Journal of Diseases and Medicinal Plants
2022; 8(4): 66-73
http://www.sciencepublishinggroup.com/j/jdmp
doi: 10.11648/j.jdmp.20220804.11
ISSN: 2469-8202 (Print); ISSN: 2469-8210 (Online)

Evaluation of Biological Parameters of Diabetic Patients Treated with Medicinal Plants: Case of the City of N'Djamena

Elise Dagosse[1], Memti Mberdoum Nguinambaye[2, *], Nadjioroum Ngam Asra[3], Brahim Boy Otchom[1]

[1]Department of Biomedical, Pharmaceutical, Nursing and Nutritional Sciences, University Toumaï, N'Djamena, Chad
[2]Department of Biological Sciences, Faculty of Exact and Applied Sciences, University of N'Djamena, N'Djamena, Chad
[3]Department of Biomedical, Faculty of Human Health Sciences, University of N'Djamena, N'Djamena, Chad

Email address:

dagosseelise@gmail.com (Elise Dagosse), memti2020@gmail.com (Memti Mberdoum Nguinambaye), nngamzolata10@gmail.com (Nadjioroum Ngam Asra), bbrahim5@hotmail.com (Brahim Boy Otchom)

[*]Corresponding author

To cite this article:

Elise Dagosse, Memti Mberdoum Nguinambaye, Nadjioroum Ngam Asra, Brahim Boy Otchom. Evaluation of Biological Parameters of Diabetic Patients Treated with Medicinal Plants: Case of the City of N'djamena. *Journal of Diseases and Medicinal Plants*. Vol. 8, No. 4, 2022, pp. 66-73. doi: 10.11648/j.jdmp.20220804.11

Received: October 8, 2022; **Accepted**: October 27, 2022; **Published**: November 10, 2022

Abstract: Diabetes is a metabolic disorder related to the secretion and / or absorption of insulin by the body, it is characterized mainly by a high level of glucose in the blood beyond 1.10 g / l. The objective of this study is to contribute to the development of medicinal plants that can help in the management of diabetes mellitus. The data collected during this study were done through a direct interview on the basis of an ethnobotanical survey form. The data of the study were analyzed on Excel and then SPSS version 22.0. Blood samples of 30 diabetic patients of both sexes subjected to plant-based treatments were collected. The different assays were performed at time 0 and 8 weeks after the first sample. The average age of the patients was 44.13 years with extremes of 18 and 70 years and a male predominance at 56%. Twenty-three medicinal plants were identified, 6 of which were used in the composition of three recipes for diabetic patients. The recipe composed of Leptadenia hastata + Guiera senegalensis had a 100% favorable effect on the carbohydrate parameters. On the other hand, the recipe composed of Boscia senegalensis+Anogeissus leiocarpus+Guiera senegalensis and the one composed of Prosopis africana+ Indigofera astragalana + Guiera senegalensis had a 57.1% and 55.6% favorable effect respectively on the carbohydrate parameters by restoring the glycemic balance All these 3 recipes had no toxic effect on the liver and kidneys: transaminases and creatine remained stable. A phytochemical and pharmacological study on animals with these plants will allow the development of phytomedicines against diabetes.

Keywords: Medicinal Plants, Diabetic Patients, N'Djamena, Chad

1. Introduction

Diabetes is a metabolic disorder of carbohydrates, lipids and proteins due to a relative or absolute deficiency in the secretion or action of insulin, or both [1]. This disorder is characterized by permanent hyperglycemia.

According to the World Health Organization (WHO), a person is diabetic only when his or her fasting blood glucose level (or glycemia) is greater than 1.26 g/l or 7mmol/l and an Aglycemic Hemoglobin (HbA1c) ≤ 7% [2].

WHO estimated the diabetic population to be 463 million in 2019 and will increase to 700 million in 2045. Various factors including an aging population, diet Hypercaloric diet, sedentary lifestyle and obesity facilitate the emergence of the disease [1]. Diabetes is estimated to cause, both directly and indirectly, about 4 million deaths per year worldwide. Africa will have 15 million diabetics by 2025, and about 2% of deaths on the continent are attributed to diabetes complications [3]. In Chad the prevalence of diabetes was

estimated at 7.39% in 2002 in rural areas [4] and 12.9% in 2004 in urban areas [5].

