

*Full Length Research Paper*

# Effect of *Canarium schweinfurthii* leaf and pulp extracts on blood glucose levels in oral glucose load - induced hyperglycemia in Wistar albino rats

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*Canarium schweinfurthii* is a common medicinal plant used as food and medicine in communities of central Uganda. Local communities and herbalists commonly used it in the management of diabetes mellitus type 2 with limited information on its effectiveness. Study assessed the hypoglycemic effect of *C. schweinfurthii* aqueous and total crude leaf and pulp extracts on blood glucose levels in Wistar albino rats. An experimental based laboratory-based study was conducted on 18 groups each with 6 Wistar albino rats. An oral glucose load of 2.5 mg/kg bwt was used to induce physiological hyperglycemia. Group 1 got 2 mL of distilled water; group 2 received 10 mg/kg bwt of glibenclamide, group 3-18 received varying doses of aqueous and total crude extracts respectively. Blood sugar levels were determined at different time intervals (fasting, time 0, 30, 60, 90, 180, and 240 min) using an automated blood glucose glucometer. Study was approved by relevant IRB. Both extracts exhibited hypoglycemic activity though less than glibenclamide drug since curves were above control drug and distilled water. All extracts of *C. schweinfurthii* had hypoglycemic effect though it was lower compared to glibenclamide and hence its continued use by the local communities in Central Uganda.

**Key words:** *Canarium Schweinfurthii*, blood sugar levels, hypoglycemic effect, hyperglycemia.

## INTRODUCTION

Diabetes mellitus type 2 (T2DM) due to chronic hyperglycemia has continued to be a serious public health problem worldwide including in Uganda (Chiwanga et al., 2016). Diabetes mellitus is a serious, chronic disease characterized by sustained high fasting blood glucose levels (more  $\geq 7$  mmol/L or 126 mg/dL, or when the 2-h plasma glucose levels after taking a 75 g glucose

load are consistently  $\geq 11.1$  mmol/L or 200 mg/dL) (Davies et al., 2018) and occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces (Asiimwe et al., 2020).

Diabetes mellitus is normally classified into three types relying on the period/time of onset; type 1 (in children),

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type 2 (in adults) and gestational diabetes (during pregnancy). The most prevailing is type 2 diabetes mellitus accounting for nearly 90% of all cases of diabetes (Abdulai et al., 2019). Unchecked high blood glucose levels in type 2 diabetes mellitus damages the vascular system, which results into vascular complications, mainly affecting the kidney, heart, nervous system and eyes (Cho et al., 2018). A recent report shows that T2DM is the leading cause of kidney failure and coronary artery diseases (Chen et al., 2020). Diabetes mellitus was reported to cause 6.7 million deaths in 2021). In Uganda, more than 3.6% of the adult population have been reported to have diabetes mellitus (Bahendeka et al., 2016; Salama et al., 2021). Management of T2DM in most cases involves living a healthy lifestyle such as regular physical activity, healthy diet, and avoidance of alcohol and tobacco abuse and use of medicines that lower blood glucose levels including insulin or oral hypoglycemic agents as well as utilization of medicinal plants as an alternative form of medicines (Cho et al., 2018).

It is reported that between 50-95% of the world population, in both developed and developing countries communities, utilize medicinal plants to manage various ailments (Ssenku et al., 2022). In Ugandan communities, lack of accessibility to conventional medicines such as insulin or oral hypoglycemic agents, shortage and low motivation of healthcare providers, inadequacy and high cost of medical supplies, limited access to medical facilities, chronicity of the disease and adverse reactions (ADR), acceptance of traditional medicines and a belief that they are safe as compared to conventional medicines are the drivers for individuals to seek alternative form of medicine especially in forms of medicinal plants (Kakudidi et al., 2016a; Ssenku et al., 2022).

The utilization of herbal medicine in the country by various communities has been estimated to be 60%, with the use observed more in rural areas as compared to urban areas (Ssenku et al., 2022). The medicinal plants are believed to be cheap, easily accessible and with limited side effects (Awodelea and Osuolale, 2015). Among the commonly used medicinal plants is *Canarium schweinfurthii*. The plant is commonly used as food and as a medicine in the management of various conditions including anemia, hyperglycemia, eye diseases, helminths infection, diarrhea, goiter and hypertension (Kakudidi et al., 2016b).

