Research on the hypoglycemic effects of Desugan liquid extract on experimental animals

Nguyen Thi Minh Thu[1], **Trinh Thi Ha**[1]
Tran Van Thanh[1], **Bui Quang Tinh**[2]
[1] Vietnam University of Traditional Medicine
[2] Institute for Elderly Health and Public Health

SUMMARY

Objective: *To test the hypoglycemic effects of Desugan liquid extract in experiments.*

Subjects and methods: *The hypoglycemic effects of Desugan were evaluated in two experimental models including rats given 10.5 g/kg glucose orally and mice induced with type 1 diabetes by intraperitoneal injection of STZ at a dose of 100 mg/kg/day x 8 days.*

Results: *After 14 days of Desugan oral administration at doses of 3.15 and 9.45 g/kg/day, rats' blood glucose levels were significantly lower than those in the control group (p<0.001) with the reduction rates after 1, 2, and 4 hours of glucose administration being 28.11%, 28.76%, and 23.22% (group 3) and 32.96%, 31.81%, and 25.42% (group 4), respectively. Furthermore, with similar oral administration intervals, Desugan at doses of 5.4 and 16.2 g/kg/day remarkablly reduced blood glucose levels in mice compared with that of the control group (p<0.001) with respective reduction rates after 2 and 4 hours of sample administration being 40.38 and 51.26% (group 3) and 53.32 and 52.65% (group 4).*

Conclusion: *Desugan had high effectiveness in reducing blood glucose levels in rats (given oral glucose) at doses of 5.15 and 9.45 g/kg/day × 14 days and in STZ-induced type 1 diabetic miceat doses of 5.4 and 16.2 g/kg/day × 14 days.*

Key words: *Desugan liquid extracts, blood glucose levels, glucose tolerrance, streptozotocin.*

INTRODUCTION

Diabetes is a chronic disease and requires lifelong treatment, so the choice of drugs and treatment methods is very important. Biguanide, sulfonylure, thiazolindinedione or insulin are all effective medicines, but they often cause a number of unwanted side effects or cause drug tolerance when used for a long time [1]. Therefore, the development of herbal diabetes drugs to limit adverse effects but still have effective treatment is increasingly interested.

Many medicinal herbs have shown good hypoglycemic effects like *Gynostemma pentaphyllum*, *Rehmannia glutinosa*, *Ophiopogon japonicus*, etc. The questions are when combining these herbs, what will be their effectiveness and adverse drug rections.

Desugan liquid extract is a combination including *Herba Gymnemae sylvestre*, *Herba Gynostemmae, Folium Steviae rebaudianae, Herba Lactucae indicae* and *Flos Lonicerae*. To date, several studies have evaluated the hypoglycemic effects of the above medicinal herbs when used separately, such as studies on *Gymnema sylvestre* (2008) [2], *Lactuca indica* (2020) [3], *Gynostemma pentaphyllum* (2022) [4], *Stevia rebaudiana* leaves extract (2023) [5].

Corresponding author: Nguyen Thi Minh Thu
Phone number: (+84) 912750167
E-mail: minhthunimpe@gmail.com
DOI: https://doi.org/10.60117/vjmap.v60iĐặc biệt 02.376

Received: 17/02/2025
Reviewed: 24/3/2025
Accepted: 08/4/2025

No studies have evaluated the hypoglycemic effects of combinations including medicinal herbs like Desugan. Thus, we conducted two tests on the hypoglycemic abilities of Desugan with the aim of developing herbal medicines and contributing to solving the above problem.

MATERIALS AND METHODS

Sample

Desugan liquid extract was produced by Tue Tinh Institute for Research on Traditional Medicine meeting basic standards. Each 100 ml of Desugan contained 75 g of total dry medicinal herbs.