In Africa, more than 80% of the population relies on traditional medicine and medicinal plants for primary health care. The lack of access to health infrastructure and the high cost of treatment in developing countries make diabetics more vulnerable. In view of all these difficulties and cultural habits, most African populations turn to traditional medicine [6, 7].

The failure of conventional pharmaceutical treatments, especially in the case of chronic diseases, and the high incidence of adverse effects associated with them, means that a large part of the world's population relies essentially on natural, complementary or alternative medicine for their care [8].

The valorization of natural resources is a concern that is becoming more and more important in many countries. Thus, since its General Assembly, the WHO recommends the evaluation of the safety and efficacy of herbal medicines in order to standardize their use and integrate them into conventional health care systems. [6].

Ethnobotanical information collected in several regions of the world estimates that more than 1123 plant species, more than 725 genera belonging to 183 families, are used for their hypoglycemic, anti-hyperglycemic and even hypolipidemic properties [9].

Despite their weak pharmacological and toxicological data, medicinal plants are preferred because of the different reasons mentioned [10].

In Chad, the use of traditional medicine is widespread. Several herbal remedies are used individually or in combination to treat several diseases including diabetes mellitus. In 2006, scientific studies conducted on some medicinal plants used by traditional health practitioners (THPs) in the region of Moundou (Chad) proved the hypoglycemic activities of these plants [11].

Although there is a will to promote TM which is reflected in the establishment of a traditional medicine department, Chad has little scientific data on the biological screening of medicinal plants which would highlight their efficacy as well as their toxicity [12].

This study aims to contribute to the valorization of medicinal plants used in the treatment of diabetes.