The medicinal properties of *C. schweinfurthii* can be attributed to the various phytochemical compounds it contains including saponins, tannins, cardiac glycoside, steroids and flavonoid balsams, phenols and flavonoids that are used for their nutritional values, especially in the management of Diabetes mellitus type 2 (Abdulai et al., 2019).

Some other studies done on this plant using

streptozotocin-induced diabetic rats mainly working on stem bark extracts, have demonstrated anti-diabetic activity of *C. schweinfurthii* (Kamtchouing et al., 2006) and (Kouambou et al., 2007). Anti-diabetic in effect studies of *C. schweinfurthii* fruit oil has been demonstrated in Wistar rats (Dimo et al., 2007; MacDonald et al., 2016). Other studies using alloxan-Induced diabetic rats on stem bark extracts has also demonstrated its anti-diabetic mellitus activity (Kouambou et al., 2007).

Furthermore, previous studies utilized stem bark which is destructive to the plant long term and therefore the present study used the leaves and fruits as alternative. The utilization of these parts promotes conservation of the plant.

In addition some of the previous studies were utilizing streptozotocin as alloxan- induced hyperglycemia with, sulfonylurea a secretagogue as control drug which is a wrong control since the pancreatic cells are already destroyed.

The current study used physiologically induced hyperglycemia with intact pancreatic cells secreting insulin using oral glucose load.

However, there is limited scientific information on the effects of *C. schweinfurthii* extracts on blood glucose levels. The study evaluated the effects of *C. schweinfurthii* aqueous and total crude leaf and pulp extracts on blood glucose levels in the oral glucose-load dosed Wistar albino rats.

## MATERIALS AND METHODS

### Study design

An experimental laboratory-based study was conducted to determine the effects of aqueous and total crude leaf and pulp extracts of *C. schweinfurthii* in orally induced glucose load hyperglycemia in Wistar Albino Rats.

### Study setting

The experiments were conducted at the Department of Pharmacology and Therapeutics laboratory at Makerere University College of Health Sciences (MakCHS) in Kampala, Uganda.

### *Canarium schweinfurthii* selection, collections and authentication

*C. schweinfurthii* leaves and fruit pulps were village harvested on 10th September 2021 from a farmland at Magere which is located along Gayaza Road, north of Kampala city Centre in Wakiso district in Central Region of Uganda. The plant was identified by a taxonomist at Makerere University who gave it a voucher number 50920 and was deposited at Makerere University herbarium for future reference. The leaves and fruit pulp were sorted, damaged and rotten ones were discarded (Olawale, 2012). The fruit pulp was removed from the seed before drying. The leaves and fruit pulp of *C. schweinfurthii* samples were air-dried separately at room

temperature under a shade at the Department of Pharmacology and Therapeutics laboratory until a constant weight was attained. Each dry sample was pounded separately to coarse powder using before commencement of the study. The experimental animals were kept at standard laboratory conditions of temperature motor and pestle, to ease the extraction of active compounds. The powder was kept in an air tight container in preparation for the extraction process.

### Extraction process

1) The extraction process followed already established extraction procedure of plant samples, using cold maceration was used (Ciulei, 1964; Cowan, 1999). Serial extraction methods in which the powder was first soaked in Diethylether; then followed by methanol and lastly water as solvents were used respectively. Three hundred (300 g) plant powder was soaked in 700 ml diethyl ether (98%) in Erlenmeyer flask for 3 days. Three hundred (300 g) of each of the plant part powder were weighed separately using an electronic weighing scale (Mettler PJ3000, Mettler-Toledo GmbH, Ockerweg, Germany). Each weighed plant powder was put in Erlenmeyer flask and then soaked in 700mL of 98% Di ethyl ether (Zayo-Sigma, Germany) for 3 days with occasional shaking to facilitate the process of extraction of the phytochemical compounds. Then each of the plant extracted was filtered using Whatman grade 1 qualitative filter papers in Büchner funnel and amber bottle. The residues for each plant part extract was air-dried for 1 h in preparation for methanol extraction. The process of methanol extraction was repeated as for the Diethyl ether extraction.

Similarly, the process was repeated in preparation for water (aqueous) extraction. Rotary evaporator (BUCHI Rotavapor R-205) was used to recover the diethyl-ether and methanol solvents.

2) The same process was repeated on the residue using methanol (95% V/V) for 3 days.

