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Hypoglycaemic Activity of *Andrographis paniculata* Crude Extract

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This paper presents the hypoglycaemic activity and toxicity of *Andrographis paniculata (Lada-lada)* crude extract in diabetic induced rats. Different doses of crude extract of *A.paniculata* were administered orally as a single dose per day for seven (7) days as 250, 500 and 750 mg/kg. The percentage decrease in blood level of diabetic induced rats was 50% with 500 mg/kg dose , for 250 mg/kg dose was 36% decrease and 14% was for 750 mg/kg dose. Thus, 500 mg/kg dose of *A.paniculata* crude extract reduced the blood glucose level of diabetic induced rats and found that there is no significant difference with the hypoglycaemic activity of insulin at 0.05 level of significance. The present study established that *A. paniculata* crude extract possess a hypoglycaemic activity to diabetic induced rats. With zero mortality 12 g/kg dose of A. paniculata has the least toxicity level.

Keywords: *alloxan induced diabetic rats, , blood glucose level, toxicity*

Introduction

A lot of literatures has been written about *Andrographis paniculatas'* medicinal uses in Ayurvedic and Unani systems of medicines that shows therapeutic benefits in the Asian countries like India, Sri Lanka, Pakistan, Java, Malaysia and Indonesia (Nyeem, et al,2017). This plant is known as King of bitter, because every part of the plant body has an extreme bitter taste. (Shahid, 2011). The taste that is usually a characteristic of plant or a fruit that was proven to reduce blood sugar level like Ampalaya or Momordica *charantia* (Baby and Jini, 2013). Basically, this plant originated from Taiwan, Mainland China, and India, and is also growing abundantly in countries in Southeast Asia like the Philippines, Sri Lanka. Malaysia and Thailand (Benoy, et al, 2012). A. paniculata is an annual, branched, erect and herbaceous plant which grows in hedgerows in almost all types of soil (Niranjana, 2010) but to ensure its well development the moist shady places, and wastelands are much preferable to cultivate this plant (Bhattacharya, 2012). It can grow up to 30 to 110 cm in height. The leaves are glabrous that measures 2-12cm with it width that is 1 to 3 cm, it is pinnate, acute apex. The stem is usually dark green and quadrangular in shape with longitudinal furrows and wings on the angles of the young parts that is slightly enlarge at the nodes with length that ranges from 30 to 100 cm and with a diameter of 2- 6 cm. Its seeds are capsules linear-oblong, acute at both ends that is 1.0 x 0.3 cm, which are yellowish brown in color. Its flowers are small, white with purple spots on the petals and are in lax spreading axillary. In 2004 the Philippine pharmacopeia listed 30 priority "crude plant drugs" in which *A. paniculata* locally known as Lada-lada, damoro, sinta and serpentina herb was among those included. The active component of *A. paniculata* is Andrographolide that viewed to lower glucose level in the blood by increasing glucose utilization acid insulin sensitivity (Zhang 1997), that show a potential to be used as an alternative medicine for diabetes.

The gaining popularity and high demand of the alternative medicine in the Philippines indicates plants and herbs can help to improve health condition hence, discovering drugs which are plant based can be made possible for degenerative diseases like diabetes which is a major cause for death globally that is projected to have prevalence to reach 366 million in 2030 (Shaw etal., 2010).

The purpose of this study is to determine the hypoglycaemic activity of *A. paniculata* crude extract in lowering the blood sugar levels of diabetic rats and measure its toxicity level as primary step in developing anti diabetes drug for human.

Materials and Methods:

Plant Collection

The plant was collected from the SLSU JGE Demo Farm located at Brgy. Bamban, Tagkawayan, Quezon and at SLSU JGE Campus during the months of June to August. Fresh matured leaves (dark green in color,) were taken from the lower part of the stem and washed with clean water to remove dirt and were sun dried for 3 days.