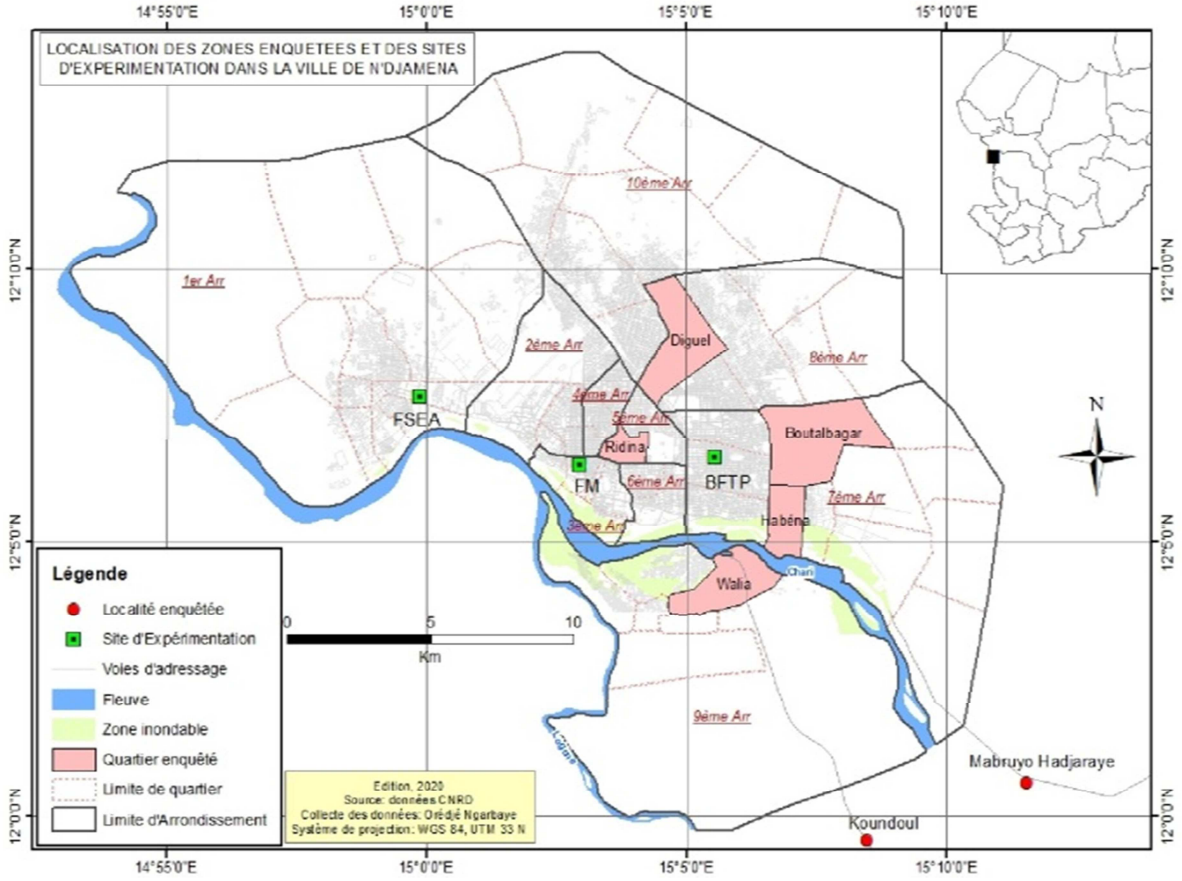


Figure 1. *Map of the city of N'djamena [13].*

2. Materials and Methods

It was an experimental, descriptive and analytical study involving thirty (30) subjects of both sexes. The recruitment of patients was done in an exhaustive and consecutive manner at the TPS practice sites over a period of four (4) months from September 2020 to December 2020 in N'Djamena. Each patient underwent biochemical examinations including blood glucose, total cholesterol, HDL, LDL, triglyceridemia, creatinine, transaminases (ALAT-ASAT) and glycated hemoglobin using the Respons 910

Diasys and semi-automated FINECARE machines. The study data were entered into Word. The study data were analyzed on SPSS version 22.0 and the separation was done according to the Student-Newman-Keuls test at the 5% threshold. The QGIS software was used to produce the map of the city of N'Djamena.

3. Results

3.1. Sociodemographic Characteristics of the Patients

3.1.1. Sex

The study population consisted of 53% men and 47% women with a sex ratio (M/F) of 1.30 (Figure 2).

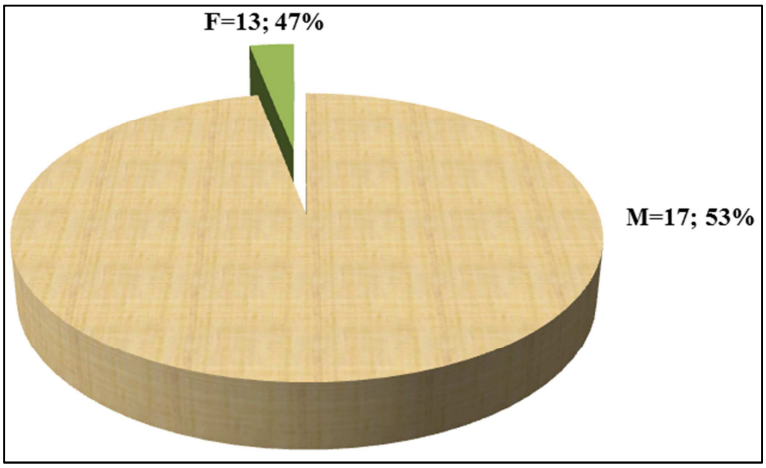


Figure 2. *Distribution of patients by gender.*

3.1.2. Age

The age of the patients ranged from 18-70 years with an average age of 44.13. The most represented age group was 36-45 years with a rate of 33% and the least represented was 66-70 years with 3% (Table 1).

Table 1. *Distribution of patients by age, body mass index and duration of disease.*

AGE	N	%	IMC	N	%	Duration of illness	N	%
18-25	2	7						
26-35	4	13	18,5- 24,9	24	80		16	53
36-45	10	33				Less than 6 months		
46-55	6	20	25 -29,9	5	17	About 1 year	10	33
56-65	7	23				More than one year		
66- 70	1	3	30-35,9	1	3		4	13
TOTAL	30	100,0		30	100,0		30	100,0

[18,5-24] = normal build. [25-29,9]= surpoids. [30-35,9]= moderate obesity

3.1.3. Marital Status

Married people represented 80% of the study population. Single people were the least represented at 3% (Figure 3).

