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Research Article

EVALUATION OF ANTI-DIABETIC ACTIVITY OF ETHANOLIC AND AQUEOUS EXTRACTS OF STEM AND LEAVES OF ALANGIUM SALVIFOLIUM AND PAVONIA ZEYLANICA

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ABSTRACT

Objective: The present study is aimed to evaluate the effect of Ethanolic and Aqueous Extracts of Alangium Salvifolium (EEAS & EEPZ) and Pavonia Zeylanica (AEAS & AEAC) on blood glucose level in normal and alloxan induced diabetic rats.

Methods: Effects of extracts on blood glucose level in Normoglycemic rats, Glucose fed hyperglycemic rats and Alloxan induced diabetic rats were evaluated for various doses of plant extracts for 7 days period.

Results: Oral administration of EEAS, EEPZ, AEAS and AEPZ (400mg and 800mg/kg body weight) results a significant reduction in blood glucose level against alloxan induced diabetic rats.

Conclusion: The result supports the traditional usage of the plants of Alangium Salvifolium and Pavonia Zeylanica by ayurvedic physicians for the treatment of diabetes.

Keywords: Alangium Salvifolium, Pavonia Zeylanica, Alloxan, Diabetes.

INTRODUCTION

Diabetes is one of the major crippling diseases in the world leading to huge economic losses. The persons suffering from this metabolic disease is considered to 'die-a-bit' and hence 'die-a-bit-is' (diabetes). The global prevalence of diabetes is estimated to increase, from 4 percent in 1995 to 5.4 percent by the year 2025. The World Health Organization has predicted that the major burden will occur in developing countries. Studies conducted in India in the last decade have highlighted that not only is the prevalence of diabetes high but also that it is increasing rapidly in urban population [1]. Today more people around the world have diabetes than ever before. The prevalence of Type II diabetes at present is one out of ten in the population. The incidence is about 3 per 1000 population. The Japanese, European and Eskimo populations have a low prevalence of Type II diabetes, while more modernized African and Chinese populations have a higher prevalence. At the end of the scale are the Pima Indians and Polynesian populations who have very high prevalence [2].

In the recent past many hypoglycemic agents are introduced. Still the diabetes and the related complications continue to be a major medical problem not only in developed countries but also in developing countries. Many Indian medicinal plants are reported to be useful in diabetes. However, search for new anti-diabetic drugs continue.

Alangium Salvifolium belongs to the family Alangiaceae. It is commonly known as sage leaved alangium, stone mango, hill sack tree and ancole fruit plant in English, nalla oodaga, oodaga chettu, aankolam and urgu in Telugu. It is a deciduous shrub or tree. It is commonly distributed in most parts of Chittoor district of Andhra Pradesh like Tirupati, Talakona, Chandragiri and Aragonda. The root bark is used for snake bite, cutaneous troubles, anthelmintic, astringent, purgative, diaphoretic and colic. Leaves are used in diabetes and the fruits are used as astringent, tonic and laxative, whereas the seeds are used in hemorrhage. Pavonia Zeylanica belongs to the family Malvaceae. It is commonly known as karubenda, china mutharapulagam, peramuthi and chittimulli in Telugu. It is very commonly distributed in farm fields, wastelands and rare in forest fringers, throughout the Chittoor district of Andhra Pradesh. Whole plant is used as febrifuge and anthelmintic [3].

An extended literature review shows that an Anti-arthritic activity of bark extracts of Alangium Salvifolium Wang [4] and Anti-fertility activity of the stem bark of Alangium Salvifolium Wang in Wistar female rats[5] has been reported. Larvicidal efficacy of medicinal plant extracts against Anopheles Stephensi and Culex quinquefasciatus [6] for Pavonia Zeylanica has been reported. However the stem and leaves of the plants are not scientifically explored for its anti-diabetic activity against alloxan induced diabetic rats. Hence an effort has been made to evaluate the plant extracts for anti-diabetic activity against alloxan induced diabetic rats.