3) The dried residue was soaked in 1.3 L distilled water at 55°C to avert fungal attack and cooled at room temperature. The mixture was shaken 2 hourly to facilitate extraction for 12 h. The filtrate was freeze dried at a pressure of 32 Pa, original temperature was set at -47°C and then maintained at 0°C for 36 h to dry the extract. Four (4 g) of powder of Diethyl ether, methanol and aqueous extracts were weighed, and added together and then 50mL of methanol was added and mixed uniformly and then air-dried to produce the total crude extract.

### Preparation of stock solutions

The 4g of each extract were added a few drops of dimethyl sulfoxide (DMSO) and then topped up to 4mL to produce 1000 mg/mL. Then serial dilution of each of the extract solutions was made to produce varying doses (1000, 500,250,100 mg/mL) that were used in the experimental studies.

### Control solutions

Control solution used was distilled water and 10 mg Glibenclimide was used as the positive control.

### Preparation and treatment of experimental animals

One hundred and eight (108) Wistar albino rats aged 6-8 weeks; disease-free rats were used for the study. They were bred from Makerere University College of Veterinary Medicine, Animal

resources and Biosecurity, animal house from where they were transferred to the Pharmacology laboratory at the Department of Pharmacology and Therapeutics in preparation for the experimental study. The animals were accommodated in the cages at the department for a week to acclimatize to the new environment (25±1°C), relative humidity (45-55%) and light/dark cycle (12 h light: 12 h dark cycle). Standard rat pellets and clean water were provided *ad libitum* to the animals (Gordon, 2001). The animals were handled according to the National academies press guideline for care and use of laboratory animals (National Research Council, 2010). The 3Rs: Replacement, Reduction and Refinement were observed based on international standard guidelines on use of laboratory animals in biomedical research. The 5 freedoms of animal welfare which are globally, recognized as the gold standard in animal welfare, encompassing both the mental and physical well-being of animals were observed including: freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury, and disease; freedom to express normal and natural behavior (Sneddon et al., 2017).

### Selection of experimental animals

#### Inclusion criteria

Adult Wistar albino rats at the age 6-8 weeks, which were judged to be healthy by their record of good appetite and clear solid stools. Their body temperature was measured using a body thermometer placed in the rectum to ascertain that they are not febrile. Temperature of 37°C was considered normal.

#### Exclusion criteria

Any rats that showed signs of ill-health like failure to feed; having diarrhea, a runny nose or being febrile were not used in the study. Pregnant, nursing rats or those with external wounds and a rough coat depictive of disease were also excluded from study and were treated promptly by the qualified veterinary doctor.

#### Sample size estimation

Wistar albino rats aged 6-8 weeks, which were randomized into 18 experimental groups, (n=108) with six adult rats in each group were used. Similarly the control groups (distilled water and Glibenclimide) each had the same number of animals.

#### Group treatment and dosing of animals

Based on the Organization of Economic Co-operation and Development (OECD) guidelines 407, that recommend that a minimum of 6-10 animals per group be used to give a statistically significant difference in the results (National Research Council, 2010).

The administration of oral glucose load (glucose load induced-hyperglycemia or physiological hyperglycemia or Oral glucose tolerance test (OGTT)), extracts, control drug (Glibenclamide) and distilled water to the animals were done using the intragastric tube orally. Animals were fasted overnight (12 h) but with access to water *ad libitum* and in the morning, the fasting blood glucose (FBG) levels were measured using blood glucose test strips and glucometer (Accucheck Advantage II; Roche Germany) (Chaimum-aom et al., 2017; Chandran et al., 2017). A drop of blood sample from each animal was obtained by a tail pricking of the tail vein. The

**Table 1.** Group treatment of experimentals.

Group	Group and controls	Drug or extract dose (mg/kg bwt)	Number of animals per group
1	Distilled water	2mL	6
2	Glibenclamide	10mg	6
<b>Aqueous Leaf extracts</b>			
3		1000	6
4		500	6
5		250	6
6		100	6
<b>Total crude Leaf extracts</b>			
7		1000	6
8		500	6
9		250	6
10		100	6
<b>Pulp Aqueous extracts</b>			
11		1000	6
12		500	6
13		250	6
14		100	6
<b>Pulp Total crude extracts</b>			
15		1000	6
16		500	6
17		250	6
18		100	6

Source: Authors

blood glucose levels (BGL) values were recorded.

