Journal of Experimental Biology and Agricultural Sciences

<http://www.jebas.org>

ISSN No. 2320 – 8694

EVALUATION OF THE ANTIOXIDANT AND α -AMYLASE INHIBITORY ACTIVITIES OF *Mitragyna inermis* (WILLD) O. KUNTZE AND *Tamarindus indica* LINN.

Relwendé Justin Ouédraogo^{1*}, Martin Bienvenu Somda², Lassina Ouattara¹, Windmi Kagambega³, Paulin Ouoba¹, Georges Anicet Ouédraogo³

¹Département de Sciences Biologiques, Unité de Formation et de Recherche en Sciences et Techniques, Université Nazi BONI, 01 BP 1091 Bobo-Dioulasso 01, Burkina Faso

²Centre International de Recherche-Développement sur l'Elevage en zone Subhumide, Institut du Développement Rural, Université Nazi BONI, 01 BP 1091 Bobo-Dioulasso 01, Burkina Faso

³Laboratoire de Recherche et d'Enseignement en Santé et Biotechnologies Animales, Université Nazi BONI, 01 BP 1091 Bobo-Dioulasso 01, Burkina Faso

Received – June 11, 2020; Revision – 04-079-2020; Accepted – October 17, 2020

Available Online – October 25, 2020

DOI: [http://dx.doi.org/10.18006/2020.8\(5\).676.682](http://dx.doi.org/10.18006/2020.8(5).676.682)

KEYWORDS

Tamarindus indica

Mitragyna inermis

Diabetes

Antioxidant

Anti- α -amylase

ABSTRACT

The current study was conducted to explore the antioxidant and anti-diabetic potential of *Tamarindus (T.) indica* and *Mitragyna (M.) inermis* aqueous leaves extracts. Along with this, the estimation of available total phenolics and total flavonoids contents was also carried out to establish the scientific background of the antioxidant and anti-diabetic potential of used plants. For estimation of total phenolics and total flavonoids contents, Folin-ciocalteu and Aluminium chloride ($AlCl_3$) colorimetric method was used respectively. Antioxidant activity of prepared aqueous extracts was determined by various *in vitro* assays such as DPPH•, ABTS•+, FRAP assay while for the determining anti-diabetic potential of two used aqueous extracts plants, α -amylase inhibition assay was performed using the 3,5-dinitrosalicylic acid method. The results of the current study suggested that the aqueous extracts of both species have similar polyphenol content while in the case of flavonoid content, it was reported higher in *T. indica* leaves (9.90 mg QE/100 mg extract) and this is significantly different ($p < 0.001$) from the aqueous leaves extract of *M. inermis*. The results revealed that both plant extracts effectively scavenged DPPH and ABTS radical which suggested the strong antioxidant potential of used extracts. Besides, plant extracts also exhibited higher Fe (III) reducing activities. When these results were compared with standard treatment, highly significant difference was reported at 10 mg/ml extract doses ($p < 0.001$). Both leaf extracts exhibit remarkable α -amylases inhibitory activity, this was reported 89.55% with *T. indica* while 75.65% with

* Corresponding author

E-mail: rjustino14@yahoo.com (Relwendé Justin Ouédraogo)

Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.

Production and Hosting by Horizon Publisher India [HPI]
(<http://www.horizonpublisherindia.in/>).
All rights reserved.

All the articles published by [Journal of Experimental Biology and Agricultural Sciences](#) are licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](#) Based on a work at www.jebas.org.

M. inermis at 10 mg/mL extract. Hence leaves extracts of selected plants have significant antioxidant and anti-diabetic potential which justify the use of these two plants in traditional remedies. Further works are necessary for the isolation, characterization, and identification of active antioxidant and anti-diabetic molecules from the aqueous extracts of *T. indica* and *M. inermis*, which may serve as a potential natural source of antioxidant and anti-diabetes.

1 Introduction

Diabetes is a metabolic disorder that is arising due to abnormal carbohydrate metabolism, insulin deficiency, and/or insulin resistance. The global prevalence of diabetes increases day by day and now it is an alarming situation for developing countries (ADA, 2007; IDF, 2017). As per the forecast of IDF (2017), worldwide the number of diabetic persons will reach 629 million by 2045 is noticed. A report of WHO (2016) revealed that the prevalence of diabetes in Burkina Faso was 4.2% in 2014. Among reported diabetes, 90% are suffering from type II diabetes.