Drying and Pulverization

Dried *A. paniculata* leaves were pulverized into fine powder through a Wiley Mill grinding machine and were stored in an airtight bottle or plastic bag for further use at Ordinary room temperature ORT (20^0 - $40^{0\,C}$) and at Cooler compartment of refrigerator temperature CCRT (10^0–15^0 C) to maintain its freshness.

Extraction of Plant Materials

The dried *A. paniculata* leaves, 975.0g were pulverized using Wiley mill and soaked in 6.0 L of 95% ethyl alcohol for 48 hours. The mixture was filtered and the filtrate obtained was concentrated using rotary evaporator at 60^0C under vacuum for 4 hours.

The concentrated extract was further evaporated using water bath at 60^0C to obtain a semi-solid extract. Crude extraction of 975.0g dried *A. paniculata* leaves produced 5.6 L of ethanolic extract. Concentration of the filtrate yielded 85.0g of semi-solid extract.

Experimental Animals and their Management

Two (2) kinds of animals were used in the experiment. Male albino rats (Sprague Dawly strain) were used for the anti-diabetic activity where three samples of A. paniculata crude extract with a dose of 250, 500, and 750 mg/kg/BW that was administered orally to alloxan-induced diabetic rats.

These animals were weighing 131-199g.They were housed in standard environmental condition for seven (7) days for acclimatization after purchased and fed with formulated rodent food and water ad libitum. Animals blood glucose levels were determined and recorded after 16 hours of fasting.

Diabetes was induced by injecting 10 mg/kg alloxan solution intraperitoneal to test animals. After 48 hours, blood glucose was determined and only test animals with blood glucose determination greater than 200 mg/dl were used. The resulting blood glucose was used as the baseline. Excreta were removed from the cages every day. The animals were divided into four (4) groups with five (5) diabetic rats per group used in the conduct of the experimental study such as: Positive Control (Insulin) and the crude extract samples at 250, 500, and 750 mg/dl dosages.

Administration of positive control and sample extract were given to test animals. Blood were extracted from the tail vein and blood glucose levels were determined and recorded after 1^{st}, 2^{nd}, 4^{th} hour and after 7^{th} day after the positive control and test sample administration. Animal weights were also determined and recorded. All animals used in the study were humanely euthanized by the in-house veterinarian and properly disposed.

The second kind of test animals used in investigating the toxicity level of (*A. paniculata*) crude extract were the male mice (22-34 grams). The median lethal dose (LD50) of the sample, administered orally to male mice is 14.9417 = 0.3578 g/kg. Toxidrome ranged from decreased motor activity and respiratory rate, grooming, piloerection, hypercemia, ptosis, defecation, straub tail, loss of grip strength and pinna reflex, passivity (+8), ataxia, tremors, convulsion and death of mice.

Preliminary dosing was done to determine the expected dose that will cause 50% death of the experimental animals. Three (3) increasing log doses of the test substance were given orally to the test animals in three (3) groups of ten. The number of deaths and other adverse abnormal signs and manifestations were closely observed and noted for the first two (2) hours after administration of the test sample. This was continued in the next 24 to 48 hours, daily up to 14 days

RESULTS AND DISCUSSIONS

The blood glucose level (BGL) were monitored after every 1st, 2nd, and 4th hour and on the 7th day period of observation. after the oral administration of insulin and different doses of *A.paniculata* crude extract. Diabetic rats were administered with 0.10 ml/kg insulin and the *A. paniculata* crude extract in 250, 500, and 750 mg/dl dosages. This section presents the data gathered in the study, its analysis and interpretations in determining the hypoglycaemic activity and toxicity of *Andrographis paniculata* (*Lada-lada*) extract in diabetic rats.