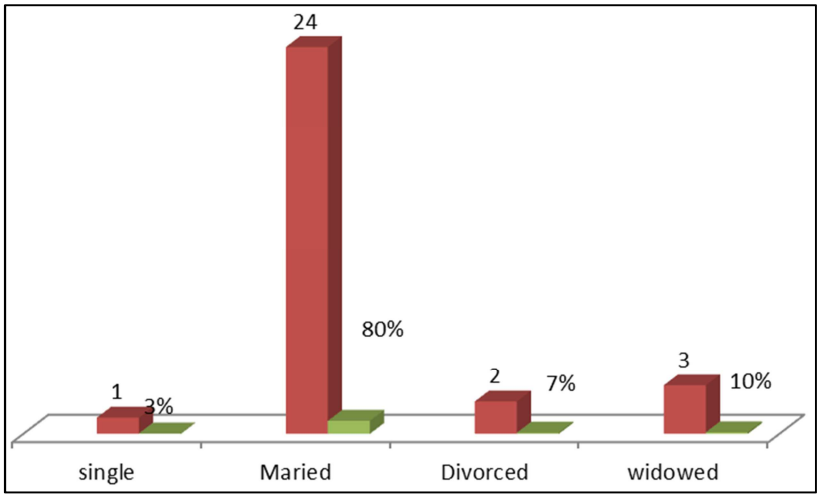
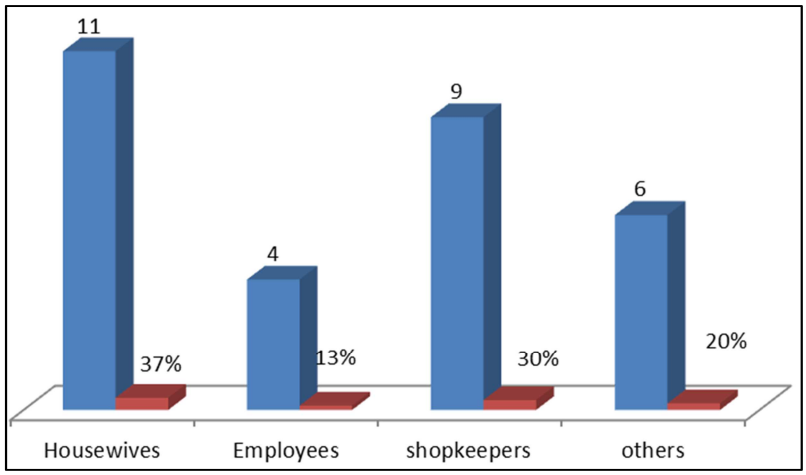


Figure 3. *Distribution of patients by marital status.*

3.1.4. Profession

The most represented profession is that of housewives with a rate of 37%, shopkeepers 30%, employees representing a rate of 13% (Figure 4).



Other: Laundry workers, carpenters, tailors

Figure 4. *Distribution of patients by profession.*

3.1.5. Study Level

Patients with no schooling represented 40% of the study population followed by secondary school with 33%, higher education and primary school with 13% (Figure 5).

Figure 5. *Distribution of patients by level of education.*

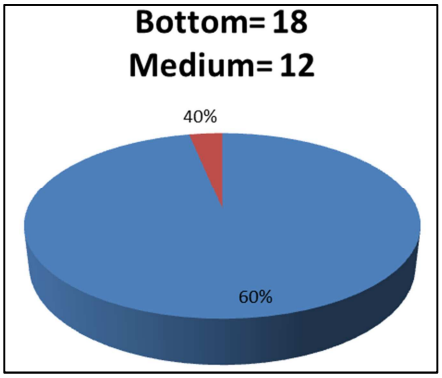


Figure 6. *Distribution of patients by income.*

3.1.6. Socioeconomic Level

Patients with a low socio-economic level represented 60% of the study population and those with an average level 40% (Figure 6).

3.1.7. Body Mass Index (BMI)

Patients with a normal BMI were more present with 80%, overweight patients (17%) and obese patients (3%) (Table 1).

3.1.8. Use of Medicinal Plants

Patients who used herbs for the first time during the study represented 50% and those who had used herbs for three (3) months or more represented 50% (Figure 7).

