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Full Length Research Paper

Comparative effects of some medicinal plants on blood glucose concentration and lipid levels in alloxan-induced diabetic rats

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The comparative effects of the chloroform extracts of the leaves of *Psidium guajava* (Myrtaceae), *Anacardium occidentale* (Anacardiaceae) and *Eucalyptus globulus* (Myrtaceae) and fruits of *Xylopia aethiopica* (Annonaceae) on blood glucose concentration and lipid levels of diabetic rats were investigated using standard methods. The results show 74, 82 and 83% reductions in the blood glucose concentrations upon the administration of *A. occidentale* (100 mg/kg body weight), *E. globulus* (100 mg/kg body weight) and *X. aethiopica* (250 mg/kg body weight) extracts respectively as from the 10th hour of treatments in relation to the 74 and 69% reductions in glibenclamide and diabetic untreated groups respectively while the synergic treatment group [*A. occidentale* + *E. globulus* (100 mg/kg body weight)] showed 83% decrease in the blood glucose concentration as from the 10th hour upon the administration of the combined extracts when compared with the values obtained for the glibenclamide and diabetic untreated groups. *P. guajava* extract had the greatest significant ($p<0.05$) reduction in the total cholesterol concentration of the treated rats. *P. guajava* + *X. aethiopica* treatment group in a similar manner showed the most significant ($p<0.05$) decrease in the triglyceride concentration of the treated rats. Hence, the individual performances of these extracts on blood glucose concentration and blood lipids confirm their ability to reduce blood glucose and diabetic complications.

Key words: Chloroform extract, *Psidium guajava* (Myrtaceae), *Anacardium occidentale* (Anacardiaceae), *Eucalyptus globulus* (Myrtaceae), *Xylopia aethiopica* (Annonaceae).

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder of carbohydrate, proteins and fats occurring in the endocrine system (Jarald et al., 2008) as a result of absolute or relative deficiency of insulin secretion as in the case of type 1 diabetes mellitus or with/without varying degree of insulin resistance (Devlin, 2006) as in the case of type 2 diabetes mellitus. This disorder is characterized by hyperglycemia, producing typical symptoms such as polyuria (frequent urination), polydipsia (increased thirst) and polyphagia (increased hunger). When diabetes is not properly treated or controlled, it causes persistent hyperglycemia that culminates in chronic complications for example, microvascular complications (atherosclerosis, myocardial infection and stroke). Other complications are: diabetic ketoacidosis, non ketotic hyperosmolar coma amongst others (Merlin et al., 2005).

Atherosclerosis is a disease of the arteries, characterized by a gradual accumulation of cholesterol, cholesterol esters, collagen, elastic fibers and proteoglycans in the arterial wall. This accumulation of cholesterol and its

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esters is caused by the increased production of this metabolite, an associated condition of hyperlipidemia. Hyperlipidemia occurs upon a diabetic state as a result of resistance to the action of lipolytic hormone on fat deposits leading to an elevated mobilization of fatty acids from the peripheral deposits where insulin inhibits the hormone-sensitive lipase (Murray et al., 2000).

It is reported that diabetes mellitus (DM) is rapidly becoming a pandemic with population growth, aging, urbanization, increasing prevalence of obesity and physical inactivity as factors influencing the rise in the population diabetics (Wild et al., 2004). On the other hand, the drugs currently used in the management of diabetes mellitus especially type 2 are plagued with several limitations that include resistances, adverse effects, lack of responsiveness in large population of diabetics, liver toxicity, worsening of heart diseases, hypoglycemia and weight gain to mention but a few (Michael et al., 2005). In addition, most of these therapeutic agents have not effectively controlled hyperlipidemia, an associated condition of diabetes mellitus (Derek, 2011). These drawbacks coupled with the high prevalence of diabetes amongst rural population globally has reveille for the development of safe indigenous inexpensive botanical sources for antidiabetic (crude or purified) drugs (Venkatesh et al., 2003). Botanical sources are materials for plant- based drugs/agents that have been employed in treating various diseases for several years (Mushtaq et al., 2009). The present study was undertaken to investigate the comparative effects of the chloroform extracts of the leaves of *Psidium guajava, Anacardium occidentale and Eucalyptus globulus* and fruits of *Xylopia aethiopica* on blood glucose concentration and lipid levels of diabetic rats.

