozotocin, dissolved in a citrate buffer solution, at a dose of 65 mg/kg BW and a nicotinamide solution at a dose of 230 mg/kg BW to Wistar rats. Healthy rats and diabetic rats are treated orally with RPNES daily for 28 days and blood samples from control and treated rats are taken for assay of biochemical parameters. This study shows that RPNES, administered at doses greater than or equal to 600 mg/kg BW, causes a significant decrease in blood sugar in diabetic rats. In addition, a significant decrease in serum total cholesterol and triglyceride levels, associated with an increase in serum HDL cholesterol level, was observed in diabetic rats which received RPNES at 800 mg/kg BW, after 28 days treatment. In addition, after 90 days of treatment, RPNES (800 mg/kg BW) induces a significant decrease in the percentage of glycated hemoglobin in diabetic rats. This study also revealed that, in diabetic rats, RPNES had antihyperglycemic and antidiabetic effects similar to those of glibenclamide. RPNES is also a hypolipemic substance which corrects lipid disorders associated with diabetes, normalizes HDL cholesterol and lowers HbA1c levels in diabetic rats. These results justify the use in traditional medicine of this medicinal recipe composed of *Parquetina nigrescens* and *Erythrina senegalensis* to treat diabetes.

**Keywords:** Diabetes, antidiabetic, glycated hemoglobin, hypolipemic, *Parquetina nigrescens*, *Erythrina senegalensis*, drug recipe

1. **Introduction**

Consistently elevated glucose levels lead to irreversible hemoglobin glycation and the formation of advanced glycation end products (AGEs) [1]. In fact, glycated hemoglobin (HbA1C) increases in response to chronic or prolonged exposure to glucose [2]. Thus, HbA1C is used both as an index of mean blood sugar and as a measure of risk for the development of complications of diabetes. Diabetes is also associated with dyslipidemia characterized by both hypercholesterolemia and hypertriglyceridemia, two risk factors for cardiovascular disease [3]. Currently, there are over 366 million people with diabetes worldwide, with 3.2 million deaths per year [4]. Given the high incidence of vascular complications associated with diabetes mellitus, various studies are underway to find cures against it. Thus, an ethnomedical survey carried out in Ivory Coast, identified *Parquetina nigrescens* (Periplocaceae) and *Erythrina senegalensis* (Fabaceae), two plants associated to obtain a medicinal recipe used by traditional healers for treat diabetes. The aim of this study is to evaluate the potential anti-diabetic effect of the aqueous extract of this drug recipe (RPNES) and its effects on the lipid profile and on the glycation of hemoglobin in diabetic rats.

2. **Materials and methods**

2.1 **Plant material**

The plant material consists of dry leaves of *Parquetina nigrescens* (Periplocaceae) and *Erythrina senegalensis* (Fabaceae). The leaves of these plants were collected in Dimbokro (Côte d'Ivoire), in October 2018. They were identified and authenticated at the National Floristic Center (CNF) of the Félix Houphouët-Boigny University (Abidjan, Côte d'Ivoire) by
ASSI Jean, Technician in this research center, in comparison respectively with the herbaria CNF, numbers 15031 and 14625, of these plants discovered on 12/28/1979 and 01/17/1979 in the Bamoro forest (Bouaké, Ivory Coast) by the late Ake-Assi Laurent, Emeritus Professor of Botany at the UFHB.

2.2 Animal material
White rats, Rattus norvegicus (Muridae), are used for blood sugar studies. Their mass varies between 150 g and 200 g. They are reared in the animal house of the Biosciences Training and Research Unit (UFR), at the UFHB, at 25 ± 2 °C, and under light during the day and dark at night. They are fed with food supplied by the IVOGRAIN® company in Abidjan, and have free access to water. All experimental protocols on these animals are conducted in accordance with directive 2010/63/EU of the European parliament and of the council of 22 September 2010 on the protection of animals used for scientific purposes and under the Commission recommendation 2007/526/EC concerning guidelines for the housing and care of animals used for experimental and other scientific purposes.