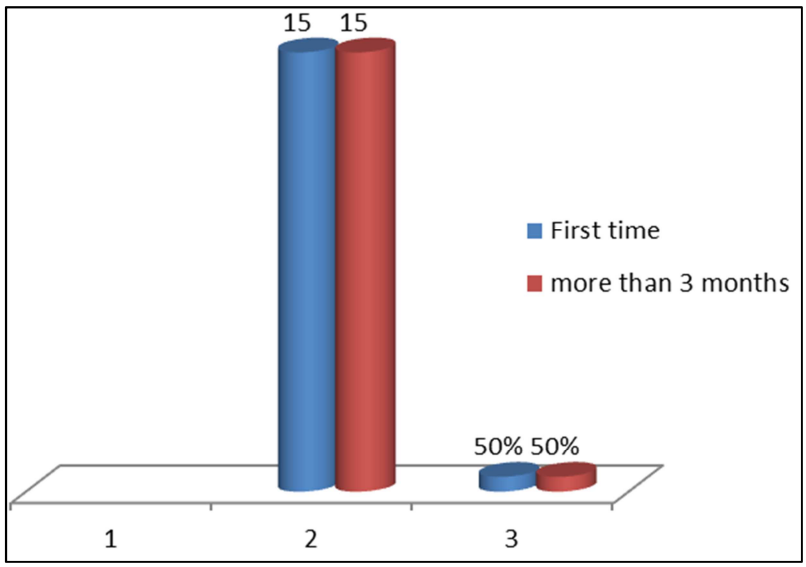


Figure 7. *Distribution of patients according to the time of intake of plants.*

3.2. Traditional Recipes and Biological Parameters

In the treatment of diabetes, TPS combined herbs in recipes. Thus, 3 recipes were divided into 3 groups.

3.2.1. Effect of Group I Recipe on Biological Parameters

It was found that the recipe of group I had favorable results on the maintenance of glycemic balance (HbA1c) of 09 patients or 55.6% (Table 2).

Table 2. *Favorable effect of Guiera senegalensis + Prosopis africana + Sclerocarya birrea on biological parameters n=5 (headcount).*

Biological parameters	T0	T8	VR
Blood glucose (g/l)	2,00±0,27	1,20±0,27	0,70-1,10
HbA1c (%)	9,36± 0,90	6,20±0,32	≤ 7
ALAT (UI/l)	7,96±7,54	12,48± 2,58	8-45
ASAT (UI/l)	18,48± 8,70	11,48±4,42	10-40
CREAT (mg/l)	8,84±0,66	7,08±1,29	7-13
TG (g/l)	1,32± 0,18	1,16± 0,07	0,45-1,75
CHt (g/l)	1,05±0,04	1,03±0,02	1,55-2,40
HDL (g/l)	0,40±0,03	0,38±0,02	0,4-0,6
LDL (g/l)	0,44±0,05	0,45± 0,05	0,9-1,6

n= number of patients; T0= time of 1st blood draw; T8= time of 2nd draw after 8 weeks; RV= reference values; HbA1C = Glycated Hemoglobin; ALAT=Alanine amino transaminase; ASAT= Aspartate amino transaminase; CREAT= Créatinine; TG= Triglycérides; CHt= Total cholesterol; HDL=High densitylipoprotein; LDL= Low density lipoprotein.

3.2.2. Effect of Group II Recipe on Biological Parameters

It was found that this recipe maintained glycemic control in all patients (100%) (Table 3).

Table 3. *Effect of Leptadenia hastata + Guiera senegalensis on biological parameters n=7.*

Biological parameters	T0	T8	VR
Blood glucose (g/l)	1,19± 0,18	1,25±0,25	0,70-1,10
HbA1c (%)	5,37±0,70	5,53±0,79	≤7
ALAT (UI/l)	12,93±1,63	12,34±0,54	8-40
ASAT (UI/l)	13,87±1,94	14,80±2,12	10-45
CREAT (mg/l)	8,39±1,26	8,89±2,45	6-12
TG (g/l)	1,01±0,05	1,01± 0,05	0,45-1,75
CHt (g/l)	1,07±0,13	1,07±0,10	1,55-2,40
HDL (g/l)	0,43±0,07	0,45±0,08	0,4-0,6
LDL (g/l)	0,44±0,11	0,43±0,08	0,9-1,6

n= number of patients; T0= time of 1st blood draw; T8= time of 2nd draw after 8 weeks; RV= reference values; HbA1C = Glycated Hemoglobin; ALAT=Alanine amino transaminase; HbA1C = Hémoglobine glyquée; ALAT=Alanine aminotransaminase; ASAT= Aspartate aminotransaminase; CREAT= Créatinine; TG= Triglycérides; CHt= Cholestérol total; HDL= High density lipoprotein; LDL= Low density lipoprotein