Feeds was reintroduced after measuring the fasting blood sugar levels. Then, varying doses of the extracts, glibenclamide (10 mg/kg body weight) and distilled water (2mL) (Table 1) were given. After 30 min of administrations of each agent, all the animals were loaded with 10mg/kg body weight glucose solution orally using intragastric tube. Blood glucose levels were then measured at 0, 30, 60, and 90,180 and 240 min time intervals after glucose load dosing (Alema et al., 2021; Ayele et al., 2021; Chaimum-aom et al., 2017; Chandran et al., 2017). The mean blood glucose levels for the entire treatment test groups were compared with the control groups. (Alema et al., 2021)

#### Quality control and data management

A well-trained and experienced Laboratory technologist in the handling of laboratory animals was involved in the preparation of the animals and carrying out the procedures. All chemicals and reagents used were of analytical grade and were checked to ensure that they were not expired before the experimentation. The sample analysis was replicated to ensure the validity and reliability of the results. The equipment used adhered to recommended methods and procedures and was calibrated regularly. Control groups were included in the study, using inbred rats of similar age groups and providing them with the same environment and diet to minimize metabolic differences. Healthy animals were used throughout the experimental studies. The data collected was entered into Microsoft Excel spreadsheet from where they were exported into STATA version 13 for statistical data analysis.

#### Data analysis

Data were analyzed using STATA version 13, the means and standard error for mean (SEM) for each treatment group was obtained. Comparisons of means were used to determine statistical significance of the results using one way ANOVA followed by a boniferroni test for binary comparison of the treatment groups (Alema et al., 2021; Ayele et al., 2021; Chaimum-aom et al., 2017; Chandran et al., 2017). The mean blood glucose levels for the entire treatment test groups were compared with the control groups (Alema et al., 2021).

#### Ethical considerations

Permission to conduct the study was sought from the Department of Medical Physiology, the School of Biomedical Sciences Institutional Review Board (IRB) and the Uganda National Council for Science and Technology. The protocol was approved and numbered SBS-812. Ethical practices that govern the handling of laboratory animals were adhered to as per international biosafety guidelines and the guidelines for the care and use of laboratory animals (Gordon, 2001).

Training in animal care and the use of animals for research was done in line with "The Global Health Network" and a certificate Number ca258ea3-580f-4d4c-846c-30305c569442 Version number was issued. The approved protocol was also reviewed and approved by the Institutional Animal Care and Use Committee at COVAB and given a reference #SVAR-

**Table 2.** Mean blood glucose levels (mmol/l)  $\pm$ SEM at different time intervals (minutes) after different extract dosing of oral glucose fed Wistar albino rats.