The treatment of diabetes is based on parenteral insulin and oral antidiabetic drugs. The most common conventional oral antidiabetic agents such as glibenclamide, chlorpropamide, tolbutamide, acarbose, rosiglitazone, sitagliptin, vildagliptin, saxagliptin, etc., are widely used for the management of diabetes (Surya et al., 2014). Although these hypoglycemic drugs are effective in managing blood sugar level, these are quite expensive and have serious side effects and deleterious contraindications, such as hypoglycemia, weight gain, diarrhea, abdominal cramping, flatulence, hepatotoxicity, hypersensitivity, and skin ulceration (Nasri et al., 2015; IDF, 2017).

Some most common alternative diabetes management strategies are stimulation of insulin production and release, inhibition of dipeptidyl peptidase-4, lens aldose reductase, oxidative stress protection and inhibition of advanced glycation (Alam et al., 2018).

Among the available alternate diabetes management strategies, the management of α -amylase and α -glucosidase end products formation, inhibition of aldose reductase, lowering plasma glucose levels, altering enzyme activity of hexokinases and glucose-6-phosphate, stimulation of GLUT-4 (Glucose Transporters), lowering the level of skeletal hexokinases, Glucagon-like Peptide-1 (GLP-1) analogs and inhibition of Sodium-Glucose co-Transporters 2 (SGLT2) (Kim et al., 2000; Tadera et al., 2006; Alam et al., 2018).

Enzymes is also the most common and effective one. Reduced the risk of postprandial glycemia by retarding glucose uptake through the inhibition of carbohydrate hydrolyzing enzymes, such as α -Glucosidase and β -Galactosidase, is the most recent and interesting approach (Read et al., 1986; Tadera et al., 2006; Alam et al., 2018).

Further, complications arising with diabetes are closely related to the free radical associated oxidative stress. Hence the use of antioxidants

and effective management of α -amylase are two effective measures for managing diabetes-related complications (Tiwari, 2001). Traditional medicine plants could serve as an alternative source of antidiabetic agents because these owe a wide variety of secondary metabolites. Previous literature revealed that plant secondary metabolites such as alkaloids, tannins, polyphenols, etc., could act as potentials sources of antidiabetic, antihyperglycemic, and hypoglycemic activities as well as an α -amylase inhibitor and antioxidant (Tiwari, 2001; Dal & Sigrist, 2016).

Tamarindus (T.) indica is widely distributed throughout the tropical belt, from Africa to South Asia, Northern Australia, Southeast Asia, Taiwan, and China (Arbonnier, 2002). In Burkina Faso, this is commonly distributed in Northern Sudan, the sub-Sahel and Southern Sudan phytogeographical areas (Bonde, 2019). *Mitragyna (M.) inermis* is a small bushy tree or shrub which spread from the Sahel to the humid forest of the tropics. In African continents, it is widely distributed in the Côte d'Ivoire, Togo, Senegal, Sudan, and seashore of Benin. While in Burkina Faso, it is frequently reported in all regions (Arbonnier, 2002).

Ethnobotanical studies have revealed the uses of *M. inermis* in traditional medicine, all plant parts such as bark, leaves, and root are used to cure various human diseases. Further bark is used in the treatment of fever, diabetes, hypertension, epilepsy, and infertility. Similarly, leaves are used in the treatment of diabetes, debility, asthenia, malaria while roots are used in the treatment of edema, leprosy, anorexia, constipation and mental illness (Nacoulma, 1996; Arbonnier, 2002; Zerbo et al., 2011; Zizka et al., 2015; Kinda et al., 2017).

Like *M. inermis*, *T. indica* also has an important place in African traditional medicines, the leaves of the tree are used in the treatment of biliary affections, liver abscess, sudden malaise, diabetes, biliary fevers, etc. Also, the barks are used in the treatment of urinary inflammations, diabetes, and digestive disorders. Similarly, roots and fruit pulp are commonly used for curing diabetes, hypoglycemic, hypertension and vasodilator (Nacoulma, 1996; Arbonnier, 2002; Konkon et al., 2006; Thiombiano et al., 2012; Olivier et al., 2013; Kinda et al., 2017).

Phytochemical studies of *M. inermis* showed that the leaves aqueous extracts of the tree contain sterols, triterpenes, polyphenols, flavonoids, catechic tannins, saponins, quinones, and alkaloids (Konkon et al., 2006; Konkon et al., 2008; Pahaye et al.,

2017). Similarly, phytochemical investigation of *T. indica* leaves showed the presence of tannins, saponins, sesquiterpenes, alkaloids, and phlobatanins (Doughari, 2006; Choudhary & Swarnkar, 2011; Raghavendra et al., 2013). The antioxidant properties of these trees are well reported by Raghavendra et al. (2013) and Pahaye et al. (2017).