2.3 Methods

2.3.1 Preparation of the drug recipe extract
The preparation is made according to the method described by seventy gram (70 g) of powder of dry leaves of Parqueta nigrescens and 30 g of powder of dry leaves of Erythrina senegalensis are put together in 1 L of distilled water. The mixture is brought to the boil at 100 °C for 20 min. The decoct obtained is allowed to cool to room temperature (25-30 °C) and filtered 3 times through cotton wool before being filtered with Whatman n°2 filter paper, then dried in an oven (Memmert, Germany) at 50 °C. The powder obtained constitutes the medicinal recipe (RPNES).

2.3.2 Study of the effects of the drug recipe (RPNES) on the glycemia of diabetic rats
2.3.2.1 Induction of experimental diabetes in rats
Diabetes is induced in rats by subcutaneous injection of streptozotocin (Sigma Aldrich, Germany) dissolved in citrate buffer solution (pH = 4.5) at a dose of 65 mg/kg BW. fifteen minutes (15 min) later, they receive a nicotinamide solution at a dose of 230 mg/kg BW subcutaneously. Two weeks after the injection of streptozotocin, the rats with a fasting blood sugar level greater than or equal to 2 g/L are considered to be diabetic and selected for the study.

2.3.2.2 Methods for Measuring Blood Glucose in Rats
The method used is that described by[7, 1, 8] Blood glucose is measured using an Accu-Chek Active® blood glucose meter, complete with test strips. This strip has an absorbent layer on complete with test strips. This strip has an absorbent layer on which is deposited a drop of blood from an incision in the caudal end of the rat. The blood glucose value is given in g/L.

2.3.2.3 Studies of the effects of the drug recipe (RPNES) and glibenclamide on the glycemia of healthy rats and diabetic rats
In this study, 60 Wistar rats are fasted for 12 hours before the experiments and are divided into six (6) groups of 10 rats.
- Batch 1: Rats normoglycemic receiving only distilled water.
- Batch 2: Rats diabetics receiving only distilled water.
- Batch 3: Rats diabetics treated daily with the glibenclamide (antidiabetic substance of reference) with the amount of 10 mg/kg BW.
- Batches 4,5 and 6: Rats diabetics treated daily with respectively 400,600 and 800 mg/kg BW of RPNES.

These rats are given distilled water or the test substances orally. The experiment lasts 28 days and the blood sugar is measured at times D5 (before the start of force-feeding), then D7, D14, D21, and D28 corresponding to the 7th, 14th, 21th and 28th days respectively after the start of force-feeding.

2.3.3 Studies of the effects of the drug recipe (RPNES) on the lipid profile and on the total hemoglobin level of healthy rats and diabetic rats
2.3.3.1 Experimental protocol
In this study, 40 Wistar rats were divided into 4 groups of 10 rats.
- Batch 1 is composed of healthy control rats (normoglycemic) which receive distilled water.
- Batch 2 is composed of diabetic control rats receiving distilled water.
- Lots 3 and 4 are those of diabetic rats treated respectively with 800 mg/kg BW of RPNES and glibenclamide at a dose of 10 mg/kg BW.

The experiment lasts 28 days during which blood samples are taken from the retro-orbital sinus[9] at time D0 (before the start of force-feeding), then D7, D14, D21, and D28 (7th, 14th, 21th and 28th days) afterstart of gavage, in dry tubes, and centrifuged at 4500 rpm for 10 minutes; the serum is collected in Eppendorf tubes and stored at -20 °C, while awaiting the assay of the lipid parameters and of the serum hemoglobin level.

2.3.3.2 Methods of assaying lipid parameters
Serum parameters related to lipid metabolism (total cholesterol, HDL-cholesterol and triglycerides) are assayed using a spectrophotometer of the BIOLABO Diagnostics type (France). This spectrophotometer used is equipped with a 9 positions incubator and an 18 μL micro-suction chamber. Serum samples are analyzed by lipid profile markers the total cholesterol is determined by the CHOD/POD method[10] HDL cholesterol is assayed according to the method described by Lopez-virella et al.[11] and triglycerides are determined using the GPO/POD method[12,13].

