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Effect of aloe vera on lipid and sugar levels in male rats exposed to high doses of dexamethasone therapy

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Abstract---The present study was undertaken to observe the effect of the aqueous leaf extract of Aloe vera gel of the reduction in blood glucose and lipid level in hyperglycemia and hyperlipidemia rats. Twenty four male rats were divided into four groups (6 rats/group) and treated as follows for 28 days. G 1 were intubated orally distal water serving as control while, G2 were administrating of Dexamethason -induced diabetic 1 mg/kg/bw. Intraperitoneally, G3 were administrating of diabetic rats given Dexamethason 1mg/kg/bw. + Aloe vera leaf gel extract (300 mg/kg) using an intragastric tube, G4 were administrating of diabetic rats given Dexamethasone 1 mg/kg/bw. intraperitoneally + Aloe vera leaf gel extract (500 mg/kg) using an intragastric tube, the following criteria were measured sugar levels and blood lipid profile. The findings show that Aloe Vera had a significant decrease influence in serum glucose, cholesterol, TG, and VLDL and a significant decrease HDL. In conclusion, this study

mention a new evidence of the role of Aloe Vera on the decreasing glucose, lipid profile.

Keywords--aloe vera gel, dexamethasone, glucose, blood lipid, rats.

Introduction

Aloe Vera Gel is a gel extracted from aloe vera leaves and comes in the form of a gel or transparent layer. Aloe vera gel is one of the most natural materials that are used in the treatment and protection of many diseases, especially skin and skin problems. Aloevera gel has many components to include vitamins, such as vitamin C and vitamin A (1) and it contains minerals, such as calcium, zinc, and magnesium, in addition to containing amino acids (2). Aloe vera gel has been widely used since ancient times due to its many benefits to treat many symptoms and diseases like diabetes mellitus (3). Dexamethasone is a long-acting synthetic corticosteroid that blocks the release of substances responsible for inflammation including prostaglandins, quinine, histamine, and lipolytic enzymes. It also alters the body's immune response. It is used in the treatment of many conditions, including rheumatic problems, a number of skin diseases, severe allergies, asthma, chronic obstructive pulmonary disease, croup, cerebral edema, eye pain after eye surgery, as well as antibiotics in tuberculosis (4)

Materials and Method

Animals of the Study

The experiment was carried at the laboratory animal's facilities Faculty of veterinary medicine karbala University. Totally, 24 albinos rats were usual in this study with an arrange age range between 150-200 g. These animals were kept in suitable environmental condition with a temperature of around 25-28 C°, relative humidity 40% - 60% conditions room with a 12:12 h/light light / dark cycle (5). The animals were housed in a plastic cage with diameters of 50×35×15 cm. The feed given were pellets. The animals were kept for at last 15 days for acclimatization before experiment began.

The Experimental Design

The study rats were divided randomly into four groups:

- Group (G1) 6 rats will be administrating normal saline and animals is euthanized after 28 day.
- Group (G2) 6 rats will be administrating of *Dexamethason* -induced diabetic 1mg/kg/bw. intraperitoneally for 28 days (6).
- Group (G3) 6 rats will be administrating of diabetic rats given *Dexamethason* 1mg/kg/bw. + *Aloe vera* leaf gel extract (300 mg/kg) in aqueous solution daily using an intragastric tube (7), for 21 days.
- Group (G4) 6 rats will be administrating of diabetic rats given *Dexamethasone* 1mg/kg/bw.intraperitoneally + *Aloe vera* leaf gel extract

(500 mg/kg) in aqueous solution daily using an intragastric tube (7), for 21 day

Preparation of Dexamethasone

Dexamethasone was obtained from Sigma Aldrich Company (USA).

Preparation of aloe vera gel

The outer part of the aloe vera leaf was peeled off to obtain aloe vera gel directly, and using a small spoon, the entire gel was extracted, and then the gel was transferred to a blender to obtain a mixture and foam ready to be dosed to the animals under study.

Blood sample collection

At the end of experiment, the animals anesthetized, this done by putting the rats in closed jar containing soaked by chloroform. Then the blood collected by heat puncture. the blood gelled tube and centrifuged for 15 minutes (300 RPM). The supernatant serum was drawn and kept by eppendorf tubes and store at (-4°C) until analyzed.