In the current study, the α -amylase inhibitory and antioxidant potential of *M. inermis* and *T. indica* leaves extracts were *in vitro* investigated.

2 Materials and Methods

2.1 Plant materials

Leaves of *T. indica* and *M. inermis* were collected from the forest of Dinderesso (15 km from the Bobo-Dioulasso) in mid of October 2019. Collected plant samples were identified and authenticated by the renowned botanist of Université Nazi BONI, Burkina Faso. Collected leaves samples were shade dried under laboratory conditions and converted into powder with the help of mortar and pestle, this prepared powder was stored in plastic zip bags. The moisture content of the powder was measured by KERN (MLS 50-3C, Germany) and used for maceration in the distilled water (40g leaves powder in 400 ml distilled water) in a ratio of 1 : 10 (W/V) for 48 h at room temperature at magnetic shaker (Souhila et al., 2013). Then, the mixture was filtered using cotton followed by Whatman filter paper N°1 (GE Healthcare companies, UK). The extraction was repeated three times for getting the average yield and this was reported as 12.27±2.06% for *T. indica* and 10.93±1.26% for *M. inermis*. Each obtained extract was stored under the refrigerator to determine the *in vitro* antioxidant and α -amylase inhibitory activity.

Seeds of *Sorghum bicolor* were purchased from the local market and used for the α -amylase extraction as per the standard protocol described by Adefila et al. (2012). The activity of α -amylase was quantified by using glucose (Scharlau Chemie S.A, Spain) as the standard as described by Miller (1959). The specific activity was expressed in μ g of glucose released per min (U) and per mg of protein. Further, the protein concentration of extracts was measured with the Bicinchoninic Acid (BCA) Protein Assay Kit (Pierce, Rockford, IL) using BSA (Bovine Serum Albumin) as standard (Sigma-Aldrich, LLC, USA). The protein concentration of the extracts was 5.03 mg/mL and has a specific activity of 3.32 U/mg protein.

2.1 Estimation of phenolic compounds

2.1.1 Determination of total polyphenols

Estimation of polyphenols content of two leaf extracts was evaluated by using a Folin Ciocalteu reagent method with some modification (Meda et al., 2010). The prepared stock solution of each sample

(10 mg/mL) was diluted with the help of distilled water (1/100); from this 125 μ L of each extract was mixed with 625 μ L of 0.2 N Folin Ciocalteu reagent (MP Biomedicals, LLC, USA). The mixture was kept in dark for 5 minutes, followed by the addition of 500 μ L sodium carbonate solution (75 mg/mL, CARLO ERBA Reagents S.A.S, France). Again the mixture was kept in the dark place for 2 h and the absorbances of the mixture were measured at 760 nm using a spectrophotometer (GENESYS 30 Visible Spectrophotometer). The standard calibration curve was plotted using gallic acid (Sigma-Aldrich Chemie, Steinheim, China) (0-200 mg/L) ($y=4.668 \times 10^{-3} x-0.034$; $R^2=0.9991$). The average of three optical densities (OD) was used and the results expressed in mg Gallic Acid Equivalents (GAE)/100 mg extract.

2.1.2 Determination of total flavonoids

The total flavonoids content of both aqueous leaf extracts was determined by modifying $AlCl_3$ method, as reported by Meda et al. (2010). The same dilution of both the extracts, as mentioned above was prepared with methanol (Fisher Scientific, UK). From this, 625 μ L of each extract (0.1 mg/mL) was mixed with 625 μ L of aluminum trichloride ($AlCl_3$) (Lab-honeywell, Germany) in 625 μ L of methanol (2%). The mixture was kept in a dark for 10 minutes and the absorbances of each sample were recorded at 415 nm using a UV-visible spectrophotometer. Quercetin (0-50 mg/L) (Sigma-Aldrich Chemie, Steinheim, China) was used as a reference compound to produce the calibration curve ($y=1.259 \times 10^{-2} x$; $R^2=0.9990$) and determine total flavonoid content. The average of three OD was used as a result and expressed in mg Quercetin Equivalent (QE) / 100 mg extract (Meda et al., 2010).