Ingredients of 100 ml of Desugan

Ingredients	Contents (g)
Herba Gymnemae sylvestre	12
Herba Gynostemmae	12
Folium Steviae rebaudianae	9
Herba Lactucae indicae	24
Flos Lonicerae	18
Citric acid	0.08
Glycerine	0.5
Isomalt	1.0
Sodium Carboxymethyl Cellulose	0.07
Sodium hydroxide, Anhydrous	0.556
Nipagin	0.2
Propylene glycol	2.0
Pure water	Just enough for 100 ml

Desugan is intended for oral use in humans at a dose of 15 ml/time × 2 times/day.

Experimental animals

A total of 40 Wistar rats and 40 mice were selected for the study, meeting the criteria of both breeds (test 1) and males only (test 2), being mature, healthy, and weighing 180-220 g and 22-25 g, respectively. All animals were kept under experimental conditions for 3-5 days before carrying out the study.

Appliances

Blunt-tipped curved needles, a Precisa XB 320C digital scale with 0.1 mg accuracy, On-Call Plus portable blood glucose meters (Acon Laboratories, USA), an Aquasearcher pH meter (USA), one-ml syringes (divided into 100 divisions), glass beakers with divisions of 50, 100, 250 ml and graduated cylinders of 10, 50 ml.

Chemicals

Double distilled water, blood glucose test strips (ACON Biotech, Hangzhou), 0.9% sodium chloride solution, pure citric acid monohydrate (lot P9H30210, Biobasic, Canada), pure TriSodium citrate dihydrate (lot O4220010, Biobasic, Canada), streptozotocin (Macklin, China) with a purity of 98%, insulin (Levemir Flexpen 100 U/ml, Denmark), acarbose (Dorobay 100 mg tablets, Domesco JSC, lot 00322, exp. 07/11/2025), glucose powder (Auvina, exp. 01/8/2027).

Time and location

This study was conducted between January and March 2025 at Vietnam University of Traditional Medicine.

Method

Glucose tolerance test:

The experiment was conducted according to Miura's method in Wistar rats [6]. All rats were coded with numbers, so researchers did not know which group the rats were in to limit errors. Next, rats were randomly divided into 4 groups with 10 rats each and the same male/female ratio in each one. Then, they fasted for 18 hours before being taken their tail vein blood samples for glucose concentration testing (D0).

- Group 1 (Biological proof): Rats were given distilled water with a volume of 10 mL/kg.

- Group 2 (Acarbose): Rats were given Acarbose at a dose of 21 mg/kg/day.

- Group 3 (Desugan): Rats were taken Desugan at a dose of 3.15 g/kg/day.

- Group 4 (Desugan): Rats were drunk Desugan at a dose of 9.45 g/kg/day.

Rats were drunk Desugan or the reference drug once a day × 14 consecutive days. On day 14, after taking Desugan or acarbose for 30 minutes, the rats were orally given glucose at a dose of 10.5 g/kg. Finally, rats' blood glucose tests were performed at 1, 2 and 4 hours after glucose administration.

Test on STZ-induced type 1 diabetic mice:

The test was conducted according to the method described by Miura et al [6]. Mice weighing 22-25 g were fed a normal diet and fasted overnight. The next morning, immediately before STZ administration, blood samples were drawn from mice's tail veins to test their glucose levels. Then, mice were injected intraperitoneally with STZ (dissolved in citrate buffer, pH 4.5) at a dose of 100 mg/kg/day for 8 consecutive days. STZ was prepared immediately before injection. On day 9, mice's blood glucose levels were determined and only mice with glucose level indices ≥ 300 mg/dl (16.7 mM/L, considered to be type 1 diabetic mice) were selected for the study. Then, the mice were divided into 4 groups as follows:

- Group 1, control: Mice were given distilled water with a volume of 0.1 ml/10 g.

- Group 2: Mice were injected intraperitoneally with insulin at a dose of 0.7 U/kg/day.

- Group 3: Mice were taken Desugan at a dose of 5.4 g/kg/day

- Group 4: Mice were taken Desugan at a dose of 16.2 g/kg/day.