MATERIALS AND METHODS

Collection of Plant Material

The proposed plants material of fresh stem and leaves of Alangium Salvifolium and Pavonia Zeylanica were collected from Tirupati, Chittoor district of Andhra Pradesh, India. The species of the proposed study was identified and authentified by Dr.K.Madhava Chetty, Asst.Professor of Dept.of Botany, Sri Venkateswara University, Tirupati, Andhra Pradesh, India. Voucher specimens were deposited at Dept. of Pharmacognosy for further reference.

Extraction and phytochemical screening

The shade dried powder of the stem and leaves of plants were packed well in Soxhlet apparatus and was subjected to continuous hot extraction with ethanol and distilled water after defatting with hexane until the completion of extraction. The extracts evaporated to dryness and kept in a desiccators till experimentation.

The extracts were subjected to qualitative chemical investigation for the identification of different phytoconstituents like sterols, glycosides, saponins, alkaloids, flavonoids, carbohydrates, tannins and proteins [7,8].

Animals

Male albino mice (20-30gm) were used for the evaluation of analgesic activity and Wistar albino rats (200-250gm) were used to evaluate anti-inflammatory activity. The animals were maintained on the suitable nutritional and environmental conditions throughout the experiment as per the rules and regulations of the Institutional animal ethics committee. Experimental protocols for the pharmacological and toxicity studies were reviewed and approved by the Institutional animal ethical committee (1423/PO/a/11/CPCSEA).

Toxicity Study

An acute toxicity study was performed to determine LD_{50} using different doses of the extracts according to the method described under OECD guidelines [9].

Effect of EEAS & EEPZ and AEAS & AEPZ on Blood Glucose Level in normoglycemic Rats

Animals were divided into ten groups of six rats in each group. In this study, the entire group of animals were fasted over night and administered with respective drugs as per the following dosage schedule. Further the blood glucose levels were determined at 0, 1, 2, 3 and 4 hours, after drug administration [10].

Group I: Normal control animals received 1% NaCMC 2ml/kg b.w. p.o.

Group II: Treated animals received EEAS 400mg/kg b.w. p.o.

Group III: Treated animals received EEAS 800mg/kg b.w. p.o.

Group IV: Treated animals received EEPZ 400mg/kg b.w. p.o.

Group IV: Treated animals received EEPZ 800mg/kg b.w. p.o.

Group VI: Treated animals received AEAS 400mg/kg b.w. p.o.

Group VII: Treated animals received AEAS 800mg/kg b.w. p.o.

Group VIII: Treated animals received AEPZ 400mg/kg b.w. p.o.

Group IX: Treated animals received AEPZ 800mg/kg b.w. p.o.

Group X: Animals received standard drug Glibenclamide 0.5mg/kg body wt. per orally.

Effect of Blood Glucose Levels on Glucose fed Hyperglycemic Rats (Oral Glucose Tolerance Test)

The animals were divided into ten groups of six rats in each group.

Group I: Animals received glucose at a dose of 2gm/kg body wt. per orally.

Group II: Animals received EEAS 400mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group III: Animals received EEAS 800mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group IV: Animals received EEPZ 400mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally. .

Group V: Animals received EEPZ 800mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group VI: Animals received AEAS 400mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group VII: Animals received AEAS 800mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group VIII: Animals received AEPZ 400mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group IX: Animals received AEPZ 800mg/kg body wt. in 1% NaCMC and glucose solution at a dose of 2gm/kg body wt. per orally.

Group-X: Animals received standard drug Glibenclamide 0.5mg/kg body wt. and glucose solution at a dose of 2gm/kg per orally.

In this study, the entire group of animals were fasted and treated with above dosage schedule orally. EEAS, EEPZ, AEAS, AEPZ and glibenclamide were administered half an hour before administration of glucose solution. Blood glucose levels were determined at 0, 1, 2, 3 and 4 hours, after glucose administration [11].

Anti-diabetic activity against Alloxan Induced Diabetic rats

Different groups of rats were used to study the effects of EEAS and EEPZ. The rats were divided into eleven groups each consisting of six rats.

Group I: Normal control animals received 2ml/kg of 1% NaCMC per orally for 15 days.

Group II: Alloxan (150 mg/kg body wt) induced diabetic animals received 1% NaCMC 2 ml/kg body wt. per orally.

Group III: Alloxan (150 mg/kg body wt) induced diabetic animals received EEAS 400 mg/kg in 1% NaCMC per orally.