2.3 Estimating of antioxidant activity

2.2.1 Radical 2,2'-azinobis-3-ethylbenzothiazoline-6-sulphonate (ABTS) decoloration assay

The antioxidant capacity of both extracts was estimated by the method given by Meda et al. (2010). For this, methanolic dilution at 1/100 was prepared from both the extracts (10 mg/mL), and from this, 10 μ L of diluted extract (0.1 mg/mL) were reacted with 990 μ L of fresh ABTS^{•+} (Meridian Rd, Rockford, U.S.A) solution and incubated in the dark. The absorbance of the ABTS^{•+} solution was measured at 734 nm. Ascorbic acid (0-10 μ g/mL) (Sigma-Aldrich Chemie, Steinheim, China) was used as standard ($y=-7.874 \times 10^{-4} x+0.709$; $R^2=0.9993$) while Quercetin was taken as the reference-free radical scavenger. Free radical scavenging capacity of extracts was expressed in μ mol Ascorbic Acid Equivalent (AAE)/g extract (Meda et al., 2010).

2.2.2 Radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging test

The methanol dilution of the used extracts was prepared as described above. Then 375 μ L of each extract was mixed with 750

μL of DPPH solution (0.02 mg/mL methanol) (Acros Organics, Spain). After incubation for 15 min at room temperature, the OD of the mixture was recorded against the blank at 517 nm. The test was performed in triplicate and the standard calibration curve was plotted using ascorbic acid (0-10 $\mu\text{g/mL}$) (Sigma–Aldrich Chemie, Steinheim, China) ($y = -2.224 \times 10^{-2}x + 0.348$; $R^2 = 0.9966$) (Meda et al., 2005).

2.3.3 Ferric reducing antioxidant power (FRAP) assay

The antioxidant capacity of the *T. indica* and *M. inermis* was estimated spectrophotometrically by FRAP assay. For FRAP assay, an aqueous solution (10 mg/mL) of the two extracts was used. For this, 0.5 mL of each extract (100 $\mu\text{g.mL}^{-1}$) was mixed with 1.25 mL phosphate buffer (0.2 M, pH 6.6) (Carlo Erba Reagents, France) and 1.25 mL potassium hexacyanoferrate [$\text{K}_3\text{Fe}(\text{CN})_6$] aqueous solution (1%) (Fisher Chemical, UK). After 30 min of incubation at 50°C, 1.25 mL trichloroacetic acid (10%) (ACS, Reagent Ph Eur, Germany) was added to the mixture and centrifuged at 3000 rpm for 10 min. Subsequently, 0.625 mL of the supernatant was mixed with 0.625 mL distilled water and 0.125 mL of a freshly prepared FeCl_3 solution (0.1%) (Chem-Lab NV, Belgium), and the absorbance at 700 nm was recorded against a reagent blank after 30 min incubation ($y = 3.270 \times 10^{-3}x$; $R^2 = 0.9990$). All the determinations were performed in triplicates and Quercetin was taken as the reference reducer. The determination of Fe^{3+} reducing activity was performed in triplicate and expressed as μmol Ascorbic Acid Equivalent (AAE)/g extract (Meda et al., 2010).

2.4 Evaluation of α -amylase inhibitory activity

In vitro α -amylase, an inhibitory assay of *T. indica* and *M. inermis* leaves extracts were performed according to Adewale et al. (2006); Adewale & Oladejo (2009) with some modifications. The test was conducted with two concentrations, viz., 10, and 0.005 mg/mL of plant extract. The 500 μL of plant extract was mixed in 1750 μL of 1% starch solution (Carlo Erba Reagents S.A, France), 727 μL of the buffer, 23 μL of α -amylase aliquot and incubated at 37°C for 60 min. To stop the reaction, 100 μL of 3,5 dinitrosalicylic acid colour reagent was added to the test tube and the test tubes were incubated in a water bath at 85°C for 5 min. The reaction mixture was then diluted after adding 750 μL distilled water and absorbance was measured at 540 nm in a spectrophotometer. Different blanks were prepared by replacing an aliquot of the enzyme with a buffer for correcting the background absorbance. Readings were taken in triplicates. The specific activity was measured by reference to the glucose calibration curve. One unit of the amylase activity was defined as the amount of enzyme which liberated reducing sugar equivalent to 1 μg of D-glucose per minute from soluble starch at 25°C. α -Amylase inhibition percentage (%I) was calculated as follows:

$$\%I = \frac{[\text{Enzyme specific activity} - \text{Enzyme specific activity in the presence of extract}]}{\text{Enzyme specific activity}} \times 100$$

2.5 Statistical analysis

Statistical analysis was performed with R 3.5.1. The results are presented as means $\pm$ standard deviations. Student t-test was used to compare the means of activities between the two plant extracts and between each extract to quercetin as standard. P-values (p) < 0.05 were considered significant.