Drug/Extract (mg/kg bwt)	Blood glucose levels (mmol/L) $\pm$ SEM at different time intervals (minutes)						
	Fasting glucose levels	0	30	60	90	180	240
100 (AqL)	6.45 $\pm$ 0.75	7.94 $\pm$ 1.42	8.63 $\pm$ 1.01	9.16 $\pm$ 0.93	7.95 $\pm$ 0.76	6.33 $\pm$ 0.41	6.4 $\pm$ 0.50
250 (AqL)	6.8 $\pm$ 0.53	10.65 $\pm$ 1.48	9.11 $\pm$ 1.33	8.76 $\pm$ 1.34	7.61 $\pm$ 0.87	6.95 $\pm$ 0.71	7.14 $\pm$ 0.99
500 (AqL)	6.61 $\pm$ 0.83	9.23 $\pm$ 0.89	9.55 $\pm$ 3.34	9.95 $\pm$ 1.30	8.23 $\pm$ 1.73	6.51 $\pm$ 0.60	6.55 $\pm$ 1.05
1000 (AqL)	5.36 $\pm$ 1.42	11.03 $\pm$ 2.25	9.58 $\pm$ 1.28	10.66 $\pm$ 1.3	7.88 $\pm$ 1.67	6.08 $\pm$ 0.79	5.86 $\pm$ 0.93
100 (TCL)	5.18 $\pm$ 0.35	11.45 $\pm$ 0.45	8.63 $\pm$ 0.41	5.85 $\pm$ 0.38	6.43 $\pm$ 0.30	6.86 $\pm$ 0.31	5.7 $\pm$ 0.30
250 (TCL)	5.56 $\pm$ 0.24	8.91 $\pm$ 0.58	8.76 $\pm$ 0.54	7.61 $\pm$ 0.3	6.28 $\pm$ 0.65	8.21 $\pm$ 0.51	5.23 $\pm$ 0.28
500 (TCL)	6.03 $\pm$ 0.29	12.95 $\pm$ 1.19	7.95 $\pm$ 0.58	7.36 $\pm$ 0.94	5.98 $\pm$ 0.65	6.56 $\pm$ 0.48	6.31 $\pm$ 0.48
1000 (TCL)	5.96 $\pm$ 0.33	9.75 $\pm$ 0.48	7.55 $\pm$ 0.53	7.13 $\pm$ 0.26	6.48 $\pm$ 0.41	6.53 $\pm$ 0.19	6.56 $\pm$ 0.33
100 (AqP)	7.57 $\pm$ 0.67	11.45 $\pm$ 1.11	6.93 $\pm$ 1.13	5.85 $\pm$ 0.94	6.43 $\pm$ 0.74	4.87 $\pm$ 0.98	5.78 $\pm$ 0.75
250 (AqP)	7.83 $\pm$ 1.21	8.91 $\pm$ 1.42	6.55 $\pm$ 1.47	6.15 $\pm$ 0.98	6.28 $\pm$ 1.59	4.75 $\pm$ 0.98	5.23 $\pm$ 0.68
500 (AqP)	7.18 $\pm$ 1.90	12.95 $\pm$ 2.92	7.95 $\pm$ 1.44	7.36 $\pm$ 2.32	5.98 $\pm$ 1.60	5.50 $\pm$ 0.54	6.31 $\pm$ 1.18
1000 (AqP)	7.78 $\pm$ 0.43	9.75 $\pm$ 1.18	7.55 $\pm$ 1.30	7.13 $\pm$ 0.64	6.48 $\pm$ 1.02	4.30 $\pm$ 1.24	6.56 $\pm$ 0.81
100 (TCP)	6.03 $\pm$ 0.84	11.45 $\pm$ 0.45	6.93 $\pm$ 0.46	5.85 $\pm$ 0.38	6.43 $\pm$ 0.30	6.86 $\pm$ 0.31	5.78 $\pm$ 0.30
250 (TCP)	7.93 $\pm$ 1.23	8.91 $\pm$ 0.58	6.55 $\pm$ 0.60	6.15 $\pm$ 0.40	6.28 $\pm$ 0.65	8.21 $\pm$ 0.51	5.23 $\pm$ 0.28
500 (TCP)	5.71 $\pm$ 0.29	12.95 $\pm$ 1.19	7.95 $\pm$ 0.58	7.36 $\pm$ 0.94	5.98 $\pm$ 0.65	6.56 $\pm$ 0.48	6.31 $\pm$ 0.48
1000 (TCP)	6.33 $\pm$ 0.71	9.75 $\pm$ 0.48	7.55 $\pm$ 0.53	7.13 $\pm$ 0.26	6.48 $\pm$ 0.41	6.53 $\pm$ 0.19	6.56 $\pm$ 0.3
GB	6.31 $\pm$ 0.79	12.16 $\pm$ 2.76	5.00 $\pm$ 2.02	3.28 $\pm$ 1.07	2.51 $\pm$ 0.91	2.56 $\pm$ 0.53	2.28 $\pm$ 0.62
DW	6.75 $\pm$ 0.74	12.10 $\pm$ 2.06	4.70 $\pm$ 1.57	5.13 $\pm$ 1.75	5.03 $\pm$ 0.93	3.95 $\pm$ 0.68	3.65 $\pm$ 1.11
Anova p-value	*0.0058	* P<0.0001	* P<0.0001	* P<0.0001	* P<0.0001	* P<0.0001	* P<0.0001

\*-p<0.05, \*\*-P<0.005, \*\*\*-P<0.0005, and \*\*\*\*-P<0.0001. (P<0.05) was marked significant where treatment groups were compared with the control group.

Source: Authors

IACUC/66/2020.