The mice were given control medicine or test samples continuously for 14 days. On day 15 and day 22 (7 and 14 days after taking the medicine, respectively), mice's blood samples were taken to determine glucose levels at 2 and 4 hours after medicine administration.

Evaluation criteria:

Blood glucose concentrations of rats and mice (mM/L) were determined just before the test, on day 7 and day 14 after medicine administration.

The percentage of blood glucose concentration reduction was calculated according to the formula:

$$A\% = (Cc - Ct)/Cc \times 100$$

In which, A% was the percentage of blood glucose concentration reduction of the group given the test sample while Cc and Ct were the blood glucose concentration of the control group and test groups, respectively.

Data processing

Data was processed by Excel program (Microsoft XP) according to the method of medical statistics, using Student's t-test and Fisher's exact test to compare the data before and after the test. Also, those data were compared among the control and treated groups. The difference was statistically significant when $p<0.05$.

Research ethics

The study complied with ethical regulations in biomedical research. Animals were handled properly after the end of the experiment.

RESULTS

Glucose tolerance test

On day 14 (D14), after 1, 2 and 4 hours of glucose administration, blood glucose concentrations of rats given Desugan were notably reduced compared with that of the control group (p<0.001).

Table 1. Effect of Desugan on rats' blood glucose levels at D14

Group (n = 10)	Rats' blood glucose levels (mmol/L, Mean ± SD)				$p_{(D0)-(D14.i)}$
	D0	D14, after glucose ingestion			
		1 hour	2 hours	4 hours	
Group 1 (Biological proof)	6.63 ± 0,87	9.89 ± 0.66	9.18 ± 0.62	7.75 ± 0.47	< 0.001
Group 2: oral Acarbose 21 mg/kg/day	6.59 ± 0.82	5.41 ± 0.77**	5.03 ±0,71**	4.45±0.83***	** < 0.01 *** < 0.001
Group 3: oral Desugan 3.15 g/kg/day	6.53 ± 0,50	7.11 ± 0,89	6.54 ± 1.13	5.95 ± 0.77	> 0.05
Group 4: oral Desugan 9.45 g/kg/day	6.52 ± 1.01	6.63 ± 1.27	6.26 ± 1.61	5.78 ± 1.57	> 0.05
$p_{(1)-(2)}$, $p_{(1)-(3)}$, $p_{(1)-(4)}$		< 0.001	< 0.001	< 0.001	
$p_{(2)-(3)}$, $p_{(2)-(4)}$		< 0.05	< 0.05	< 0.05	
$p_{(3)-(4)}$		> 0.05	> 0.05	> 0.05	

(< 0.05, **< 0.01, ***< 0.001)*

On D14, after 1, 2, 4 hours of being drunk glucose, rats' blood glucose concentrations in the control group increased significantly compared with that on D0 (p<0.001) while blood glucose levels of rats in group 2 (given Acarbose 21 mg/kg/day) decreased gradually over time and were statistically lower than that on D0 (p<0.01 and < 0.001). Moreover, rats in both groups being given Desugan had blood glucose concentrations that tended to decrease but were not statistically different from that on D0 (p>0.05). Nevertheless, rats' blood glucose levels in all three groups of Acarbose and Desugan were statistically lower than that of the control group (p<0.001). Blood glucose concentrations of rats in the Acarbose group decreased remarkably than the two Desugan groups (p<0.05). At both Desugan dose regimens of 3.15 and 9.45 g/kg/day, rats' blood glucose concentrations at 1, 2 and 4 hours after glucose administration were not statistically different (p>0.05).