MATERIALS AND METHODS

The plant samples

The leaves of *A. occidentale*, *E. globulus* and *P. guajava* were collected from the premises of University of Nigeria, Nsukka while the fruits of *X. aethiopica* were purchased from a local market in Delta State. The plant samples were identified by Prof. (Mrs.) May Nwosu of the Department of Botany, University of Nigeria, Nsukka, Enugu State, Nigeria; where the voucher specimens were deposited in the herbarium.

Preparation of the crude extract

The leaves of *A. occidentale, E. globulus, P. guajava* and fruits of *X. aethiopica* were air dried to constant weight at room temperature and then reduced to powder. Six hundred grams of each plant material was macerated in 2.7 l of analytical grade chloroform. After 48 h, the resulting extracts were filtered and concentrated with rotary evaporator at reduced pressure and the yield of extracts calculated. A standard weight 8 g of each extracts was dissolved in 16 ml of 10% dimethyl sulphuroxide (DMSO). The doses of each extracts administered was estimated by the methods of Tedong et al. (2007), where volumes given were calculated as follows:

$$V\ (ml) = \frac{D \times P}{C}$$

Where, D, dose used (g/kg body weight of test animals); P, body weight (kg); C, concentration (g/ml); V, volume (ml).

Animals

Seventy five (75) male Wistar albino rats of weight (180 -230 g) and 128 male mice of weight (20-30 g) were used for this study. They were housed and maintained at a 12 h light and dark cycle and fed with rat diet *ad libitum*. The mice were used for acute oral toxicity study while the rats were made diabetic by a single dose of 180 mg/kg body weight of alloxan monohydrate intraperitonially.

Acute oral toxicity test (LD_{50})

A lethal dose toxicity study of each plant material was carried out by the method described by Lorke (1983).

Measurement of plasma glucose concentrations

Monitoring of blood glucose concentrations was carried out by life scan ultra one touch ultra-mini 2 glucose meter using blood samples from pricked tails of rats.

Determination of blood lipids

Determination of cholesterol concentration was done according to the methods of Abell et al. (1952) and Richmond (1973) while that of triglyceride level was by the methods of Tietz (1990) and Jacobs and VanDemark (1960).

Statistical analysis

Data generated from this study were represented as mean ± SEM. Variables were analyzed by one-way analysis of variance (ANOVA) and comparison done by multiple comparisons using Duncan test.

RESULTS

Effects of the various plant extracts on blood glucose concentration at different time intervals

As shown in Figure 1, reductions in blood glucose concentration were recorded after 10 h of establishment of diabetes and treatment with the various plant extracts. Fourteen percent (14%) decrease in blood glucose was observed up to the fortieth hour in the group treated with 100 mg/kg body weight of *A. occidentale* when compared with diabetic untreated group while the group administered 250 mg/kg of the same extract had 70% reduction in blood glucose concentration at the 10th to 40th hour. The group administered 100 mg/kg of *E. globulus* showed 82% decline in blood glucose concentration at the 10th to 40th hour when compared with the 74 and 6.9% recorded for glibenclamide and diabetic untreated groups, respectively. 60% decrease in blood glucose was observed in the group administered 250 mg/kg of the same extract. *P. guajava* extract (100 mg/kg) showed 50% reduction in blood glucose from the tenth to fortieth hour when compared with the values obtained for glibenclamide and