Table 1. Blood Glucose Levels (BGL) of Rats Before, During and After the Oral Administration of Insulin and Different Doses of *A.paniculata* Crude Extract

Group/Sample	Dose	Rat No.	Weight, kg	BLOOD GLUCOSE LEVELS, mg/dl					
				Before alloxan	After alloxan	1st hr	2nd hr	4th hr	7th day
Group 1 Positive Control *Insulin*	0.10 ml/kg	1	0.1526	96	>600	>600	>600	>57030	died
		2	0.1308	64	410	188	62	<32378	148
		3	0.1524	98	215	131	55	<26180	48
		4	0.144	81	>600	336	203	<36564	died
		5	0.1874	84	600	550	233	311	30
Group 2 Test Sample *A.paniculata crude extract*	250 mg/kg	1	0.1828	104	323	326	298	311	30
		2	0.1634	97	>600	>600	>600	>600	died
		3	0.1435	97	212	255	233	235	79
		4	0.1434	103	378	400	386	467	died
		5	0.1787	86	395	456	485	449	Died
Group 3 Test Sample *A.paniculata crude extract*	500 mg/kg	1	0.1619	104	336	468	355	354	54
		2	0.1616	110	352	393	365	373	15
		3	0.1672	86	286	444	388	373	24
		4	0.155	76	>600	>600	>600	>600	died
		5	0.1626	83	588	>600	>600	>600	died
Group 4 Test Sample	750mg/kg	1	0.158	102	396	467	370	444	104
		2	0.1992	94	>600	>600	>600	>600	died

A.paniculata crude extract		3	0.1617	95	330	461	581	461	died
		4	0.1748	91	261	424	501	341	382
		5	0.1608	64	430	458	510	430	died

The blood glucose levels (BGL) of rats before, during and after the oral administration of insulin and different doses of *A.paniculata* crude extract. Diabetic rats were administered with 0.10 ml/kg insulin and the *A. paniculata* crude extract in 250, 500, and 750 mg/dl dosages. The blood glucose level (BGL) were monitored after every 1st, 2nd, and 4th hour and on the 7th day period of observation.

The blood glucose levels of test animal administered with 0.10 ml/kg insulin were 64, 98 and 84 mg/dl. Three (3) out of the five (5) rats survived until the 7th day period of observation with a blood glucose levels of 148, 48 and 30 mg/dl for rats nos, 2, 3 and 5. After the injection they obtained a BGL of 410, 215 and 600 mg/dl. A decreasing BGL of 188, 62 and <32378 were denoted after 1st and 2nd hours and 4th hours for rat no. 2. Rat no. 3 had a BGL of 215 after they were induced with alloxan. After the 1st, 2nd and 4th hour a decreasing BGL of 131, 55 and <26180 was observed. Rat No. 5 had increased in blood glucose level of 600 mg/dl after the induction of insulin. It decreased by 550, 233 and 311 mg/dl after the 1st, 2nd and 4th hour. The BGL of rat No. 5 is unpredictable for it increases its BGL on the 4th hour and decreased on the 7th day.

Two out of the five test animals given with 250 mg/d dose survived until the 7th day period of observation with a blood glucose levels of 30 and 79 mg/dl for rat nos. 1 and 3. The blood glucose levels were 104 and 97 mg/dl before they were treated with alloxan and 323 mg/dL and 212 mg/dL after the injection of alloxan. After the oral administration of the 250 mg/dl dose of the sample, their blood glucose levels increased to 326 and 255 mg/dL. For the 2nd hour decreased in 298 mg/dL was observed, and 311 mg/dL in 4th hour in rat no. 1. A decrease to 233 mg/dL blood glucose level was observed in rat no. 3 on the 2nd hour and increase to 235 mg/dL on the 4th hour.

Three (3) rats treated with 500 mg/dl dose survived with blood glucose levels of 54, 15 and 24 mg/dl after the 7th day. They have the blood glucose levels of 104, 110, and 86 before the alloxan induction. The blood glucose levels after the injection were 336, 362, and 266 mg/dl. On the 1st hour, there was an increase observed in the blood glucose level to 468, 393 and 444 mg/dl respectively. On the 2nd hour blood glucose level decreased to 355, 365 and 388 mg/dL. On the 4th hour, rat nos, 1 and 3 decreased to 354 and 373 while rat no 2 increased to 373mg/dl.