Table 2. Effects of Desugan on the reduction rates of rats' blood sugar levels

Group (n = 10)	Rates of reduction (%) in rats' blood glucose levels after oral glucose administration		
	1 hour	2 hours	4 hours
Group 1 (Biological proof)	-	-	-
Group 2: oral Acarbose 21 mg/kg/day	45.30	45.21	42.58
Group 3: oral Desugan 3.15 g/kg/day	28.11	28.76	23.22
Group 4: oral Desugan 9.45 g/kg/day	32.96	31.81	25.42

Acarbose reduced rats' blood glucose concentrations significantly more than that of rats being taken Desugan at both doses of 3.15 and 9.45 g/kg/day × 14 days ($p<0.05$). At the dose of 9.45 g/kg/day, Desugan tended to reduce rats' blood glucose levels better than that of the ones with dose of 3.15 g/kg/day, however the difference was not statistically significant ($p>0.05$).

Test on STZ-induced type 1 diabetic mice

Mice's blood sugar levels in the groups receiving gliclazide and Desugan were statistically lower than the values of ones in the control group at each study time point.

Table 3. Effects of Desugan on blood glucose levels of STZ-induced type 1 diabetic mice

Group (n = 10)	Mice's blood glucose levels (mmol/L, average ± SD)						$p_{(D0)-(Di.j)}$
	D0	D8	D15.2hrs	D15.4hrs	D22.2hrs	D22.4hrs	
Group 1 (Biological proof)	6.22 ± 0.40	18.05 ± 1.12	19.26 ± 0.92	27.21 ± 2.71	30.31 ± 0.68	25.85 ± 3.69	< 0.001
Group 2: insulin 0.7 U/kg/day	6.11 ± 0.55	18.06 ± 0.92	18.11 ± 2.37	19.86 ± 3.49	13.96 ± 4.29	11.46 ± 3.89**	< 0.001 ** < 0.01
Group 3: oral Desugan 5.4 g/kg/day	6.19 ± 0.60	17.47 ± 1.25	18.92 ± 2.42	22.98 ± 5.00	18.07 ± 6.59	12.60 ± 3.99	< 0.001
Group 4: oral Desugan 16.2 g/kg/day	6.15 ± 1.48	17.59 ± 0.94	13.14 ± 3.24***	15.18 ± 5.90	14.15 ± 2.68	12.24 ± 2.96	< 0.001
$p_{(1)-(2)}$, $p_{(1)-(3)}$, $p_{(1)-(4)}$	> 0.05	> 0.05	> 0.05 *** < 0.001	< 0.001	< 0.001	< 0.001	
$p_{(2)-(3)}$	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	
$p_{(2)-(4)}$, $p_{(3)-(4)}$	> 0.05	> 0.05	< 0.01	< 0.05	> 0.05	> 0.05	

(< 0.05, ** < 0.01, *** < 0.001)*

Before the study (D0), the blood glucose concentrations of mice in all groups were not significantly different ($p>0.05$). After 8 days of hyperglycemia induced by STZ, all mice's blood glucose levels increased significantly compared to those of D0 ($p<0.001$) and exceeded the threshold of 300 mg/dL (16.67 mmol/L). Therefore, all mice were selected for further study. The blood glucose concentrations of mice in the control group gradually increased over time and reached the highest threshold (30.31 ± 0.68 mmol/L) on day D22.2hrs, then decreased on day D22.4hrs; however, the blood glucose concentrations were all much higher than that of D0 ($p<0.001$). Mice in groups receiving insulin and Desugan all had blood glucose concentrations that increased gradually over time, reaching the highest level at D15.4hrs, then gradually decreased; nevertheless, the values were significantly higher than those of D0 ($p<0.001$ and < 0.01). On D15, after 2 hours of taking reference drug or test samples, mice's blood glucose levels in groups 2 and 3 tended to decrease compared with that of

the control group, but the difference was not statistically significant (p>0.05). However, mice in the group receiving Desugan of 16.2 g/kg/day had notably lower blood glucose concentrations than that of the remaining groups (p<0.01). Moreover, at D15.4hrs, D22.2hrs and D22.4hrs, blood glucose levels of the reference group and the two groups being taken Desugan were significantly lower than those of the control group (p<0.001). Besides, at D15.2 hrs and 4hrs, blood glucose levels of group 4 were remarkably lower than those of groups 2 and 3 (p<0.01 and < 0.05, respectively).