2.3.3.3 Method for determining the total hemoglobin
Level the serum total hemoglobin level is measured by the complete blood count carried out using the Sysmex brand electronic analysis counter (Diamond Diagnostics, USA) on the blood samples taken from the retro-orbital sinus rats in EDTA tubes at time D0 (before the start of the force-feeding) and on the 7th, 14th, 21th and 28th days after the force-feeding.

2.3.4 Study of the effects of RPNES on the glycated hemoglobin (HbA1c) level of healthy rats and diabetic rats
2.3.4.1 Experimental protocol
Forty (40) Wistar rats are divided into 4 batches identical to those used for the assay of the lipid parameters. But, for this study, the rats of each group are treated for 90 days. It is after 90 days of experimentation that the blood of the rats is taken from the retro-orbital sinus[9] in EDTA tubes for the determination of the level of HbA1c.
2.3.4.2 Method for determining the level of glycated hemoglobin (HbA1c)
The percentage of glycohemoglobin is assayed by the immuno-turbidimetric method \[^{14, 1}\] using an automatic, electronic analysis counter of the Sysmex KX21N type (Diamond Diagnostics, USA). From the hemolyzed blood, the total hemoglobin concentration is determined by measuring by photometry at 525 nm the hemoglobin released from the erythrocytes. The concentration of glycated hemoglobin is determined by measuring the absorbance at 625 nm of the complex formed of polyhapten and anti-HbA1c antibodies. The ratio of the two absorbances gives the percentage of HbA1c.

2.3.5 Statistical analysis and plotting methods
Data analysis is done using GraphPad Instat software (San Diego CA, USA). The results are given as the mean followed by the standard error on the mean (M ± ESM). The difference between two values is determined by the Turkey-Kramer comparison test and is considered not significant for p > 0.05, very significant for p < 0.001 (**), significant for p < 0.05 (*) and very significant for p < 0.01 (***)

3. Results
3.1 Dose-response effects of drug recipe (RPNES) and glibenclamide on blood glucose levels in diabetic rats
During the 28 days of the experiment, the glycemia in the healthy control rats (normoglycemic controls) did not vary significantly (p > 0.05). It is of the order of 0,98 ± 0,25 g/L (Figure 1).

After the injection of streptozotocin (STZ) into the rats, the glycemia of these animals increases from 0,98 ± 0,25 g/L to 2,40 ± 0,17 g/L; that is to say an increase in blood sugar 1,42 ± 0,17 g/L (140 %). In the rats which are made diabetic and which are not treated (diabetic controls), this glycemia (hyperglycemia) does not vary significantly (p > 0.05) during the 28 days of experimentation.

The drug recipe extract (RPNES), administered at a dose of 400 mg/kg BW, had no significant effect (p > 0.05) on the blood glucose levels of diabetic rats. However, administered at doses of 600 and 800 mg/kg BW, RPNES causes significant (p < 0.01) and dose-dependent decreases in blood glucose from the 14th day of treatment. These reductions in blood sugar increased over time and, after 28 days of treatment with RPNES at 600 and 800 mg/kg BW, the blood sugar levels of the treated rats were no more than 1,80 ± 0,12 g/L and 1,40 ± 0,10 g/L respectively; or reductions 42,25 % and 70,42 % (p < 0.001) of streptozotocin-induced hyperglycemia, respectively, when diabetic rats are treated with RPNES.

Likewise, from the 7th day of administration of glibenclamide, the glycemia of the treated diabetic rats drops significantly (p < 0.01). Thus, the blood sugar level is no more than 1,16 ± 0,09 g/L on the 28th day; or 91,54 % reduction (p < 0.001) in hyperglycemia induced by streptozotocin in diabetic rats treated with glibenclamide.

3.2 Effects of Drug Recipe (RPNES) on Serum Lipid Profile in Diabetic Rats
3.2.1 Effects of RPNES on the Serum Total Cholesterol Level of Healthy Rats and Diabetic Rats
The total serum cholesterol level of the healthy control rats is of the order of 0,83 ± 0,15 g/L, during the 28 days of the experiment (Figure 2).