Group of rats that were administered with (750 mg/kg dose) had two (2) survivors, rat nos. 1 and 4. Before injected with alloxan, their blood glucose levels were 102 and 91 but were increased to 396 and 261 after the injection. A noticeable increase in blood glucose levels of 467 and 424 mg/dl can be seen in the two test animals on the 1st hour. On the 2nd hour rat no. 3 decreased to 370 and again increased to 444 on the 4th hour. The blood glucose level of rat no. 4 increased to 501 on the 2nd hour, and decreased to 341 on the 4th hour. On the seventh day, the blood glucose levels decreased to 104 and 382 mg/dL.

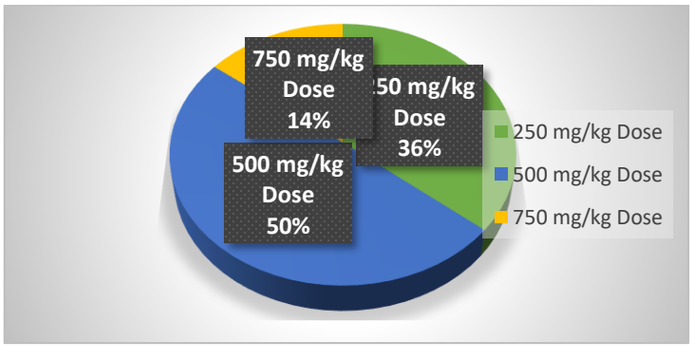

Figure 2. Percentage Decrease in Blood Glucose Level of Diabetic Induced Rats After the Administration of the Different Treatments

This presents the percentage decrease in blood glucose level of diabetic induced rats after taking the different doses of *A.paniculata* crude extract. The percentage decrease in blood glucose level of diabetic induced rats after taking 500 mg/kg dose of the crude extract was 50%. For 250 mg/kg dose of the crude extract the precentage decrease in blood glucose level of diabetic induced rats was 36% while 14% was the percentage decrease for 750 mg/kg dose of *A.paniculata* crude extract.

Table 2. Toxicity of the Different Doses *A. paniculata* Crude Extract in Mice for Fourteen Days

Group No.	Dose g/kg	No. of Mice	Mortality Ratio				
			Day 1	Day 2	Day 3	Day 7	Day 14
I	12	10	0/10	0/10	0/10	0/10	0/10
II	13.85	10	1/10	3/10	3/10	3/10	3/10
lll	16	10	9/10	9/10	9/10	9/10	9/10

The toxicity of *A.paniculata* crude extract with 12g/kg, 13.85 g/kg and 16 g/kg dose of *A. paniculata* crude extract for 14 days presenred as Group 1 where 10 mice were orally administered with 12g/kg dose of *A. paniculata* extract, zero death was obtained 0/10 with a mortality rate of 0%. Fifteen (15) to twenty (20) minutes after dosing, the following manifestations were observed: decreased motor activity and respiratory rate, hyperaemia, grooming followed by ptosis, piloerection, straub tail and loss of grip strength. All mice were normal after 24 hours. No other adverse/abnormal signs or death occurred within the 14 days period of observations.

In group 2, given a dose of 13.86 g/kg extract, 3 deaths was observed in this group. Thus, the mortality rate in this group was 30%. The following manifestations were observed fifteen (15) to twenty (20) minutes after dosing; decreased motor activity and respiratory rate, hyperaemia, grooming followed by ptosis, piloerection, straub tail and loss of grip strength, passivity (+ 4), ataxia, tremors and death of one (1) mouse was

observed within 24 hours; and two (2) mice died after 24 hours. The remaining seven (7) mice recovered after 24 hours until the 14 days period of observation.