3 Results and discussion

3.1 Total polyphenol, flavonoid and Antioxidant contents of plant extracts

The selection of a good extraction method is a crucial step in getting extracts with an acceptable yield of antioxidant compounds. The presence of phenolic and flavonoid compounds are important constituents of plant extracts responsible for antioxidant activity. Total polyphenol and flavonoid contents were quantified in the aqueous extract of *M. inermis* and *T. indica* and the results of total polyphenol were derived from a calibration curve ($y = 4.668 \times 10^{-3}x - 0.034$; $R^2 = 0.9991$) of gallic acid and expressed in gallic acid equivalents (GAE) per 100 mg extract weight. While the results of flavonoid contents were derived from the calibration curve ($y = 1.259 \times 10^{-2}x$; $R^2 = 0.9990$) of quercetin and expressed in quercetin equivalents (QE) per 100 mg dry extract weight. Results of the study revealed that both aqueous extracts have almost equal polyphenol content and it was reported 20.24 mg GAE/ 100 mg and 24.42 mg GAE/ 100 mg for *T. indica* and *M. inermis* respectively (Table 1). While in the case of flavonoid content, a significant difference was reported between *T. indica* (9.90 mg QE/100 mg extract) and *M. inermis* (0.95 mg QE/100 mg extract). The extracts rich with phenolic compounds could be a good antioxidant source that would help increase the overall antioxidant capacity of an organism and guard it against diabetes.

Antioxidant activity of *T. indica* and *M. inermis* leaves aqueous was related to the available concentration of total phenols and flavonoids which are responsible for deactivating free radicals based on their ability to donate hydrogen atoms to free radicals. The results of the study revealed that the tested extracts had different levels of antioxidants (Table 2). The ABTS and DPPH tests have significantly lower antioxidant levels than quercetin ($p < 0.01$). As for the Fe^{3+} reduction test, the aqueous extracts of *T. indica* (677.26 μmol AAE/g extract) and *M. inermis* (329.95 $\pm$ 49.11 μmol AAE/g extract) showed very low levels of reduction as compared to the reference ferric reducer ($p < 0.001$). These plant phenolic compounds and flavonoid content are responsible for significant antioxidant activities (Lamien-Meda et

Table 1 Total polyphenol and flavonoid content

Plant	Polyphenols (mg GAE/ 100 mg extract)	Flavonoids (mg QE/ 100 mg extract)
<i>T. indica</i>	20.24±0.15	9.90±0.12
<i>M. inermis</i>	24.42±0.91	0.95±0.08
P-value	P > 0.05	P < 0.001

GAE : Gallic Acid Equivalent, QE : Quercetin Equivalent

Table 2 Antioxidant content of extracts

Plant	ABTS (μmol AAE/g extract)	FRAP (μmol AAE/g extract)	DPPH (μmol AAE/g extract)
Quercetin	14550.26± 281.08	6034.64±12.05	646.00±0.00
<i>T. indica</i>	7067.58±0.00**	677.26±24..53***	360.02±7.23**
<i>M. inermis</i>	6815.16±51.00**	329.95±49.11***	522.17±1.81**

AAE : Ascorbic Acid Equivalent ; n = 3 ; * : p<0.05 ; ** : p<0.01 ; *** : p<0.001 vis quercetin

Table 3 Effect of different plant extracts on α-amylase

	<i>T. indica</i>		<i>M. inermis</i>	
Extract (mg/mL)	0.005	10	0.005	10
SA (U/mg protein)	2.13	0.35	2.47	0.81
Inhibition (%)	36.49	89.55	26.28	75.65

SA : Specific activity of the enzyme ; U : μg of glucose released per minute

al., 2008; Choudhary & Swarnkar, 2011; Raghavendra et al., 2013; Nyambe-Silavwe et al., 2015). Antioxidant compounds counter with free radicals mediate oxidative stress in the cell and prevent chronic illness such as diabetes (Lamien-Meda et al., 2008; Pahaye et al., 2017). Mostly plant antioxidants act as hydrogen/electron donors or radical scavenger; in this either they donate one electron/hydrogen to the free radical present in a biological system or suppress chain initiation and/or break the chain propagation reactions by scavenging the active radicals (Rolland, 2004). The antioxidants present in the aqueous extracts of *T. indica* and *M. inermis* leaves trapped the radicals DPPH, ABTS and reduced Fe(III) which help in preventing antioxidants. The result of the study revealed that both extracts have the potential to overcome oxidative stress and could serve as therapeutic agents for treating radical related pathological damage associated with diabetes but some further detailed study is required to get more molecular details.