After 7 days of treatment of healthy rats, RPNES at a dose of 800 mg/kg BW had no significant effect on the serum total cholesterol level of these animals. However, from the 14th day of treatment, RPNES causes a significant (p < 0.05) and progressive drop in total cholesterol in these healthy rats, up to the 28th of treatment. Thus, this rate is 0,50 ± 0,12 g/L at the end of the treatment; that is a significant drop of 39,76 % (p < 0,01) compared to that of the healthy control rats.

On the other hand, when the rats are made diabetic, this rate increases significantly and reaches 1,45 ± 0,17 g/L; that is an increase of 74,70 % (p < 0,001) over that of the healthy control rats, then maintained (p < 0,05) throughout the duration of the experiment after 7 days of treatment of the rats rendered diabetic with RPNES at a dose of 800 mg/kg BW, the total serum cholesterol level of these animals does not vary significantly (p < 0,05) compared to that of the diabetic control rats. But, from the 14th day, RPNES causes a significant (p < 0,05) and progressive drop in the total cholesterol level in these diabetic rats. Thus, on the 28th day of treatment, this total cholesterol level is no more than 0,90 ± 0,11 g/L, therefore substantially identical (p < 0,05) to the cholesterolemia of the healthy control rats.
3.2.2 Effects of RPNES on Serum HDL Cholesterol Levels in Healthy Rats and Diabetic Rats

In healthy control rats, the serum HDL cholesterol (HDLc) level is 0.47 ± 0.04 g/L. This rate remains constant (p > 0.05) during the 28 days of experimentation (Figure 3). Similarly, the serum HDLc level of healthy rats treated with 800 mg/kg BW RPNES was not different (p > 0.05) from that of healthy control rats during this experiment.

In diabetic controls, this rate drops significantly to 0.33 ± 0.05 g/L; or 29.79 % decrease (p < 0.01) in serum HDL cholesterol level compared to that of healthy control rats, after induction of diabetes, then it isstabilizes (p < 0.05) until the end of the experiment. In diabetic rats treated with RPNES at a dose of 800 mg/kg BW, after 7 days of treatment, the HDLc level of the rats did not vary significantly (p > 0.05) compared to that of the diabetic control rats.

From the 14th day of treatment, this rate increases significantly (p < 0.05) and gradually. Thus, it goes from 0.33 ± 0.05 g/L (before treatment) to 0.42 ± 0.02 g/L on the 28th day of treatment, whereas in healthy control rats, the HDLc level is of 0.47 ± 0.04 g/L. This represents a hypocholesterolemia of 10.64 % (p < 0.05) compared to the HDLc levels of the healthy control rats and a reduction in hypocholesterolemia observed in the rats made diabetic by 64.29 %.

3.2.3 Effects of RPNES on the Serum Triglyceride Levels of Healthy Rats and Diabetic Rats

The serum triglyceride level of the healthy control rats is constant (p > 0.05) during the 28 days of experimentation. It is of the order of 0.86 ± 0.13 g/L.

From the 14th day of treatment of healthy rats, RPNES at a dose of 800 mg/kg BW causes a significant drop (p < 0.05) in the serum triglyceride level of these animals which is progressive until the end of the treatment. Thus, on the 28th day, this rate is 0.56 ± 0.10 g/L; that is a significant drop (p < 0.01) of 34.88 % compared to the triglyceride level in healthy control rats (Figure 4).

The serum triglyceride level of diabetic control rats increased after induction of diabetes and was maintained (p > 0.05) until the end of the experiment at 1.68 ± 0.15 g/L; that is an increase of 95.35 % (p < 0.001) compared to the healthy control rats. From the 7th day of treatment with RPNES at a dose of 800 mg/kg BW, the serum triglyceride level in diabetic rats decreases significantly (p < 0.05) and gradually. Thus, after 28 days of treatment, this level in diabetic rats decreases significantly (p < 0.05).
treated with RPNES is no more than 0.99 ± 0.08 g/L; or a hypertriglyceridemia of 15.12 % ($p < 0.05$) which persists on the 28th day in diabetic rats treated with RPNES. Thus RPNES at 800 mg/kg BW reduced hypertriglyceridemia observed in rats made diabetic by 84.14 %.