In group 3, administered with a dose of 16 g/kg extract, 9 rats were recorded died with a mortality rate of 90%. The following behavioural observation were shown fifteen (15) to twenty (20) minutes after dosing: decreased motor activity and respiratory rate, hyperemia, grooming followed by ptosis, piloerection, straub tail and loss of grip strength and pinna reflex, defecation, passivity (+8), ataxia, tremors, convulsion and death of nine (9) mice within 24 hours. The remaining one (1) mouse recovered after 24 hours until the 14 days period of observation. Data presents that as the dose of the sample administered to mice increases the number of death among the test animals also increases.

The results of the experiment signifies that out of the three dosages, 12 g/kg dose (Group 1) had the least toxicity level. It is the dose most acceptable to mice as implicated in the zero death results.

Table 3. Paired Sample t-test on the Blood Sugar Level of Diabetic Induced Rats Before and After the Injection of Different Doses of *A.paniculata* Crude Extract

Dose	Variables	*t*-value	*p*-value	Interpretation
	Before			
250 mg/kg	After	2.663	0.229	Not Significant
	Before			
500 mg/kg	After	13.097	0.006	Significant
	Before			
750 mg/kg	After	0.414	0.759	Not Significant

The paired sample t-test of the blood glucose level of diabetic induced rats before and after taking the different doses of *A. paniculata* crude extract. For 250 mg/kg dose of *A. paniculata* crude extract, the computed t-value was 2.663 with a p-value of 0.229. Since the p-value is greater than 0.05 level of significance, findings denote that there is no significant difference on the blood glucose level of the induced rats before and after taking the 250 mg/kg dose of *A. paniculata* crude extract. Similarly, for 750 mg/kg dose of *A. paniculata* crude extract with t-value equals 0.414 and p-value 0.759, there is no significant difference on the blood glucose level of the induced rats before and after taking the *A. paniculata* crude extract with 750 mg/kg dose.

However, there is a significant difference on the blood glucose level of the induced rats before and after taking the 500 mg/kg dose of *A. paniculata* crude extract since the p-value = 0.006 is less than the 0.05 level of significance. This implies that 500 mg/kg dose of *A.paniculata* crude extract has a hypoglycaemic activity on the blood glucose level of diabetic induced rats.

Table 4. Comparison of the Reduced Blood Glucose Level of Diabetic Induced Rats with the Different Doses of *A. paniculata* Crude Extract with Insulin as Control Group

	Sum of Squares	*Df*	*Mean Square*	*F*	*p-value*
Between Groups	83, 192.933	3	27, 730.978		
Within Groups	189, 867.167	6	31, 644.528	0.876	0.504
Total	**273, 060.100**	**9**			

The ANOVA table for the comparison of the reduced blood glucose level of diabetic induced rats after taking 250 mg/kg, 500 mg/kg and 750 mg/kg doses of *A. paniculata* crude extract with insulin as control group. This table shows that the *f*-value of the reduced blood glucose level of the different groups is 0.876 with a *p*-value of 0.504. Since the *p*-value is greater than 0.05, there is no significant difference between the reduced blood glucose level of the different groups.

Table 5. Multiple Comparison Test of the Different Groups using Least Significant Difference (LSD) with Insulin as Control Group.

Treatment (I)	Treatment (J)	Mean Difference (I-J)	Std. Error	*p*-value
	250 mg/kg	120.00	162.39	0.488
Insulin	500 mg/kg	39.33	145.25	0.796

	750 mg/kg	247.50	162.39	0.178

Table 5 gives the multiple comparison tests of the different groups using the Least Significant Difference (LSD) with Insulin as control group. The table shows that the mean

difference of the reduced blood glucose level of the induced rats using Insulin to 250 mg/kg dose, 500 mg/kg dose and 750 mg/kg dose of *A. paniculata* crude extract are 120.00 mg/dL, 39.33 mg/dL and 247.50 mg/dL with *p*-values of 0.488, 0.796 and 0.178, respectively. Since the *p*-v greater than the 0.05 level of significance, there is no significant difference between the blood glucose level using insulin and the different doses of *A. paniculata extract*.