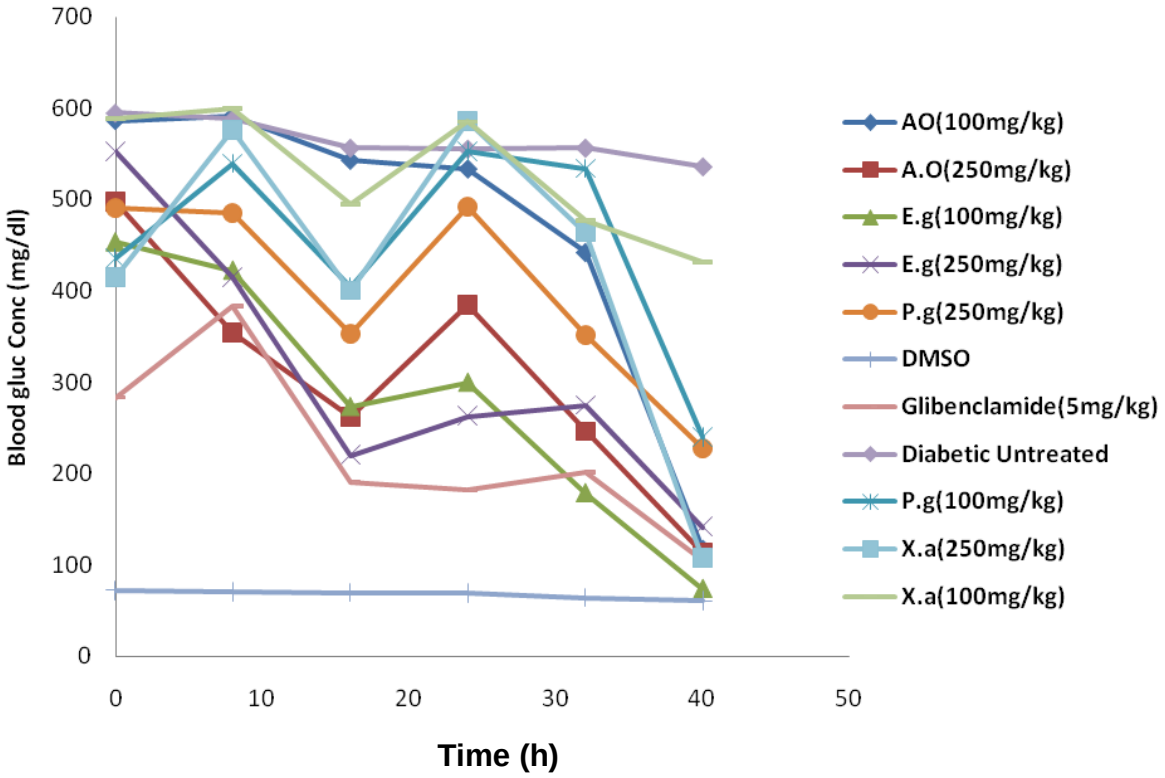

Figure 1. Effects of the various plant extracts on blood glucose concentration at different time intervals.

diabetic untreated groups at the said time interval. However, the group administered 250 mg/kg of the same extract had 50% fall in blood glucose concentration relative to those of glibenclamide and diabetic untreated groups. Blood glucose concentration was reduced by 23% in the group given 100 mg/kg of *X. aethiopica* from the 10th to 40th hour while an effective decrease in blood glucose concentration up to 82% occurred in the group administered 250 mg/kg of the same extract as from the 10th to 40th hour when compared with the values obtained for glibenclamide and diabetic untreated groups. The glibenclamide-treated group exhibited only 74% decline in blood glucose concentration at the tenth to fortieth hour of treatment in relation to the 74% for *A. occidentale* (100 and 250 mg/kg), 82 and 62% for *E. globulus* (100 and 250 mg/kg respectively) and 23 and 82% for *X. aethiopica* (100 and 250 mg/kg, respectively).

Effects of the combined plant extracts on blood glucose concentration at different time intervals

Figure 2 shows that 83% decline in blood glucose was observed in the group administered 100 mg/kg of *A. occidentale* + *E. globules* while 79% reduction occurred in the group administered 250 mg/kg of the same combined extracts when compared with the 74 and 6.9% obtained for glibenclamide and diabetic untreated groups, respectively, from the tenth to the fortieth hour. 66% reduction was observed in the group administered 100 mg/kg of *P. guajava* + *X. aethiopica* when compared with the values recorded for glibenclamide and diabetic untreated groups while 58% decrease was observed in the group given 250 mg/kg of the same combined extracts when compared with the values obtained for glibenclamide and diabetic untreated groups from the tenth to the fortieth hour.