Table 4. Effect of Desugan on the rates of reduction of mice's blood glucose levels

Group (n = 10)	Rates of reduction (%) in mice's blood glucose levels			
	D15.2hrs	D15.4hrs	D22.2hrs	D22.4hrs
Group 1 (Biological proof)	-	-	-	-
Group 2: insulin 0.7 U/kg/day	5.97	27.01	53.94	55.67
Group 3: oral Desugan 5.4 g/kg/day	1.77	15.55	40.38	51.26
Group 4: oral Desugan 16.2 g/kg/day	31.78	44.21	53.32	52.65

On D15, after 2 and 4 hours of oral administration, Desugan at a dose of 16.2 g/kg/day reduced mice's blood glucose levels better than the dose of 5.4 g/kg/day and insulin 0.7 U/kg/day (p<0.01 and < 0.05). On D22, the blood glucose concentration reduction rates of the referene drug and test groups were not statistically different (p>0.05), although the high-dose Desugan group still tended to reduce the blood glucose rates better than the low-dose one.

DISCUSSION

Oral glucose tolerance test

The test measures the body's response to sugar, also called glucose. It is usually used to test for diabetes mellitus, insulin resistance, impaired pancreatic beta cell function, and sometimes reactive hypoglycemia or acromegaly, or rarer disorders of carbohydrate metabolism. In this study, the control group was used to evaluate the ability to tolerate glucose of rats while the remaining groups were assessed to hypoglycemia after taking glucose of the reference drug (acarbose) and test samples (Desugan). The results revealed that with both tested regimen doses of 3.15 and 9.45 g/kg/day × 14 consecutive days, Desugan extracts had their effects of reducing the statistical significance of rats' blood sugar levels compared with that of the control group after taking glucose 1, 2 and 4 hours (p<0.001). The percentages of decrease in blood sugar levels of rats being taken Desugan were significantly lower than that of the ones drunk acarbose 21 mg/kg/day (p<0.05). In addition, reduction rates in blood sugar concentrations of all three groups 2, 3 and 4 were over 20 % and these are satisfactory levels to evaluate a drug capable of hypoglycemia. This proved that Desugan had its effects of lowering rats' blood sugar levels after a meal that the way acarbose has shown.

Our results are also consistent with the application in traditional medicine of many countries. Accordingly, the medicinal ingredients in Desugan liquid extract have been used separately to treat diabetes and diabetes mellitus [7],[8].

In addition, the above results are also similar

to that of Tran Van On et al. (2018) when evaluating the hypoglycemic effect of Herba Gymnemae sylvestre on normal mice. In which, the leaf extract of Gymnema sylvestre, ratio 1:2, with a dose of 10 g/kg reduced mice's blood sugar rate by 37.58% [2]. Similarly, S. Jamal et al. (2023) evaluated the hypoglycemic potential of Folium Steviae rebaudianae in Wistar rats fed 8 g/kg glucose at time points after 30, 60, 90 and 120 minutes. They found that both ethanolic and aqueous extracts of Stevia leaves (2 g/kg) reduced rats' blood glucose levels by 39.49% and 35.39% after 120 minutes, respectively [5].

Test on STZ-induced type 1 diabetic mice

The present study was undertaken to assess hypoglycemic properties of Desugan in type 1 diabetic mice. The results revealed that Desugan at doses of 5.4 and 16.2 g/kg/day for 14 consecutive days significantly reduced mice's blood glucose concentrations compared to that of the control group ($p<0.001$). On D14, rates of reduction in mice's blood glucose levels after 2 and 4 hours of taking Desugan were 40.38%, 51.26% and 53.32%, 52.65% (respectively), which were not statistically different from the effect of insulin 0.7 U/kg/day ($p>0.05$). The above data demonstrates that Desugan had hypoglycemic effects in the STZ-induced type 1 diabetic mice model.