3.3 Effects of Drug Recipe (RPNES) on Hemoglobin Levels in Healthy Rats and Diabetic Rats

The hemoglobin level of the healthy control rats did not vary significantly during the 28 days of the experiment. This rate is of the order of 14.82 ± 0.97 g/dL (Figure 5). Similarly, the hemoglobin level of healthy rats treated with 800 mg/kg BW of RPNES remains identical ($p > 0.05$) to that of healthy control rats.

When rats are made diabetic by STZ, the hemoglobin level decreases from 14.82 ± 0.97 g/dL to 9.45 ± 0.95 g/dL; that is a significant drop of 36.23 % ($p < 0.01$) compared to that of the healthy control rats, then this rate remains constant ($p > 0.05$) until the end of the experiment in diabetic control rats.

After 7 days of treatment of the rats rendered diabetic with RPNES at a dose of 800 mg/kg BW, a non-significant increase ($p > 0.05$) in the hemoglobin level of these animals appears. This increase continues over time and, thus, compared to the hemoglobin level of the diabetic control rats, becomes significant from the 14th day of treatment with RPNES. It drops to 14.35 ± 0.88 g/dL after 28 days of treatment; that is then a normalization of the hemoglobin level which becomes statistically identical ($p > 0.05$) to that of the healthy control rats when the diabetic rats receive RPNES at 800 mg/kg BW.

3.4 Effects of Drug Recipe (RPNES) on Glycated Hemoglobin Levels in Healthy Rats and Diabetic Rats

At the end of 90 days of experimentation, the level of glycated hemoglobin (HbA1c) of the healthy control rats (normoglycaemia) is 5.30 ± 0.40 % (Figure 6). This HbA1c level is statistically identical ($p > 0.05$) to that of healthy rats treated for 90 days with RPNES at 800 mg/kg BW.

On the other hand, the glycated hemoglobin level of the
diabetic rats is 10.70 ± 0.80 %; or a significant increase (p < 0.001) in the HbA1c level of 101.89 % when the rats are made diabetic. When diabetic rats are treated for 90 days with RPNES (800 mg/kg BW), their HbA1c level drops from 10.70 ± 0.80 % to 6.80 ± 0.70 %. Thus, treatment of rats for 90 days with RPNES results in a reduction in the increase in glycated hemoglobin level in diabetic rats by 72.22 % (p < 0.001).

4. Discussion
Injection of streptozotocin (a diabetogenic compound) into rats results in an increase in blood sugar which remains high, reflecting the onset of experimental diabetes following necrosis of the β cells of the pancreas. Streptozotocin (STZ) is an antibiotic isolated from a strain of bacteria: Streptomyces achromogenes [15], which causes the massive destruction of β cells in islets of Langerhans. Streptozotocin is taken up by the pancreatic β cell via the glucose transporter GLUT2. STZ deteriorates the oxidation of glucose and causes insulinitis and decreased sensitivity of β cells to glucose [16]. Streptozotocin also induces the formation of free radicals which contribute to the destruction of pancreatic β cells. After their formation, these molecules act in synergy with STZ to generate DNA damage, thus leading to the diabetic state [17].

The hyperglycaemia which occurs following the injection of streptozotocin persisted during the 28 days of the experiment in untreated diabetic rats. On the other hand, when the rats rendered diabetic are treated with RPNES at doses greater than or equal to 600 mg/kg BW, or with glibenclamide, the hyperglycaemia significantly decreases in a dose-dependent manner and the glycemia tends to return to the normal for the RPNES dose of 800 mg/kg BW, as for glibenclamide at 10 mg/kg BW. The same effects were observed by Saba et al., [18] Kahou et al., [19] and Bilanda et al., [20]. In fact, these authors have shown that the aqueous extracts of Parquetina nigrescens (Periplocaceae), Pseudarthria hookeri (Fabaceae) and Erythrina senegalensis (Fabaceae) reduce hyperglycaemia in diabetic rats.