## RESULTS

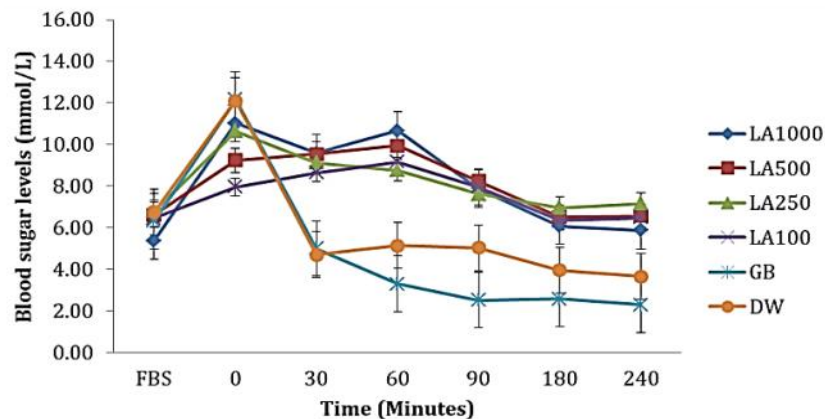
### Effect of the aqueous and total crude leaf and pulp extracts of *C. schweinfurthii* on blood sugar levels in oral glucose load fed normal Wistar rats.

The effect of the crude extract of *C. schweinfurthii*,

aqueous Leaf and pulp extracts on blood sugar levels (BSL) following the oral glucose load induced physiological hyperglycemia showed that the crude extracts treated groups had a reduction in BSL at all dose levels up to 240 minutes though not comparable to the control groups (distilled water and glibenclamide drug). The mean BGL values and the curves for the test groups were higher than those of the controls though with varying statistical significance (p<0.05) (Tables 2;

Figures 1A, 1B, 1C and 1D).

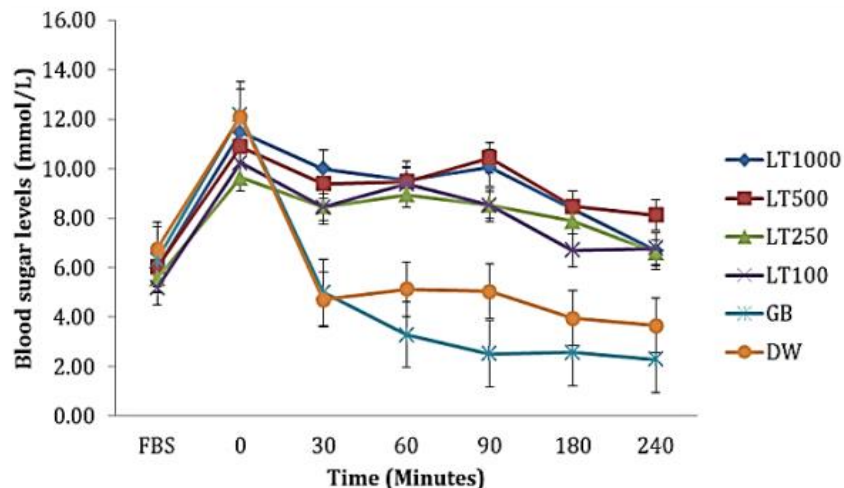
Experimental induction of hyperglycemia of glucose at a dose of 2.5 mg/kg body weight resulted in a 1.5 to 2-fold increase in plasma glucose levels (comparing curves for baseline FBS and 0 min) (Figure 1A). The findings showed no significant differences in BSL among all the groups (p >0.05) before glucose loading. But all groups showed increase in blood glucose levels following oral glucose dose ingestion, thus



**Figure 1A.** Effects of dosing different leaf and pulp extracts of *C. schweinfurthii* on blood sugar levels (mmol/L) at different time intervals (minutes).

LA: leaf aqueous extract: at different concentrations 1000mg/kg body weight, 500, 250 and 100 mg/kg body weight, GB- Glibenclamide (positive control); DW- distilled water (normal control).

Source: Authors



**Figure 1B.** Effects of dosing different leaf and pulp extracts of *C. schweinfurthii* on blood sugar levels (mmol/L) at different time intervals (minutes). LT: leaf total crude extract at 1000mg/kg body weight, 500, 250 and 100 mg/kg body weight; GB; Glibenclamide; DW- distilled water.