3.2 α-amylase Inhibitory activity of plant extracts

In this study, the α-amylase inhibitory activity of *T. indica* and *M. inermis* leaves extracts was investigated (Table 3). The percentage inhibition of α-amylase by both the extracts was studied at two concentrations viz., 0.005 mg/ml, and 10 mg/ml. At the lowest concentration (0.005 mg/mL), 36.49 and 26.28% α-amylase inhibition was reported for *T. indica* and *M. inermis* leaves extracts respectively. While this inhibition reached 89.55 and 75.65% for *T.*

indica and *M. inermis* extracts respectively at higher concentrations (10 mg/mL). The percentage inhibition of both the extracts was dose-dependent. It has been reported that plant phenolic compounds modulate the enzymatic breakdown of carbohydrates by inhibiting α-amylase enzymes (Kim et al., 2000; Tadera et al., 2006).

Various studies suggested that leaves of *T. indica* contain various polyphenols such as 8-C-glycosyl-apigénin, 6-C-glycosyl-apigénin, 8-C-glycosyl-lutéolin, 6-C-glycosyl-lutéolin, 7-o-glucosidelutéolin, vitexin, isovitexin, orientin, and iso-orientin which could justify the α-amylase inhibitory activities of this tree (Bhatia et al., 1966; Nacoulma, 1996; Escalona-Arranz et al., 2010). This α-amylase inhibitory activity of this plant extracts could justify the antidiabetic property and traditional use of these plants in diabetes treatment (Tadera et al., 2006; Alam et al., 2018). Similarly, Mentreddy (2007) and Alam et al. (2018) associated the antihyperglycemic properties of this plant with the presence of various secondary metabolites, such as polyphenols, alkaloids, terpene compounds, glucosides, and saponosides.

However, phytochemical investigations of the *M. inermis* leaves extracts have identified the presence of many alkaloids such as uncarin D, rhynchophyllin, isorhynchophyllin, rotundifolin, isorotundifolin, ciliaphyllin, speciogynin, pteropodin, uncarin F, mitraphyllin, isomitraphyllin and mitracilantin (Shellard &

Sarpong, 1969; Shellard & Sarpong, 1970; Phillipson, 1973; Toure et al., 1996; Fiot et al., 2005). Thus, the result of the study suggested that the antidiabetic activities of a plant is not only associated with the phenolic compounds alone but it is a combined effect of various biomolecules such as polyphenols, flavonoids, alkaloids, etc. (Feknous et al., 2014). The results of α -amylase inhibitory properties of *M. inermis* were also confirmed by the findings of previous researchers (Narkhede, 2012).

Conclusion

Hence the above results suggest that the leaf extracts of *T. indica* and *M. inermis* could be greatly beneficial in reducing the absorption of starch into the body also justify the use of these plants in traditional herbal medicines. The extent of antioxidant and α -amylase inhibition by these extracts is dependent on the available active ingredients polyphenols and flavonoids. Thus this study confirms that the leaves of *T. indica* and *M. inermis* can mitigate postprandial hyperglycemia and oxidative stress and therefore assist in combating diabetic complications but the crude extract contains several bioactive compounds; therefore, further deep investigations are required to characterize the active molecule, which may be a potent antioxidant and enzyme inhibitor.

Acknowledgement

We are thankful to Herbalists of Bobo-Dioulasso city for having shared their recipes.

Conflict of interest

The authors declare no interest conflicts in this manuscript.