Statistical Analysis

The data were analyzed by using one-way analysis of variance (ANOVA) and significant difference between groups was of the level ($P \leq 0,05$) according to least significant difference (LSD)(version 29,SPSS,in UAS 2010).

Biochemical tests

- **Estimation of serum total Cholesterol concentration (mg/dL) :**
Cholesterol concentration was measured by using Cormay cholesterol kit produced by PZ CORMAY S.A. company. oxidation and after enzymatic hydrolysis, the cholesterol is determined in the presence of phenol and peroxidase, 4-aminoantipyrine and the hydrogen peroxide forming quinoneimine the indicator (8).
- **Estimation of serum Triglyceride concentration (mg/dL) (mg/dl):**
Triglyceride concentration was measured by Cormay triglyceride kit produced by PZ CORMAY S.A. company. Its hydrolyzed to glycerol enzymatically according to the following reaction (9).
- **Estimation of serum HDL-Cholesterol concentration (mg/dL)**
HDL-Cholesterol concentration was measured by using Cormay HDL kit produced by PZ CORMAY S.A. The supernatant contains high density lipoprotein (HDL). The HDL-cholesterol is then spectrophotometrically measured by means of the coupled reaction (10).
- **Estimation of serum LDL-Cholesterol concentration (mg/dL)**
LDL-C was Measured by using Cormay LDL kit produced by PZ CORMAY S.A. company (11).
- **Estimation of serum VLDL-Cholesterol concentration (mg/dL) (mg/dl):** VLDL-C was measured by using the following equation (11).

VLDL = TG /5

- **Glucose Estimation:** To detect fasting blood glucose in the morning of PND 85, animals were fasted overnight for 12 hr, and blood samples were obtained from the tail vein. An Accu-Chek compact glucometer was used to detect fasting blood glucose (12).

Results

Glucose level

The main value of serum Glucose showa significant ($P<0.05$) decreased was noticed at the (G1), (G3), and (G4) groups respectively compared with the (G2) group (table 1).

Table 1
Comparison of glucose levels for all groups under study

Groups parameters	Control(G1)	Dexamethzone(G2)	Dexamethzone +Alovera 300(G3)	Dexamethzone +Alovera 500 (G4)
Glucose	97.83 $\pm$ 8.40 C	195.50 $\pm$ 5.20 A	118.00 $\pm$ 4.04 B	107.83 $\pm$ 6.55 C

Different letters in the same column represent a significant different at ($P<0.05$)

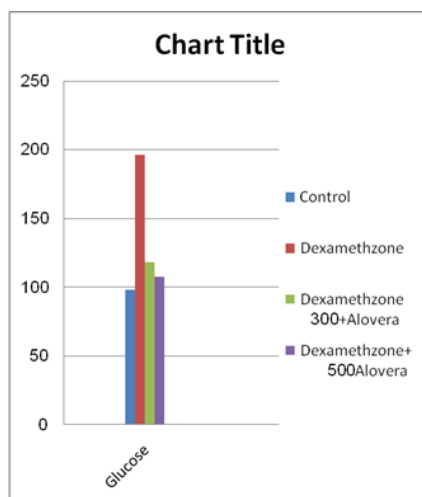


Figure1. Effect of Alovera gel in the alleviating the deleterious effect of Dexamethzone on Glucose levelsin adult male rats

Lipids profile

A significant ($P<0.05$) decreased was noticed in the serum concentration of cholesterol, triglyceride, vLDL and LDL at the (G1), (G3), and (G4) groups

respectively compared with the (G2) group (table 2). while HDL was increased significantly ($P<0.05$) in the same groups.