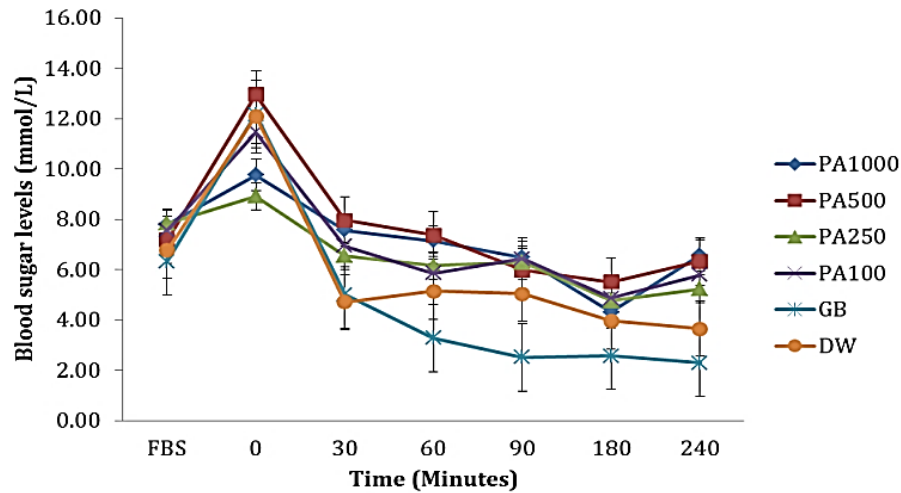
Source: Authors

confirming the induction of hyperglycemia (Figure 1A).

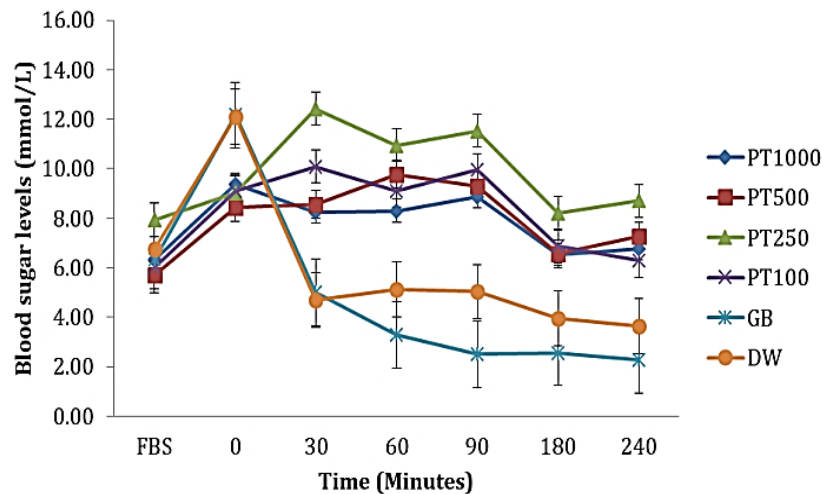
The blood glucose levels reduced following the dosing of the drugs and extracts at doses of 1000mg/kg, 500, 100, 250 after 30 minutes respectively, though the reduction was more with controls (glibenclamide and distilled water). Then a slight increase in blood glucose levels from 30 min to 60 min; then finally gradually reducing up to 240 min following dose administration was observed. The positive control Glibenclamide at a dose of 10mg/kg resulted in a very significant reduction in BSL from time 0 to 30 min after dosing and the reductions were

more observed with Glibenclamide as compared to the extracts and distilled water (Figure 1A). Furthermore, the blood glucose levels for the extracts were higher than for positive control (Glibenclamide) and negative control group (distilled water) at different time intervals suggesting hypoglycemic effect of the extracts which is less than the controls (Figure 1A).

Following the administrations of leaf total crude extracts of *C. schweinfurthii* in Wistar albino rats, the findings showed a similar trend in the reductions of blood glucose levels to that of the leaf aqueous extracts (Figure 1B).



**Figure 1C.** Effects of dosing different leaf and pulp extracts of *C. schweinfurthii* on blood sugar levels (mmol/L) at different time intervals (minutes). PA: Pulp aqueous extract: at different concentrations 1000 mg/kg body weight, 500,250 and 100 mg/kg body weight; GB- Glibenclamide; DW- distilled water. Source: Authors



**Figure 1D.** Effects of dosing different leaf and pulp extracts of *C. schweinfurthii* on blood sugar levels (mmol/L) at different time intervals (minutes). PT- pulp total crude extract at different concentrations 1000 mg/kg body weight, 500, 250 and 100 mg/kg body weight; GB- Glibenclamide; DW- distilled water. Source: Authors

For this part of the study, following the administrations of the aqueous extracts of *C. Schweinfurthii* to Wistar albino rats, a similar trend in blood glucose levels reductions was observed similar to that of the aqueous and total crude extracts (Figure 1C and 1D). Though however, a slight higher effect in reducing the blood glucose levels were observed especially with 1000 mg/kg bwt dose of aqueous pulp extract at 180 min though

the trend was still above the curves (Figure 1D).