Table 4. *Favorable effect of Boscia senegalensis + Anogeissus leiocarpus + Guiera senegalensis on biological parameters. n=8.*

Biological parameters	T0	T8	VR
Biological parameters (g/l)	1,57± 0,56	1,40±0,31	7-1,10
HbA1c (%)	5,89±1,54	5,71±0,81	≤7
ALAT (UI/l)	10,60±2,65	12,94±4,35	8-45
ASAT (UI/l)	17,15±4,96	14,61±3,35	10-45
CREAT (mg/l)	8,81±0,75	8,95±1,14	6-12
TG (g/l)	1,36±0,64	1,31±0,34	0,45-1,75
CHt (g/l)	1,17±0,11	1,13±0,34	1,55-2,40
HDL (g/l)	0,39±0,03	0,39±0,03	0,4-0,6
LDL (g/l)	0,51±0,07	0,54±0,05	0,9-1,6

n= number of patients; T0= time of 1st blood draw; T8= time of 2nd draw after 8 weeks; RV= reference values; HbA1C = Glycated Hemoglobin; ALAT=Alanine amino transaminase; HbA1C = Hémoglobine glyquée; ALAT=Alanine aminotransaminase; ASAT= Aspartate aminotransaminase; CREAT= Créatinine; TG= Triglycérides; CHt= Cholestérol total; HDL= High density lipoprotein; LDL= Low density lipoprotein

3.2.3. Effect of Group III Recipe on Biological Parameters

It was found that this recipe maintained glycemic control in 8 out of 14 patients (57.1%) (4).

4. Discussion

4.1. Sociodemographic Characteristics of the Patients

The average age of the patients was 44.13 years with extremes of 18 years and 70 years with a male predominance of 53%. The age group 36-45 years was the most represented with 33%. The results of Motobessingar in 2020 [14] are similar to ours with a mean age of 42.62 years. On the other hand, Bochra et al, in Algeria in 2016 [15] had found that the age range of 50-59 years was the most representative with a female predominance. This could be explained by the fact that this age group is aware of the risks that could be related to taking drugs over a long period of time and thus chose the treatment by plants.

Married patients were more representative (80%), the remaining 20% were divided between divorced, widowed and single patients. These results are consistent with those of Meriem in N'Djamena in 2020 who found 92% of the patients to be married [16].

The vast majority of participants in the study using medicinal plants were uneducated (40%), This percentage is in line with that found in a 2013 study by Mohamed et al. in Morocco [17]. The remaining patients were divided between primary schooling (13%), secondary schooling (33%), and higher education (13%). These results could be explained by the high frequency of non-education in Chadian society.

Patients from urban areas represented 93% against 3% from rural areas and housewives represented 37%, shopkeepers 30%, and employees 13%. Sixty (60%) of the patients had a low socio-economic level and 40% of the patients had an average level. Studies by Mohamed et al. in 2013 [17] and Motobessengar in 2020 [14] corroborate our results. This result could be justified by the fact that the study was conducted in the city and the dominant professions were housewives and shopkeepers. Economic income and cost of treatment are among the reasons for using traditional medicine.

The most commonly used plant parts were leaves (52%) and bark, seeds (22%), roots (17%). The most common form for the preparation of plants was decoction, to which infusion and maceration were added. This result is consistent with work done in Algeria by Ouafae in 2014 [18]. This could be explained by the fact that the leaves are at the same time the seat of photochemical reactions and the reservoir of organic matter derived from them and decoction is the beneficial mode of preparation in order to extract a maximum amount of the active principles as highlighted by Telli in Algeria (2016) [19].

The medicinal plants used by diabetic subjects were administered mainly orally (ingestion) because it is the simplest route to use and it can allow a better absorption of the active principle found in the medicinal plant.