These show that the reduced blood glucose level of diabetic induced rats after taking 500 mg/kg dose of *A. paniculata* crude extract has no significant difference with the reduced blood glucose level of the rats after taking the insulin at 0.05 level of significance. This implies that the 500 mg/kg dose of *A. paniculata* crude extract has the same hypoglycaemic activity with insulin in reducing the blood glucose level of the diabetic induced rats. Hence, the 500 mg/kg dose of *A. paniculata* crude extract can be used as alternative hypoglycaemic agent for insulin.

SUMMARY AND CONCLUSION

Based from the results, at 0.05 level of significance, there is no significant difference on the blood glucose level of diabetic induced rats before and after taking a 250 mg/kg and 750 mg/kg doses of *A.paniculata* crude extract with p-values 0.229 and 0.759, respectively. However, there is a significant difference on the blood glucose level of diabetic induced rats before and after taking a 500 mg/kg dose of the extract with 0.006 as the p-value.

As compared to the hypoglycaemic activity of insulin, the hypoglycaemic activity of a 500 mg/kg dose of *A.paniculata* crude extract had no significant difference with a p-value of 0.796.

For the toxicity level of *A.paniculata* crude extract, results revealed that the toxicity level of the crude extract at 13.85 g/kg and 16 g/kg doses were 30% and 90% while the toxicity level of the a 12 g/kg dose of the crude extract was 0%. Thus, *A. paniculata* leaf extract at 12 g/ has the least toxicity level as manifested by zero mortality.

With these, a 500 mg/kg dose of A.paniculata crude extract reduced the blood glucose level of diabetic induced rats and there is no significant difference on the hypoglycaemic activity of insulin at 0.05 level of significance. The results also revealed that the toxicity level of *A. paniculata* leaf extract at 12 g/kg dose has the least toxicity level as manifested by zero mortality. Thus, a 500 mg/kg dose of *A.paniculata* crude extract has a hypoglycaemic activity and can be used as an alternative hypoglycaemic agent for insulin in reducing the blood glucose level of a diabetic rat.

IMPLICATIONS AND RECOMMENDATIONS

Looking at the findings and conclusion of the study, the researchers instigate the following recommendations:

That the management of diabetes in rats may be considered by utilizing 500 mg/kg *Androgaphis paniculata* extract in diabetic mice as an alternative oral hypoglycaemic agent. The knowledge that there are safe, cheap alternative medications for managing the disease and the skill to prepare such treatment may prevent many life-threatening complications and non-compliance to treatment regimen.

Further test on the chemical component present on the *A.paniculata* crude extract that affect the hypoglycaemic activity of the plant.

For future researchers to conduct more researches on the extract of *A. paniculata* leaves to further study the activity of the extract specifically on the following areas: toxic component, hypolippidemic and its anti-oxidant effects.

Furthermore, collection and propagation of plant materials is also recommended.

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Literature Cited

A. Niranjan, S. K. Tewari, and A. Lehri, "Biological activities of Kalmegh (Andrographis paniculata Nees) and its active principles-A review," Indian Journal of Natural Products and Resources, vol.1,no.2,pp.125–135,2010.

A. Shukla, P. Kuyal, UK Tiwari, AK Gaur (2010). Chemical constituents isolated from *A. paniculata* Indian J. of Chem.

Agung Endro Nugroho, Mohamad Andrie Ni KadekWardditiani (2012). Antidiabetic and antihyperlipidemic effect of *Andrographis paniculata* (Burm. F.)Nees and andrographolide in high-fructose-fat-feds rats

Andrographis, in depth review. (2010). Alpha Omega Labs Database. Article 114. Retrieved February 16, 2012 from http://www.altcancer.com

Baby Joseph And D. Jini, 2013, Antidiabitic effects of Momordica charantia(bitter Melon) and its medicinal potency . Asia Pac J Trop Dis. 2013, Apr(3): 93-102

Black, J. M. and Hawks, J. H. (2009). Medical surgical Nursing. Clinical Management for Positive outcomes China: Elsevier Ltd.