It thus appears that RPNES, like glibenclamide, has antidiabetic properties. In fact, glibenclamide, administered on an empty stomach, stimulates insulin secretion, decreases the secretion of glucagon, inhibits the hepatic release of glucose and potentiates the effects of insulin in the liver [21]. The similar effects of RPNES with those of glibenclamide in diabetic rats suggest that this extract may act by the same mechanism as glibenclamide. Thus, the antidiabetic effects of the drug recipe could be induced by the increased secretion of insulin by the pancreas. More over, these effects of this extract could also be explained by a decrease in intestinal glucose uptake by an extrapancreatic which includes stimulation of peripheral glucose utilization, or by processessglycolytics and glycogenics with a concomitant decrease in glycogenolysis and gluconeogenesis [22].

The study of the effects of the aqueous extract of the medicinal recipe (RPNES) on the lipid profile shows that the treatment of healthy rats for 28 days with this extract at a dose of 800 mg/kg BW leads to a decrease in cholesterolemia and bloodtriglyceridermia. RPNES therefore has hypocholesterolemic and hypotriglyceridermic properties. Similar results have been reported by Kahou et al., [3] who showed that Pseudarthria hookeri (Fabaceae) decreases cholesterol and triglyceride levels. The decrease in cholesterol and triglyceride levels by RPNES also indicates that this medicinal recipe would have cardioprotective effects and could prevent and reduce the risk of cardiovascular diseases.

When the rats are made diabetic by administration of streptozotocin, their total cholesterolemia and their triglyceridermia increase significantly compared to those of healthy control rats, while that of HDLc decreases. The hyperlipidemia observed following the injection of STZ is justified by a degradation of lipid reserves under the action of lipolytic hormones on adipose tissue. Indeed, Yousfi and Zadi [23] have shown that lipoprotein lipase (LDL) activity is reduced in diabetic mice. Khanna et al., [23] indicate that the high abnormal concentration of serum lipids observed in diabetic subjects is mainly due to the increased mobilization of fatty acids from adipose tissue.

This study shows RPNES, administered at a dose of 800 mg/kg BW to diabetic rats, causes a significant increase in serum HDLc and a significant decrease in serum total cholesterol, while triglyceridermia decreases and normalizes. These results show that RPNES has antihyperlipidemic effects. RPNES, by increasing the level of HDL cholesterol or "good cholesterol", could prevent cardiovascular diseases.
Similar results have been reported by Kahou et al., who showed that the aqueous extract of *Pseudarthria hookeri* (Fabaceae) at a dose of 1200 mg/kg BW causes an increase in serum HDL cholesterol levels and a reduction in total cholesterol and triglyceride levels in diabetic rats after 28 days of treatment. The decrease in lipidemia in diabetic rats treated with RPNES could be explained by a decrease in fatty acid synthesis or by an increase in the catabolism of LDL cholesterol. In fact, lecithin cholesterol acyltransferase (LCAT) is an enzyme responsible for transferring free cholesterol into esterified cholesterol which migrates to the center of the lipoprotein (HDL), which promotes the reduction in its cholesterol which migrates to the center of the lipoprotein responsible for transferring free cholesterol into esterified lecithin cholesterol acyltransferase (LCAT) is an enzyme

The decrease in cholesterol and triglycerides results from the modification of lipoprotein metabolism, the decrease in fatty acid synthesis, the activation of lecithin cholesterol acyltransferase (LCAT) and tissue lipases and/or acetyl-CoA carboxylase inhibition. This reduction would also be due to the production of triglyceride precursors such as acetyl-CoA and glycerol phosphate.

The decrease in total hemoglobin is to the benefit of the increase in glycated hemoglobin (HbA1c). Glycated hemoglobin (HbA1c) increased in diabetic rats by more than 10 % compared to the healthy control group (5.3 %), while total hemoglobin decreased by 56.82 % compared to that in healthy control rats. this indicates poor glycemic control for total hemoglobin decreased by 56,82 % compared to that in healthy control group (5,3 %), while total hemoglobin decreased by 56.82 % compared to that in healthy control rats. this indicates poor glycemic control for hyperglycemia in diabetic rats.