References

- ADA (2007) Standards of medical care in diabetes. Diabetes Care 30 : S4-S41.
- Adefila OA, Bakare MK, Adewale IO (2012) Characterization of an α -amylase from sorghum (*Sorghum bicolor*) obtained under optimized conditions. Journal of the Institute of Brewing 118: 63 - 69.
- Adewale IO, Agumanu EN, Otihi-Okoronkwo FI (2006) Comparative studies on α -amylases from malted maize (*Zea mays*), millet (*Eleusine coracana*) and Sorghum (*Sorghum bicolor*). Carbohydrate Polymers 66:71-74. DOI: 10.1016/j.carbpol.2006.02.022
- Alam F, Shafique Z, Amjad ST, Asad MHHB (2018) Enzymes inhibitors from natural sources with antidiabetic activity: a review. Phytotherapy Research 2018:1 - 14. <https://doi.org/10.1002/ptr.6211>.
- Arbonnier M (2002) Arbres arbustes et lianes des zones sèches d'Afrique de l'Ouest. CIRAD-MNHN.
- Bhatia VK, Gupta SR, Seshadri TR (1966) C-glycosides of Tamarind leaves. Phytochemistry 5:177 - 181.
- BONDE L (2019) Densité des peuplements, equations allométriques, gradient climatique, mode d'utilisation des terres, PFNL, potentiel économique. These, Université Joseph Ki-Zerbo Pp. 181.
- Choudhary RK, Swarnkar PL (2011) Antioxidant activity of phenolic and flavonoid compounds in some medicinal plants of India. Natural Product Research 25:1101 - 1109.
- Dal S, Sigrist S (2016) The protective effect of antioxidants consumption on diabetes and vascular complications. Diseases 4 : 1 - 51.
- Doughari JH (2006) Antimicrobial activity of *Tamarindus Indica* Linn. Tropical Journal of Pharmaceutical Research 5 :597 - 603.
- Escalona-Arranz JC, Pérez-Rosés R, Irina LJ, Rodríguez-Amado J, Argota-Coello H, Cañizares-Lay J, Morris-Quevedo HJ, Sierra-González G (2010) Chemical constituents of *Tamarindus Indica* L. leaves. Revista de Cubana Química 3:65 - 71.
- Feknous S, Saidi F, Said RM (2014) Extraction, characterization and identification of some secondary active metabolites of Lamelissa (*Melissa officinalis* L.). Nature Technology 11 :7-13.
- Fiot J, Baghdikian B, Boyer L, Mahiou V, Azas N, Gasquet M, Timon-David P, Balansard G, Ollivier E (2005) HPLC quantification of uncarine d and the anti-plasmodial activity of alkaloids from leaves of *Mitragyna Inermis* (Willd.) O. Kuntze. Phytochemical Analysis Phytochem 16:30 - 33.
- IDF (2017) IDF Diabetes Atlas. 8th Edition.
- Phillipson JD, Rungsiyakul D, Shellard EG (1973) N-oxides of 1H-exindole alkaloids, rhynchocline and ciliaphylline. Phytochemistry 12:2043 - 48.
- Kim JS, Kwon CS, Son KH (2000) Inhibition of alpha-amylase and amylase by luteolin, a flavonoid. Bioscience Biotechnology Biochemistry 64 : 2458 - 2461.
- Kinda P, Zerbo P, Guenné S, Compaoré M, Ciobica A, Kiendrebeogo M (2017) Medicinal plants used for neuropsychiatric disorders treatment in the hauts bassins region of Burkina Faso. Medicines 4:1 - 21.
- Konkon NG, Adjoungoua AL, Manda P, Simaga D, N'Guessan KE, Kone BD (2008) Toxicological and Phytochemical Screening Study of *Mitragyna Inermis* (Willd.) O. Kuntze (*Rubiaceae*), Anti Diabetic Plant. Journal of Medicinal Plants Research 2 :279 - 284.