Following the administrations of the total crude pulp extracts to oral glucose load fed Wistar albino rats, a similar trend was observed in the previous extracts' treatment groups (figure 1B, 1C and 1D). However, the effects observed as in the blood glucose levels trend was far higher than that of distilled water and Glibenclamide controls suggesting a lower hypoglycemic effect of this

extract dose, (Figure 1B, 1C and 1D).

## DISCUSSION

The hyperglycemia following the glucose load dosing was brought down by the aqueous extract at a dose of 1000 mg/kg, 500, 100, 250 after 90 min (Figure 1C) and again slightly down after 180 min of administration. The positive control Glibenclamide at a dose of 10 mg/kg resulted in a significant reduction in BSL starting from bwt 30 min of glucose load dosing though it was less than the normal control group. These findings were similar to findings of a study done by (Kouambou et al., 2007), that revealed that *C. schweinfurthii* stem barks possess anti-diabetic properties and can be useful for the management of diabetes mellitus type 2, (Kouambou et al., 2007). Study results were in agreement with the findings of (Dimo et al., 2007), which investigated the *C. schweinfurthii* use in Africa for the treatment of various ailments, including diabetes mellitus type 2. But they used stem bark which is different from fruit pulp and leaves which were used, in the study. The observed effects could probably be due presence of the phytochemical compound in the stem bark have higher hypoglycemic activity as compared to the other parts such as pulp and leaves.

In the current study, the reduction in BSL in the oral glucose treated Wistar rats with *C. schweinfurthii*, extract (Table 1, Figure 1C and 1D) did not show significant differences in the activity of *C. schweinfurthii* on oral glucose induced hyperglycemic Wistar rats. The pulp aqueous bwt 1000mg/kg was the most active extract concentration; since it recorded the lowest decline of BSL to 4.30 mg/kg body weight, compared to all treated groups but still above both distilled water and glibenclamide. The findings show hypoglycemic activity of the extract after dosing of the animals. Therefore, knowing the most effective solvent extract and isolating the active fraction from the most effective extract would be useful in the development of new drugs from plants (Jarald et al., 2009). Another study done in Nigeria showed that *C. schweinfurthii* fruit pulp was safer for use in long-term use management of diabetes mellitus type 2. while *C. schweinfurthii* fruit oil maybe considered for use for a short period to handle diabetes mellitus type 2. Probably if the extracts are used for a bit longer time and hence, it can provide a beneficial effects in the management of diabetes mellitus type 2 will actually cause higher hypoglycemia (Figure 1C) (MacDonald et al., 2016). The most common herbal active ingredients responsible for the observed hypoglycemic effects include flavonoids, tannins, phenolic, and alkaloids (Mamun-or-Rashid et al., 2014). The existence of these compounds indicates the significance of the anti-diabetic properties of these plants. For example, tannin enhances the function of pancreatic Beta-cells and increases insulin

secretion of the pancreas (Gupta et al., 2012). The observed hypoglycemic effects of the extracts could be due to the active compounds that could be enhancing the insulin secretions from the beta cells of the pancreas or working on the insulin receptors as well as increasing glucose uptake and thus leading to the observed hypoglycemia. The study showed that the extracts had hypoglycemic effect lower than that of distilled water and Glibenclamide controls (Figure 1D). The present findings has provided evidence on. *C. schweinfurthii* is one of medicinal plants commonly used in the treatment of diabetes mellitus type 2 within Communities in Uganda and globally. It has been used as food and utilized in the management of hyperglycemia in diabetes mellitus type 2 and a number of condition (Tugume et al., 2019). It has a variety of other nutritional and medicinal properties that are attributed to the various phytochemical compounds present in the plant.

## Conclusion

Findings showed that both the pulp and leaf extract, of *C. schweinfurthii* have hypoglycemic activity in wistar albino rats. Though the total crude extract seems to have higher hypoglycemic activity. The findings concur with what is claimed by the communities and herbalists. Long term effects of the extracts may need to be investigated since it could be the reason for its use by local communities and herbalists in the management of DM type 2.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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