The percent increase in the percentage of HbA1c in untreated diabetic rats is explained by the binding of a sugar to the N-terminal amine function of a protein (NH2) of the β chains of hemoglobin A1. The percentages of HbA1c decrease after administration of RPNES to diabetic rats. This is shown by the increased total hemoglobin level in treated diabetic rats. Similar results have been reported by Kahou et al., who also demonstrated that the aqueous extract of *Pseudarthria hookeri* (Fabaceae) has antihyperglycemic effects and reduces the level of HbA1c in diabetic rats.

5. Conclusion

This study shows that the drug recipe (RPNES), administered at doses of 600 and 800 mg/kg BW significantly reduced hyperglycemia in diabetic rats just like glibenclamide. Thus, RPNES has antihyperglycemic and antidiabetic properties. In addition, total cholesterol and triglyceride levels were significantly reduced in diabetic rats treated with RPNES at 800 mg/kg BW. RPNES is therefore a hypolipemic substance which corrects lipid abnormalities associated with diabetes. In addition, RPNES normalizes HDL cholesterol and lowers HbA1c (HbA1c < 7%) in diabetic rats and provides better blood sugar control thanks to its antihyperglycemic and hypolipemic properties. Thus, RPNES is found to be an antidiabetic substance which normalizes glycemic control and corrects lipid disorders in diabetics. This justifies the use by traditional therapists of this medicinal recipe composed of *Parquetina nigrescens* and *Erythrina senegalensis* to treat diabetes.

6. References

1. Peppa M, Uribarri J, Vlassara H. Glucose, Advanced Glycation End Products and Diabetes complications: What is New and What Works. Clinical Diabetes 2003;21(4):186-187.

2. Sen S, Kar M, Roy A, Chakraborti A. Effect of nonenzymatic glycation on functional and structural properties of hemoglobin, Biophysical Chemistry 2005;113:289-298.

3. Kahou BG, Abo KJ-C, Mea A, Irie BJS, Karou TG. Antidiabetic and Hypolipemic Effects of Total Aqueous Extract of *Pseudarthria Hookeri* Wight & Arn. (Fabaceae). on Hemoglobin Glycation in Alloxan induced Diabetic Rats, International Journal of Pharmacy & Pharmaceutical Research 2016;7(4):145-156.

4. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes Atlas Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Research and Clinical Practice 2011;94(3):311-321.

5. Anonyme. La protection des animaux utilisés à des fins scientifiques, Journal officiel de l’Union européenne 2010, pp 33-45.

6. Ekissi YHR, Kahou BGP, N’Doua ARL, Abo KJ-C. Hypoglycemic, antihyperglycemic, and inhibitory effects of intestinal glucose absorption of a medicinal recipe of *Parquetina nigrescens* (Periploceae) and *Erythrina senegalensis* (Fabaceae) in the Wistar rat, International Journal of Biosciences 2021;18(5):38-47.

7. N’Doua LAR, Abo KJC, Aoussi S, Gbogbo M, Yapo AP, Ehle EE. Effets hypoglycémique et anti-hyperglycémique de l’extrait éthanolique 70 % de racines de *Rauvolfia vomitoria* Aizel (Apocynacées). European Scientific Journal 2015;11(6):176-190.

8. Ehoue AP, Kahou BGP, N’Doua ARL, Abo KJ-C. Antioxidant Potentials of Vernonia amygdalina (Asteraceae), Antidiabetic Plant, "In Vitro" and "In Vivo" in Healthy Rats and Diabetic Rats, American Journal of Pharmacy & Health Research 2021;9(06):1-16.

9. Pakoussi T, Kodjo MK, Metowogo K, Lawson-Evi P, Mouzou AP, Aklikokou AK, et al. Évaluation des propriétés hémostatiques et hypocholestérolémiantes des feuilles de *Spondias mombin* L (Anacardiaceae). Phytothérapie 2015;14(6):349-354.

10. Allain CC, Poon LS, Chan CSG, Richmond W, Fu PC. Enzymatic determination of total serum cholesterol, Clinical Chemistry 1977;23:470-475.

11. Lopez-Virella MF, Stone S, Eils S, Colwell JA. Determination of HDL-cholesterol using enzymatic method, Clinical Chemistry 1977;23:882-884.