Effects of varying doses of the different plant extracts on total cholesterol concentration

As shown in Figure 3, there were significant ($p<0.05$) differences between the total cholesterol concentration of group 1 and those of groups 4, 5, 6, 7, 9, 10, 11, 12, 13 and 14 whereas there were no significant ($p>0.05$) differences between that for group 1 and those of groups 2, 3, 8 and 13. The administration of 250 mg/kg of *A. occidentale* extract caused significant ($p<0.05$) decrease in total cholesterol concentration relative to that of the diabetic untreated group. The total cholesterol concentrations of other test groups were however, not significantly ($p>0.05$) different from that of the 250 mg/kg of *A. occidentale* group. Group 3 was found to be significantly ($p<0.05$) different from groups 4, 5, 6, 7, 9, 10, 11, 12, 13 and 14. No significant ($p>0.05$) difference occurred between group 3 and groups 1, 2, 8 and 15.

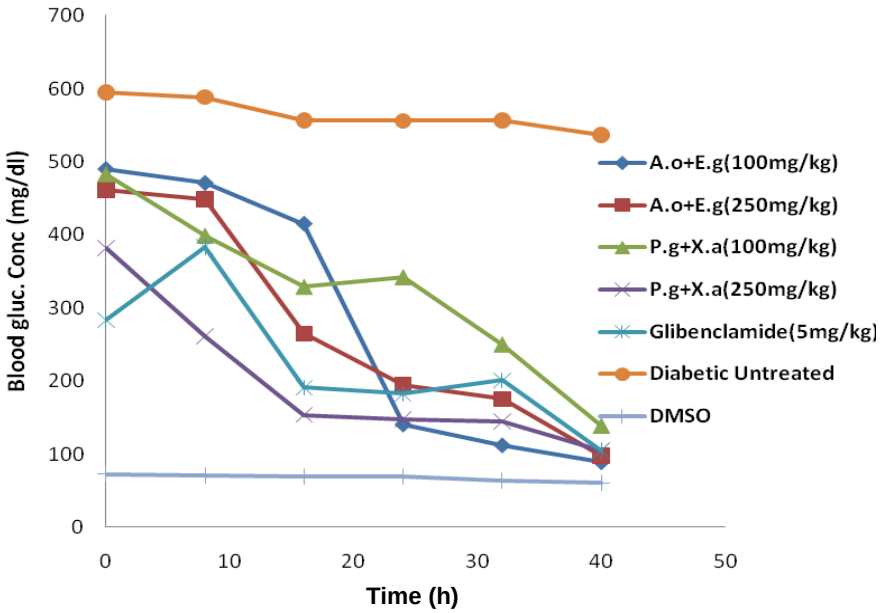

Figure 2. Effects of the combined plant extracts on blood glucose concentration at different time intervals.