Brunner L. S. & Suddhart, D. S. (2009). Textbook of Medical-surgical nursing (12th ed.) Hongkong Lippincott, Williams and Wilkins.

Department of Health (2005). Mortality: Ten Leading causes, number and rate/100, 000 population, 5 year average (2000-2004) and 2005, Retrieve Feb. 21, 2011 from the Department of Health Web Site: http://www.doh.gov.phkp/statisticsleading_mortality.

DOH-BFAD (2005). Philippine pharmacopeia with supplements: Philippines: Hemiko Arts and Concepts

Eisenbrand G. and Tang W. (2002.) Chinese drugs of plant origin. Germany: Springer-Verlag 97-102

Feria, M. (2007). Ten medicinal plants. Retrieved February 10, 2011 from the Philippine council for Health Research and Development Library Website: http://library.pchrd.dost.gov.ph/index.php/news-archive/658.

G. K. Benoy, D. K. Animesh, M. Aninda, D. K. Priyanka, and H.Sandip, 2012,"An overview on Andrographisp aniculata(burm.F.) Nees," International Journal of Research in Ayurveda and Pharmacy,vol.3,no.6,pp.752–760,2012

Mohammad Abu Bin Nyeem, Md. Abdul Mannan, Mohammad Nuruzzaman, KM Kamrujjaman and Samir Kumar Das (2017) Indigenous king of bitter (Andrographis paniculata): A review, Journal of Medicinal Plants Studies 2017; 5(2): 318-324

P. Misra, NL Pal, PY Guru, JC Kathiyar, V. Shrivastava, and JC Tandon (1992). Antimalarial activity of *A. paniculata* (Kalmegh) against *Plasmodium berghei* NK 65 in *Mastomys natalensis Int. J. of Pharmacognosy*

Ravinder Sangala, DevenderRaoKodati, ShashidherBurra, Jayaprakashreddy Gopuand AjyDubasi (2011). Evaluation of antidiabetic activity of *Annonasquamosa Linn* seed in Alloxan – induced Diabetic http:// www.preclinicaljournal.com/admin/fckeditor/_samples/php/articl...

S. Bhattacharya, S.Puri, A.Jamwal, and S.Sharma (2012),"Studies on seed germination and seedling growth in Kalmegh (Andrographis paniculata Wall. Ex Nees) under abiotic stress conditions," International Journal of Science, Environment and Technology, vol.1,no.3,pp.197–204,2012.

Sangwan NS, Sangwan RS, Mishra SK (2007). *Andrographis paniculata (kalmegh): a review.* Pharmacogn Rev 1 283-298

Shahid A., 2011, Andrographis paniculata: A review of pharmacological activities and clinical effects, Alternative Medicine Review, 2011; 16:66-77

Shaw, JE; Sicree,RA;ZImmet PZ, 2010. Global estimates of the prevalence of diavetes for 2010 to 2030. Diabtes Res Clin. Pract. 2010;87:4-14

Verna N., Vinayak M.(2008). Antioxidant action of Andrographis paniculata on lymphoma. Mol Biol Rep

Yaman Nizmawardini, Hanani Endang, Ruray Djunaidi and Santa Purna Sari (2013.) "The Hypoglycemic, hypolipiddemic and antioxidant effects of leaves methanolic extract of *Baccaurea ramiflora* in Diabetic Induced Rats

Zhang CY, Tan BK (1997). Mechanism of cardiovascular activity of *Andrographis paniculata* in the anaesthetized rats. J. Ethnopharmacol