Group IV: Alloxan (150 mg/kg body wt) induced diabetic animals received EEAS 800 mg/kg in 1% NaCMC per orally.

Group V: Alloxan (150 mg/kg body wt) induced diabetic animals received EEPZ 400 mg/kg in 1% NaCMC per orally.

Group VI: Alloxan (150 mg/kg body wt) induced diabetic animals received EEPZ 800 mg/kg in 1% NaCMC per orally.

Group VII: Alloxan (150 mg/kg body wt) induced diabetic animals received AEAS 400 mg/kg in 1% NaCMC per orally.

Group VIII: Alloxan (150 mg/kg body wt) induced diabetic animals received AEAS 800 mg/kg in 1% NaCMC per orally.

Group IX: Alloxan (150 mg/kg body wt) induced diabetic animals received AEPZ 400 mg/kg in 1% NaCMC per orally.

Group X: Alloxan (150 mg/kg body wt) induced diabetic animals received AEPZ 800 mg/kg in 1% NaCMC per orally.

Group XI: Alloxan (150 mg/kg body wt) induced diabetic animals received Glibenclamide 0.5 mg/kg body wt.

In this study, all the surviving diabetic animals having blood glucose level above 200mg/dl were used. The blood samples were collected from fasted animals prior to the treatment with above dosage schedule and after administration at 0,1,3,5 and 7th day. For glucose determination, blood was obtained by snipping tail with sharp razor. Then the blood glucose levels were determined by using Haemo-Glucotest (20-800R) glucose strips. This method, which permits the measurement of blood glucose levels with minimum injury to rat, was previously validated by comparison with glucose oxidase method [11-13]. Further the effect of EEAS & EEPZ and AEAS & AEPZ on Body Weight of Alloxan Induced Diabetic Rats was recorded on 0 day and day 7.

Statistical analysis

Experimental results were expressed as mean±SEM. Statistical analysis was performed with one way ANOVA followed by Dunnett's test using GraphPad InStat 3.

RESULTS

The preliminary phytochemical studies indicated the presence of alkaloids, flavonoids, terpenoids, glycosides and carbohydrates, etc. In acute toxicity study, the EEAS & EEPZ and AEAS & AEPZ did not produced lethality up to the dose level of 2000mg/kg.

The results of effect of EEAS & EEPZ and AEAS & AEPZ on Blood Glucose Level in Normoglycemic rats were given in table-1. The mean blood glucose level decreased from 92.83 to 76.33mg/dl at dose of EEAS 400mg/kg, 89.17 to 72.50mg/dl at dose of EEAS 800mg/kg, 92.00 to 75.17mg/dl at dose of EEPZ 400mg/kg and 90.00 to 72.16mg/dl at dose of EEPZ 800mg/kg at 3 hrs duration. Whereas the mean blood glucose level decreased from 89.83 to 82.83mg/dl at dose of AEAS 400mg/kg, 90.66 to 77.67mg/dl at dose of AEAS 800mg/kg, 89.17 to 83.16mg/dl at dose of AEPZ 400mg/kg and 92.00 to 75.33mg/dl at dose of AEPZ 800mg/kg at 3 hrs duration. Standard drug shows the decreased blood glucose level from 89.50 to 71.50mg/dl. On comparison, ethanolic extracts shows significant result than aqueous extracts.

Table-2 shows the results of Oral glucose tolerance test for the extracts on glucose fed hyperglycemic rats. The mean blood glucose level decreased from 80.00 to 76.67mg/dl at dose of EEAS 400mg/kg, 81.50 to 74.50mg/dl at dose of EEAS 800mg/kg, 88.17 to 77.00mg/dl at dose of EEPZ 400mg/kg and 90.16 to 74.16mg/dl at dose of EEPZ 800mg/kg. Whereas the mean blood glucose level decreased from 82.16 to 84.50mg/dl at dose of AEAS 400mg/kg, 84.33 to 77.50mg/dl at dose of AEAS 800mg/kg, 86.00 to 82.16mg/dl at dose of AEPZ 400mg/kg and 87.67 to 76.67mg/dl at dose of AEPZ 800mg/kg. Standard drug shows the decreased blood glucose level from 79.50 to 71.66mg/dl. The results of the test clearly shows that, the ethanolic and aqueous extracts show the reduction of blood glucose level significantly when compared with the glucose fed animals.