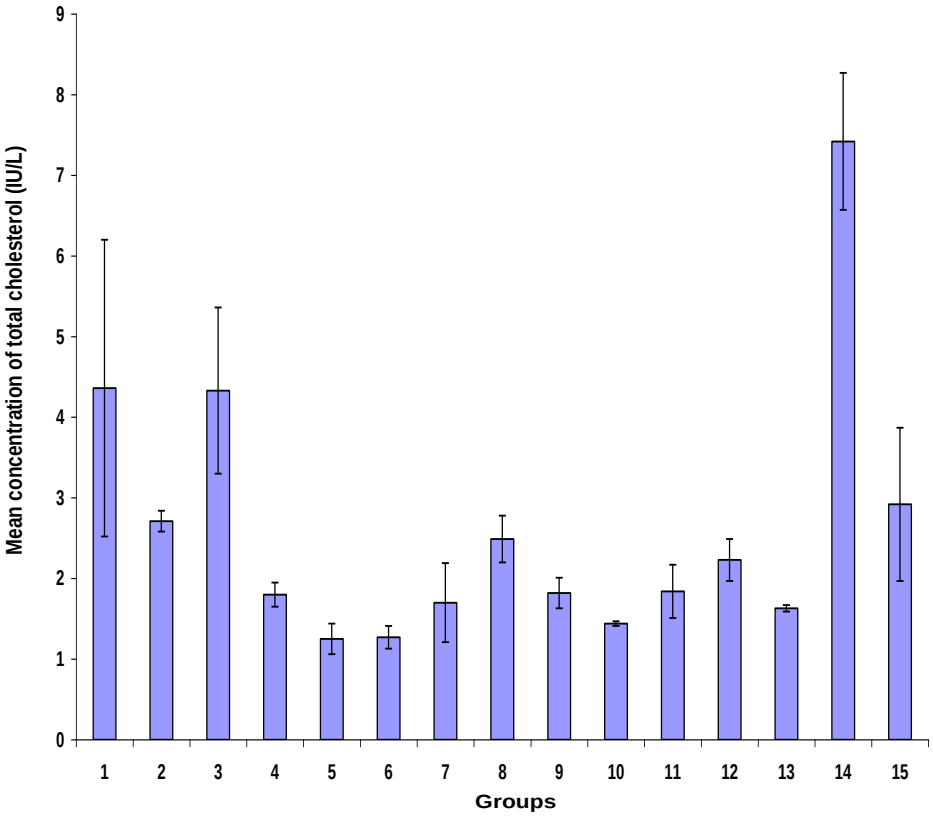

Figure 3. Group 1=*Anacardium occidentale* (100 mg/kg); Group 2=*Anacardium occidentale* (250 mg/kg); Group 3=*Eucalyptus globulus* (100 mg/kg); Group 4=*Eucalyptus globulus* (250 mg/kg); Group 5=*Psidium guajava* (100mg/kg); Group 6=*Psidium guajava* (250 mg/kg); Group 7=*Xylopia aethiopica* (100 mg/kg); Group 8=*Xylopia aethiopica* (250 mg/kg); Group 9=*A. occidentale* + *E. globulus* (100 mg/kg); Group 10= *A. occidentale* + *E. globulus* (250 mg/kg) ; Group 11= *P. guajava* + *X. aethiopica* (100 mg/kg); Group 12 = *P. guajava* + *X. aethiopica* (250 mg/kg); Group 13 = Glibenclamide (5 mg/kg); Group 14 = Diabetic Untreated; Group 15 = DMSO Control.