The above results are also consistent with a number of studies on individual effects of each medicinal ingredient conducted domestically and internationally. In 2014, Tran Thi Oanh et al. evaluated the hypoglycemic effect of DHK extracted from Herba Gymnemae sylvestre on mice induced with diabetes by STZ and found that, with oral doses of 0.72 and 2.16 g/kg, DHK had good hypoglycemic effects after 1, 2 and 3 hours of oral administration [4]. T. Rosanto et al. (2020) when studying mice induced with diabetes by STZ found that Dandelion leaves (ethyl acetate extract) at a dose of 200 mg/kg had a significant hypoglycemic effect on the 9th day [3].

CONCLUSION

The hypoglycemic effects of Desugan were evaluated in glucose-treated rats and STZ-diabetic mice. Desugan at both doses of 3.15 and 9.45 g/kg/day × 14 consecutive days significantly reduced rats' blood glucose levels compared to that of the control group ($p<0.001$) after 1, 2, and 4 hours of glucose administration. Additionally, the percentage reductions in blood glucose levels were 28.11%, 28.76%, and 23.22% (at 3.15 g/kg/day) and 32.96%, 31.81%, and 25.42% (at 9.45 g/kg/day), respectively. The hypoglycemic effects of Desugan's two tested doses in rats were not notably different ($p>0.05$) but were remarkablly lower than those of the reference drug acarbose 21 mg/kg/day × 14 days ($p<0.05$).

Desugan at doses of 5.4 and 16.2 g/kg/day for 14 consecutive days showed good hypoglycemic effects in STZ-induced diabetic mice with their blood glucose levels decreased significantly compared to that of the control group after 2 and 4 hours of sample administration ($p<0.001$). In addition, the blood glucose concentration reduction rates were 40.38 and 51.26% (at a dose of 5.4 g/kg/day) and 53.32 and 52.65% (at a dose of 16.2 g/kg/day), respectively, similar to the values of mice using the reference drug insulin 0.7 U/kg/day ($p>0.05$).

REFERENCES

1. **Hoang Thi Kim Huyen, J.R.B.J. Brouwers.** *Clinical Pharmacy - Basic principles and use of drugs in treatment*, Medical Publishing House, 2014, Vol 2.
2. **Tran Van On, Phung Thanh Huong, Do Anh Vu et al.** Hypoglycemic effects of *Gymnema sylvestre* (Retz.) R. Br. ex Schult) in Vietnam. *Journal of Pharmacy*, 2008.
3. **T. Rosanto, N. Marline, R. Noersal.** Phytochemical Screening and Antidiabetic Activity Test of Extracts and Fractions of Lactuca Indica (L.) In Streptozotocin-Induced Diabetic Mice. *Asian Journal of Pharmaceutical Research and Development*, 2020, 8(3), pp.62-65.
4. **Tran Thi Oanh, Do Thi Nguyet Que.** Study on the hypoglycemic effect and acute toxicity of DKH preparation from *Gymnema latifolium* Wall. ex Wight. in experiments. *Journal of Pharmacy*, 2014, no. 6, vol. 54.
5. **S. Jamal, S. Barua, A. Barua, A. J. M. Morshed, R. Akter and S. Akhter.** Phytochemical Screening and Antihyperglycemic Effects of *Stevia rebaudiana* Leaves Extract on Glucose Loaded Rats. *Oriental Journal of Chemistry*, 2023, No. (1), Vol. 40, pp.74-81.
6. **Institute of Medicinal Materials.** *Methods of studying the pharmacological effects of herbal medicines*, Science and Technology Publishing House, 2006
7. **Ministry of Health.** *Vietnamese Pharmacopoeia V*, Medical Publishing House, 2017.
8. **Do Huy Bich et al.** *Medicinal plants and animals in Vietnam*, Vol 1, Vol 2, Science and Technology Publishing House, 2006.