Table 1: Effect of EEAS & EEPZ and AEAS & AEPZ on Blood Glucose Level in Normoglycemic Rats

Groups		Blood Glucose Level (mg/dL)				
		0 hour	1 hour	2 hours	3 hours	4 hours
I	Normal	90.16±1.08	88.67±1.28	87.16±2.40	85.00±2.32	91.17±2.24
II	EEAS 400mg	92.83±1.83	83.16±1.85	84.50±2.28	76.33±1.89*	91.00±2.08
III	EEAS 800mg	89.17±2.07	83.50±2.04	79.83±1.60*	72.50±1.71**	83.16±1.96*
IV	EEPZ 400mg	92.00±1.41	83.83±1.51	82.66±1.38	75.17±2.53*	90.33±1.38
V	EEPZ 800mg	90.00±1.53	84.66±1.08	78.33±1.41**	72.16±2.43**	82.66±2.03*
VI	AEAS 400mg	89.83±2.07	87.16±2.17	85.00±2.38	82.83±1.83	92.16±1.76
VII	AEAS 800mg	90.66±1.98	87.00±1.53	84.00±1.39	77.67±1.69*	84.00±1.46
VIII	AEPZ 400mg	89.17±1.80	87.50±1.73	87.16±2.27	83.16±1.78	90.83±2.09
IX	AEPZ 800mg	92.00±1.95	89.33±1.80	79.33±1.40*	75.33±1.71**	83.00±1.75*
X	Standard	89.50±2.45	85.50±1.65	77.00±1.73**	71.50±2.04**	80.50±2.81**

Values are expressed as Mean±SEM (n=6). * p<0.05, ** p<0.01. Statistical significant test for comparison was done by ANOVA , followed by Dunnett's test. The blood glucose values of group II to X are compared with group I.

Table 2: Effect of Blood Glucose Levels on Glucose fed Hyperglycemic Rats (Oral Glucose Tolerance Test)

Groups		Blood Glucose Level (mg/dL)				
		0 hour	1 hour	2 hour	3 hours	4 hours
I	Glucose	83.83±1.92	144.83±2.52	113.50±4.14	101.17±3.52	86.00±3.39
II	EEAS 400mg	80.00±1.88	140.00±3.02	125.00±3.18	87.00±3.88*	76.67±2.39*
III	EEAS 800mg	81.50±2.23	150.00±2.34	131.16±4.56*	86.50±3.21*	74.50±1.54**
IV	EEPZ 400mg	88.17±2.56	137.17±3.26	125.67±3.63	88.66±3.13*	77.00±1.24*
V	EEPZ 800mg	90.16±3.58	151.33±3.12	131.33±4.59*	82.17±2.72**	74.16±1.25**
VI	AEAS 400mg	82.16±1.85	144.50±2.67	132.33±3.90*	92.66±3.65	84.50±2.10
VII	AEAS 800mg	84.33±1.52	150.33±2.66	135.00±4.97**	88.17±3.50*	77.50±1.41*
VIII	AEPZ 400mg	86.00±2.30	141.00±2.48	130.17±3.82*	91.16±3.64	82.16±2.24
IX	AEPZ 800mg	87.67±2.52	152.17±3.12	133.83±4.31**	86.33±3.01*	76.67±1.61*
X	Standard	79.50±1.41	154.83±2.57	131.33±3.05*	82.83±3.08**	71.66±2.20**

Values are expressed as Mean±SEM (n=6). * p<0.05, ** p<0.01. Statistical significant test for comparison was done by ANOVA , followed by Dunnett's test. The blood glucose values of group II to X are compared with group I.