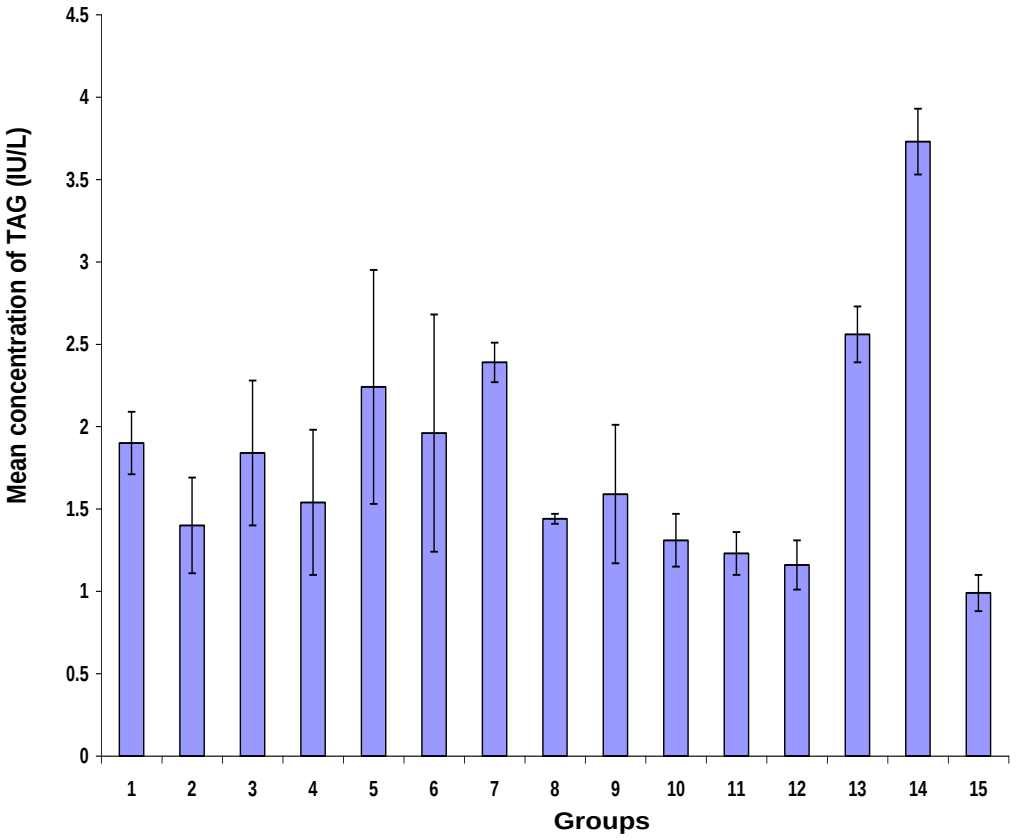

Figure 4. Group 1=*Anacardium occidentale* (100mg/kg); Group 2= *Anacardium occidentale* (250mg/kg); Group 3=*Eucalyptus globulus* (100mg/kg); Group 4=*Eucalyptus globulus* (250mg/kg); Group 5=*Psidium guajava* (100mg/kg); Group 6=*Psidium guajava* (250mg/kg); Group 7=*Xylopia aethiopica* (100mg/kg); Group 8=*Xylopia aethiopica* (250mg/kg); Group 9= *A. occidentale* + *E. globulus* (100mg/kg); Group 10= *A. occidentale* + *E. globulus* (250mg/kg) ; Group 11= *P. guajava* + *X. aethiopica* (100mg/kg); Group 12 = *P. guajava* + *X. aethiopica* (250mg/kg); Group 13 = Glibenclamide (5mg/kg); Group 14 = Diabetic Untreated; Group 15 = DMSO Control.

Effects of varying doses of the different plant extracts on triglyceride concentration

Figure 4 shows that the diabetic untreated group had the highest triglyceride value. Other groups apart from the DMSO, upon the administration of the extracts (especially 250 mg/kg) had decreases in the triglyceride concentrations. There was significant ($p<0.05$) difference between the triglyceride concentration of the 100 mg/kg of *A. occidentale* group and that of the diabetic untreated group. However, there were no significant ($p>0.05$) differences between the triglyceride concentrations of *A. occidentale* (250 mg/kg) group, *E. globulus* (100 and 250 mg/kg) groups, *P. guajava* (100 and 250 mg/kg) groups, *X. aethiopica* (100 and 250 mg/kg) groups, *A. occidentale* + *X*. *aethiopica* (100 and 250 mg/kg) groups and glibenclamide group and that of the diabetic untreated group. Triglyceride concentration was significantly ($p<0.05$) reduced in group 4 when compared with those of groups 7, 13 and 14 whereas there were no significant ($p>0.05$) differences between the triglyceride concentrations of groups 1, 2, 5, 6, 8, 10, 11, 12 and 15 and that of group 4.

DISCUSSION

Results on the performances of the various extract on blood glucose concentration indicate that *A. occidentale* and *E. globulus* extracts effectively decreased blood glucose concentration upon their administration. This finding is in concert with the investigations of Kamtchouing et al. (1998) and Sokeng et al. (2001) who reported the hypoglycemic effect of *A. occidentale* aqueous leaf extract in streptozotocin-induced diabetic rats. Also, Tedong et al. (2007) showed that the hexane extract of *A. occidentale* significantly ($p<0.05$) decreased blood glucose concentration in diabetic rats. In addition, oral administration of *E. globulus* leaf extract to diabetic rats led to significant ($p<0.05$) reduction in the blood glucose concentration and restored liver glycogen to a high concentration (Soussi et al., 2009). The antihyperglycemic properties demonstrated by these plants in the present study may be attributed to the enhancement of glucose absorption by peripheral tissues.

Figures 3 and 4 indicate that the concentrations of total cholesterol and triglycerides of the diabetic rats were sig-

nificantly ($p<0.05$) increased when compared with those of the DMSO control group. However, administration/ treatment of the various plant extracts reversed these biochemical parameters. This study shows that there were greater reductions in the total cholesterol concentrations of the groups treated with *P. guajava* (100 and 250 mg/kg) when compared with that of the glibenclamide group. The overall performance of *P. guajava* in the reductions of blood lipids correlates with the findings of Deguchi and Miyazaki (2010) who reported that a single dose ingestion of *P. guajava* leaf tea for eight weeks resulted in decreases of serum concentrations of total cholesterol and triglycerides in hypercholesterolemia and hypertriglyceridemia subjects.

In conclusion, results of this study show that the chloroform extracts of the leaves of *P. guajava, A. occidentale and E. globulus* and fruits of *X. aethiopica* exhibited remarkable effects in restoring blood glucose concentration to normal and ameliorating diabetic complications.

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