12. Bucolo G, David H. Quantitative determination of serum triglycerides by the use of enzymes. Clinical Chemistry 1973;19(5):476-482.

13. Fossati P, Princep L. Méthode colorimétrique enzymatique pour la détermination des triglycéridés, Clinical Chemistry 1982;28(1):2077-2080.

14. Trivelli LA, Ranney HM, Lai HT. Composants de l'hémoglobine chez les patients atteints de diabète sucré. Journal de médecine de la Nouvelle-Angleterre 1971;284(7):353-357.

15. Vavra JJ, Deboer C, Dietz A, Hanka L, Sokolski WT. Streptozotocin, a new antibacterial antibiotic. Antibiotics Annual 1959;7:230-235.

16. Szkudelski T. Le mécanisme d'action de l'aloxane et streptozotocine dans les cellules β du rat pancreas. Physiological Research 2001;50:537-546.

17. Pavan P, Sethupathy S, Manoharan S. Antihyperglycemic and antilipidperoxidative effects of *tephrosia purpurea* seed extract in streptozotocin induced diabetic rats. Indian Journal of Clinical Biochemistry 2007;22(1):77-83.

18. Saba AB, Oyagbemi AA, Azeez OI. Effets antidiabétiques et hématiniques de *Parquetina nigrescens*
19. Kahou BGP, Abo K J-C, Irie BJS. Effet D’un Extrait Aqueux De *Pseudarthria Hookeri* Wight & Arn. (Fabaceae) Sur La Glycémie Et Sur La Libération et le Stockage Du Glucose Hepatique De Rats Diabétiques, European Scientific Journal 2017;12(6):37-47.

20. Bilanda DC, Dzeufiet PDD, Fouda YB, Ngapout RF, Tcheutchoua Y, Owona PE, *et al.* Activités antihypertensives et antidiabétiques *d’Erythrina senegalensis* DC (Fabaceae) extrait aqueux d’écorce de tige sur des rats diabétiques hypertendus, Journal d’Ethnopharmacologie 2020;246:112200.

21. Jackson JE, Bressler R. Clinical pharmacology of sulphonylurea hypoglycémie agents. Part I. DRUG 1981;212:211-245.

22. Yousif F, Zadi Y. Evaluation de l’effet antidiabétique de l’extrait méthanolique des feuilles de *Rhamnus alaternus* L. sur des souris *Swiss* albinos rendues diabétiques par la streptozotocine. Université Abderrahmane Mira de Bejaia, Bejaia, Algérie, 2013, 47 p.

23. Khanna K, Rizvi F, Chander R. Lipid lowering activity of *Phyllanthus niruri* in hyperlipemic rats. Journal of Ethnopharmacology 2002;89:19-22.

24. Arii K, Suehiro T, Yamamoto M, Ito H, Hashimoto K. Suppression of plasma cholesteryl ester transfer protein activity in acute hyperinsulinemia and effect of plasma nonesterified fatty acid, Metabolism 1997;46(10):1166-1170.

25. Bopanna KN, Kannan J, Sushma G, Balaraman R, Rathod SP. Antidiabetic and antihyperlipaemic effects of neem seed kernel powder on alloxan diabetic rabbits. Indian Journal of Pharmacology 1997;29(3):162-167.

26. McCarty MF. Inhibition of acetyl-CoA carboxylase by cystamine may mediate the hypotriglyceridemic activity of pantethine, Medical Hypotheses 2001;56(3):314-317.

27. Amoah KS, Osonuga A, Djankpa TF, Osonuga AO, Addai FK, Affram OK, *et al.* Prolonged ingestion of dietary cocoa attenuates hemoglobin glycation associated with diabetes mellitus in Rats, World Journal of Medical Sciences 2012;7(3):147-150.

28. Gariani K, Tran C, Philippe J. Hémoglobine glyquée: nouvel outil de dépistage, Revue Medicale Suisse 2011;7:1238-1242.

29. Sepulchre E, Lutteri L, Cavaleri E, Guerci B, Radermecker RP. Concerns about glycated haemoglobin and the limitations of its interpretations. Revue Medicale de Liege 2014;69(9):497-503.