Table 3: Effect of EEAS & EEPZ and AEAS & AEPZ on Blood Glucose Level in Alloxan Induced Diabetic Rats

Groups		Blood Glucose Level (mg/dL)				
		0 Day	1st Day	3rd Day	5th Day	7th Day
I	Normal Control	81.66±1.11	81.83±0.94	81.50±0.62	81.67±2.44	81.00±1.29
II	Diabetic Control	205.17±1.72	212.00±3.91	219.83±4.70	236.33±3.71	259.00±3.36
III	EEAS 400mg	205.00±2.08	204.17±2.86	202.16±4.23*	174.00±3.56**	147.83±2.75**
IV	EEAS 800mg	206.33±2.39	203.30±3.24	198.00±4.74**	160.66±4.39**	125.17±3.32**
V	EEPZ 400mg	206.16±2.02	203.83±3.42	199.80±4.31*	162.16±3.60**	130.50±2.64**
VI	EEPZ 800mg	209.00±2.14	202.67±3.59	190.16±4.08**	147.00±3.71**	104.66±2.87**
VII	AEAS 400mg	204.83±1.83	204.00±3.39	202.83±4.16*	192.66±3.27**	172.50±3.31**
VIII	AEAS 800mg	206.67±1.80	204.83±3.22	201.83±3.87*	174.67±4.03**	142.00±3.08**
IX	AEPZ 400mg	207.50±2.20	206.00±3.27	203.50±3.31*	180.83±4.36**	155.16±2.55**
X	AEPZ 800mg	206.83±2.21	203.66±3.40	194.66±3.59**	164.00±4.01**	129.83±2.84**
XI	Standard	208.00±2.70	198.33±3.14*	179.67±3.24**	130.50±4.50**	85.83±2.61**

Values are expressed as Mean±SEM (n=6). * p<0.05, ** p<0.01. Statistical significant test for comparison was done by ANOVA , followed by Dunnett's test. The blood glucose levels of group III to XI are compared with group II.

Effects of EEAS & EEPZ and AEAS & AEPZ on Body Weight of Alloxan Induced Diabetic Rats were given in table-4.

Table 4: Effect of EEAS & EEPZ and AEAS & AEPZ on Body Weight of Alloxan Induced Diabetic Rats

Groups		Body Weight (Gm)	
		Pretreatment (0 Day)	Post treatment (7th Day)
I	Normal Control	214.50±1.94	227.16±4.24
II	Diabetic Control	219.33±3.77	193.67±3.28
III	EEAS 400mg	213.00±2.85	215.33±2.81
IV	EEAS 800mg	209.50±2.51	217.00±3.14
V	EEPZ400mg	216.16±3.07	222.17±3.73
VI	EEPZ 800mg	214.33±2.33	223.83±2.95
VII	AEAS 400mg	215.17±2.28	216.66±2.70
VIII	AEAS 800mg	211.66±2.62	217.50±3.12
IX	AEPZ 400mg	212.16±2.41	215.00±3.42
X	AEPZ 800 mg	212.83±2.60	219.83±2.15
XI	Standard	207.00±1.92	221.50±2.38

Values are expressed as mean±SEM, n=6.

The results of the anti-diabetic activity of EEAS & EEPZ and AEAS & AEPZ against alloxan induced diabetic rats were given in table-3. The results of all the groups were compared with the diabetic control group. The blood glucose level of diabetic animals significantly reduced from 205.00 to 147.83mg/dl at 400mg/kg of EEAS, 206.33 to 125.17mg/dl at 800mg/kg of EEAS, 206.16 to 130.50mg/dl at 400mg/kg of EEPZ and 209.00 to 104.66mg/dl at 800mg/kg of EEPZ. Whereas the blood glucose level of diabetic animals reduced from 204.83 to 172.50mg/dl at 400mg/kg of AEAS, 206.67 to 142.00mg/dl at 800mg/kg of AEAS, 207.50 to 155.16mg/dl at 400mg/kg of AEPZ and 206.93 to 129.83mg/dl at 800mg/kg of AEPZ. The blood glucose level of EEPZ 800mg/kg was comparable with that of the standard drug which shows the significant reduction of blood glucose level from 208.00 to 85.83mg/dl.

DISCUSSION

The plants have been selected based on its traditional uses. The phytochemical and pharmacological studies were performed on the extracts of stem and leaves of Alangium Salvifolium and Pavonia Zeylanica. The ethanolic extracts of both the plants significantly suppresses blood glucose level in Normoglycemic animals, the same effect was not observed with the aqueous extracts of the plants.