- Konkon NG, Simaga D, Adjoungova AL, N'guessan KE, Zirihi GN, Kone BD (2006) Etude phytochimique de *Mitragyna inermis* (Willd.) O. Ktze (*Rubiaceae*), plante à feuille antidiabétique. *Pharmacopée et Médecine Traditionnelle Africaine* 14:73 - 80.
- Lamien-Meda A, Lamien CE, Compaoré MMY, Meda RNT, Kiendrebeogo M, Zeba B, Millogo JF, Nacoulma OG (2008) Polyphenol content and antioxidant activity of fourteen wild edible fruits from Burkina Faso. *Molecules* 13 : 581 - 594.
- Souhila M, Mustaphaa K, Nacérab M (2013) Etude de l'extraction des composés phénoliques de différentes parties de la fleur d'artichaut (*Cynara scolymus* L.). *Nature & Technologie* 9:35 - 40.
- Meda A, Lamien CE, Romito M, Millogo J, Nacoulma OG (2005) Determination of the total phenolic, flavonoid and proline contents in Burkina Faso an honey, as well as their radical scavenging activity. *Food Chemistry* 91:571 - 577.
- Meda NTR, Lamien-Meda A, Kiendrebeogo M, Lamien CE, Coulibaly AY, Millogo-Rasolodimby J, Nacoulma OG (2010) In vitro antioxidant, xanthine oxidase and acetylcholinesterase inhibitory activities of *Balanites aegyptiaca* (L.) del. (*Balanitaceae*). *Pakistan Journal of Biological Sciences* 13:362 - 368.
- Mentreddy SR (2007) Medicinal plant species with potential antidiabetic properties. *Journal of the Science of Food and Agriculture* 87:743 - 750.
- Miller GL (1959) Use of dinitrosalicylic acid reagent for determination of reducing sugar. *Analytical Chemistry* 31 : 427 - 428.
- Nacoulma OG (1996) Plantes médicinales et pratiques médicinales traditionnelles: cas du plateau central. These d'Etat, Université de Ouagadougou 1-328.
- Narkhede MB (2012) Evaluation of alpha amylase inhibitory potential of four traditional culinary leaves. *Asian Journal of Pharmaceutical and Clinical Research* 5:75 - 76.
- Nasri H, Shirzad H, Baradaran A, Rafieian-kopaei M (2015) Antioxidant plants and sweet diabetes. *Journal of Research in Medical Sciences* 20 :491 - 502.
- Nyambe-Silavwe H, Villa-Rodriguez JA, Ifie I, Holme M, Aydin E, Jensen JM, Williamson G (2015) Inhibition of human α -amylase by dietary polyphenols. *Journal of Functional Foods* 19 : 723 - 732.
- Olivier M, Zerbo P, Boussim JI, Guinko S (2013) Les plantes des galeries forestières à usage traditionnel par les tradipraticiens de santé et les chasseurs dozo sénoufo du Burkina Faso. *International Journal of Biological and Chemical Sciences* 6 :2170 - 2191.
- Pahaye DB, Bum EN, Taïwé GS, Ngoupaye GT, Sidiki N, Moto FCO, Kouemou N, Njapdounke SJK, Gisele N, Antoine K, Omam JPO, Mairaira V, Ojong JL (2017) Neuroprotective and anti-amnesic effects of *Mitragyna Inermis* Willd. (*Rubiaceae*) on scopolamine-induced memory impairment in mice. *Behavioural Neurology* 2017 :1 - 11.
- Raghavendra M, Madhusudhana AR, Pulala RY, Sudharshan RA, Siva KL (2013) Comparative studies on the *in vitro* antioxidant properties of methanolic leafy extracts from six edible leafy vegetables of India. *Asian Journal of Pharmaceutical and Clinical Research* 6:96 - 99.
- Read NW, Welch IM, Austen CJ, Barnish C, Bartlett CE, Baxter AJ, Worlding J (1986) Swallowing food without chewing ; a simple way to reduce postprandial glycaemia. *British Journal of Nutrition* 55 : 43 - 47.
- Rolland Y (2004) Natural plant antioxidants. *Oilseed and fats, Crops and Lipids* 11 :419 - 424.
- Shellard EJ, Sarpong K (1969) The alkaloids of the leaves of *Mitragyna Inermis* (Willd.) O. Kuntze. *Journal of Pharmacy and Pharmacology* 21:113S - 117S.
- Shellard EJ, Sarpong K (1970) The alkaloidal pattern in the leaves, stem-bark and root-bark of *Mitragyna* species from Ghana. *Journal of Pharmacy and Pharmacology* 22:34S - 39S.
- Surya S, Salam AD, Tomy DV, Carla B, Kumar RA, Sunil C (2014) Diabetes mellitus and medicinal plants-a review. *Asian Pacific Journal of Tropical Disease* 4:337 - 347.
- Tadera K, Minami Y, Takamatsu K, Matsuoka T (2006) Inhibition of α -glucosidase and α -amylase by flavonoids. *Journal of Nutritional Science and Vitaminology* 52 : 149 - 153.
- Thiombiano A, Schmidt M, Dressler S, Ouédraogo A, Hahn K, Zizka G (2012) Catalogue des plantes vasculaires du Burkina Faso. Editions des Conservatoire et Jardin botaniques 1 - 391.
- Tiwari AK (2001) Imbalance in antioxidant defence and human diseases: multiple approach of natural antioxidants therapy. *Review Articles Current Science* 81 :1179 - 1187.
- Toure H, Balansard G, Pauli AM, Scotto AM (1996) Pharmacological investigation of alkaloids from leaves of *Mitragyna Inermis* (*Rubiaceae*). *Journal of Ethnopharmacology* 54:59 - 62.
- WHO (2016) WHO Diabetes : country profiles in 2016. Available at <https://www.who.int/diabetes/country-profiles/fr/>, accessed 7 January 2020.
- Zerbo P, Millogo-Rasolodimby J, Nacoulma-Ouedraogo OG, Van Damme P (2011) Plantes médicinales et pratiques médicales au Burkina Faso : cas des sanan. *Bois et Forêts des Tropiques* 307:42 - 50.
- Zizka A, Thiombiano A, Dressler S, Nacoulma BMI, Ouédraogo A, Ouédraogo I, Ouédraogo O, Zizka G, Hahn K, Schmidt M (2015). Traditional plant use in Burkina Faso (West Africa): a national-scale analysis with focus on traditional medicine. *Journal of Ethnobiology and Ethnomedicine* 11 :2 - 10.