4.2. Variations in Biological Parameters According to the Different Recipes

Effect of Guiera senegalensis +Prosopis africana + Sclerocarya birrea:

The results showed that with the group I recipe (Table 2), more than 55.6% of the patients had a regulated glycemic index. The mean blood glucose level of 2.00 ± 0.27 g/l at T0 with an HbA1c of 9.36 ± 0.90 was stabilized with a mean of 1.20 ± 0.27 g/l and a mean HbA1c of 6.20 ± 0.30. The lipid level was not very variable and was always within the normal range.

The same treatment was unfavorable in 44.4% of the patients who had a baseline mean blood glucose of 1.08±0.16 g/l and HbA1c from 6.08±0.42 to 1.56±0.12 and HbA1c 8.33±0.73. This could be explained by the fact that there may have been carelessness in taking the treatment. It was found that this recipe in non-diabetic individuals could possibly destabilize glycemic control but it is not toxic. Furthermore, a study conducted in Senegal in 2002 by Gbodossou et al [20], highlighted the hypoglycemic effects of anti-diabetic plants, including Prosopis africana. Another study conducted in Cameroon by David in 2020 [21] proved the potential of treating diabetes and its complications with Guiera senegalensis. In 1998 in Bamako, Mali, a study conducted on rabbits by Keita and his collaborators [22], proved the hypoglycemic effects of Sclerocarya birrea. The study showed that 2 hours after the administration of the plant, the blood sugar level decreased by 38%. This plant is found in

the repertoire of plants provided by the surveyed TPS.

Leptadenia hastata+Guiera senegalensis:

The group II recipe composed of Leptadenia hastata and Guiera senegalensis maintained the patients' blood glucose balance at 100%, the baseline mean blood glucose was 1.19± 0.18 g/l and after 8 weeks, this mean was 1.25± 0.25 g/l. HbA1c ranged from 5.37± 0.70% to 5.53±0.79%, transaminases, creatinine, as well as lipid levels were within normal values and varied little. A study conducted in Nigeria in 2011 by Bello et al [23], on diabetic mice with the extract of Leptadenia hastata proved that the plant has indeed hypoglycemic and lipid-lowering effects.

Boscia senegalensis + Anogeissus leiocarpus + Guiera senegalensis:

The recipe of group III composed of the association of 3 plants (Boscia senegalensis, Anogeissus leiocarpus and Guiera senegalensis) had a favorable effect in 8 patients out of 14 (57.1%). The mean blood glucose level at T0 was 1.57± 0.56 g/l with HbA1c 5.89±1.54 and was slightly reduced to 1.40± 0.31 g/l with HbA1c 5.71± 0.81 at T8. Glycemic control was maintained in the study throughout the 8 weeks. In 42.9% of patients, this recipe did not improve the situation. There was a slight increase in blood glucose and HbA1c. This could be due to compliance with the diet of these patients. Transaminases, creatinemia as well as lipids of all patients remained in the norms, the recipe has no toxicity and side effects.

A study conducted in Chad in 2011 by Adam et al [24], showed the antihyperglycemic effect of Boscia senegalensis extracts and another in 2018 in Nigeria by Uwakwe et al [25], provided evidence with Anogeissus leiocarpus of its hypoglycemic and anti hyperlipidemic effect on diabetic rats.

5. Conclusion

Plants are potential natural remedies that can be used in curative and/or preventive treatment. According to numerous surveys, populations do not stop using traditional medicine, which has led to maintain a living therapeutic tradition despite the spectacular development of modern medicine.

It is important to know that medicinal plants represent a potential source of hypoglycemic and hypolipidemic substances, but also of side effects and toxicity, sometimes even lethal, hence the need to develop a phytovigilance system. Enormous efforts must be made to unlock the secrets of the panoply of bioactive molecules naturally present in the plant kingdom in the hope of developing potentially effective substances in the treatment of diabetes and to make a successful plan in the management of diabetics at the lowest cost.

The difficulties encountered during this study were mainly the refusal of collaboration of some TPS, the refusal of collaboration of some patients and the lack of information of the biological screening of some plants.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgements

The authors of this article would like to thank the TPSs and patients who agreed to collaborate.

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