The ethanolic extracts also show the significant improvement in Glucose tolerance in glucose fed normal rats. However the effect was less significant when compared to standard drug and more significant when compared with an aqueous extracts.

Alloxan is the most commonly employed agent for the induction of experimental diabetic animal models of human insulin-dependent diabetes mellitus. There is an increasing evidence that alloxan causes diabetes by rapid depletion of β cells, by DNA alkylation and accumulation of cytotoxic free radical that is suggested to result from initial islet inflammation, followed by infiltration of activated macrophages and lymphocyte in the inflammation focus. It leads to a reduction in insulin release, thereby a drastic reduction in plasma insulin concentration leading to stable hyperglycemic state. In this study significant hyperglycemia was achieved after alloxan injection. The studies on antidiabetic activity in alloxanised rats showed significant reduction of blood glucose level. The comparable effect of the extract with glibenclamide may suggest similar mode of action.

Thus the present study supports the traditional folklore and reveals that the stem and leaves of Alangium Salvifolium and Pavonia Zeylanica possess good hypoglycemic and anti-diabetic activity.

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REFERENCES

1. Dixit PP, Londhe JS, Saroj SG, Devasagayam TPA. Antidiabetic and Related Beneficial Properties of Indian Medicinal Plants. Herbal Drugs: A Twenty First Century Prospective. Jaypee Brothers Medical Publishers (P) Ltd: New Delhi; 2006.
2. Lele RD. Clinical Science and Clinical Research. The National Book Depot: Mumbai; 2008.
3. Madhava Chetty K, Sivaji K, Tulasi Rao. Flowering Plants of Chittoor District Andhra Pradeh, India. Student Offset Printers: Tirupati; 2008.
4. Jubie S, Jawahar N, Ruby Koshy, Gowramma B, Murugan V, Suresh B. Anti-arthritic activity of bark extracts of Alangium Salvifolium Wang. Rasayan J.Chem 2008; 1(3):433- 436.
5. Murugan V, Shareef H, Rama Sarma GVS, Ramanathan M, Sureh B. Anti-fertility activity of the stem bark of Alangium Salvifolium (Linn.F) Wang in wistar female rats. Indian J.Pharmacol 2000; 32(6):388-399.
6. Kamaraj C, Abdul Rahuman A, Bagavan A, Abduz Zahir A, Elango G, Kandan P, et al. Larvicidal efficacy of medicinal plant extracts against Anopheles Stephensi and Culex quinquefasciatus. Tropical Biomedicine 2010; 27(2):211-219.
7. Poornima VH. Evaluation of Antimicrobial activity of Litsea Glutinosa. Int J Pharm Applications 2011; 2(1): 105-114.
8. Mundhe KS, Torane RC, Devare S, Deshpande NR, Kashalkar RV. Preliminary Phytochemical Analysis of Polyalthia Longifolia seeds. Int J Pharm Pharm SCi 2012; 4(1): 450-451.
9. OECD Guideline for testing of Chemicals. Test No.423. Acute Oral Toxicity-Acute toxic class method.
10. Shalini A, Sagar V, Ravindrasingh R, Vasantha. Evaluation of the effect of Leucas Aspera Alcoholic Extract on Blood Glucose level in normal and diabetic rats. Pharmacology online 2011: 1046-1050.
11. Kumar R, Patel DK, Satyendra KP, Sairam K, Hemalatha S. Antidiabetic activity of alcoholic root extract of Caesalpinia digyna in streptozotocin-nicotinamide induced diabetic rats. Asi Pac J Trop Biomed 2012: S934-940.
12. Saba AB, Oyagbemi AA, Azeez OI. Antidiabetic and haematinic effects of parquetina nigrescens on alloxan induced type-1 diabetes and normocytic normochromic anaemia in wistar rats. Afr Health Sci 2010: 276-282.
13. Okokon JE, Antia BS, Udobang JA. Antidiabetic activities of ethanolic extract and fraction of anthocleista djalonensis. Asi Pac J trop Biomed 2012: 461-464.
14. Abidah P, Mohammad I, Fida Mohammad. Antihyperglycemic activity in Grewia Asiatica, A comprehensive investigation. Int J Pharm Pharm SCi 2012; 4(1): 210-213.