Table 2
Comparison of glucose levels for all Lipids profile under study

Groups parameters	Control (G1)	Dexamethzone (G2)	Dexamethzone +Alovera 300 (G3)	Dexamethzone +Alovera 500 (G4)
Cholesterol mg/dl	50.59 $\pm$ 9.14 D	155.16 $\pm$ 8.88 A	111.33 $\pm$ 9.39 B	76.66 $\pm$ 8.09 C
Triglyceride mg/dl	77.00 $\pm$ 5.58 C	171.83 $\pm$ 11.26 A	118.00 $\pm$ 5.40 B	88.66 $\pm$ 9.75 C
HDL mg/dl	57.04 $\pm$ 4.64 A	39.45 $\pm$ 3.13 B	38.94 $\pm$ 3.90 B	53.40 $\pm$ 4.19 A
LDL mg/dl	9.11 $\pm$ 1.36 C	150.37 $\pm$ 1.02 A	118.35 $\pm$ 33.09 B	26.61 $\pm$ 16.37 C
VLDL mg/dl	15.48 $\pm$ 1.48 C	44.33 $\pm$ 8.57 A	24.26 $\pm$ 3.59 B	18.66 $\pm$ 2.16 BC

Different letters in the same column represent a significant different at ($P<0.05$)

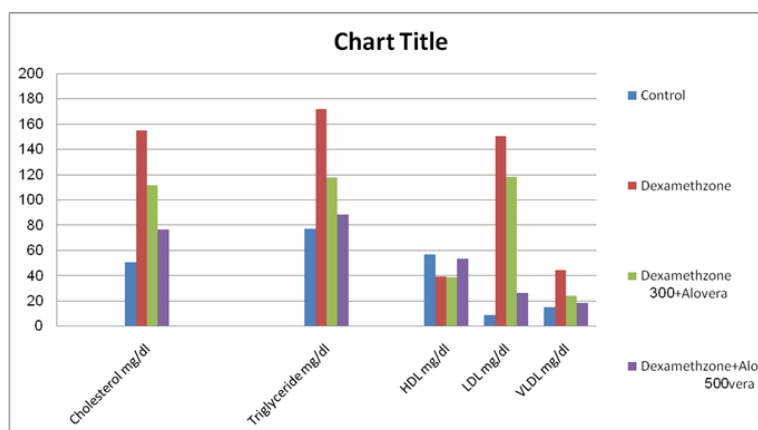


Figure 2. Effect of Alovera gel in the alleviating the deleterious effect of Dexamethzone on Lipids profile in adult male rats.

Discussion

Effect of Aloe Vera on glucose

The influence of alovera on liver and pancreas was investigated in the present study. Pre-diabetes is a serious global epidemic that increases the risk of getting type 2 diabetes by fivefold and the probability of cardiovascular disease by two times. A primary preventive measure for this disease is lifestyle modification, which is usually difficult. Therefore, it is necessary to utilize other therapies to

reduce the consequences of this disease (13,14). In the present study, the effects of different doses of Aloe vera extract at different time spans were studied on blood glucose and lipids in diabetic patients. The results of this study showed that both the 300 and 500 mg Aloe vera significantly reduced fasting blood glucose levels. Also, Similar studies indicate that Aloe vera extract is effective in increasing insulin sensitivity, reducing fasting blood glucose, and decreasing the level of HbA1C in patients with pre-diabetes during eight weeks (15).

In models of type I diabetes laboratory animals, it is shown that Aloe vera extract had a similar effect on blood glucose to that of glibenclamide (16). Even in patients who did not respond to glibenclamide alone, consumption of Aloe vera extract for 2 weeks could reduce fast blood glucose (17). Other studies have also shown the effectiveness of Aloe vera extract on the regulation of blood glucose levels in diabetic animals (18,19). Few studies have indicated a rise in blood sugar levels after consumption of Aloe vera extract (20) which might be related to the use of different parts of the plant (not the gel) or short duration of the intervention (2 times a day for 3 days). Researchers have also introduced an important element in the hypoglycaemic effects of Aloe vera in a substance called Acemannan. This is actually a D-isomer of compound polysaccharide that is extracted from Aloe vera leaf gel and has such properties as anti-virus, anti-cancer, digestive, and immune stimulating properties (15).

Effect of Aloe Vera on Lipids profile

The results of this study showed that AL500 could significantly reduce the levels of total cholesterol, TG, and LDL-C, and increase the level of HDL-C significantly during the 60 days of drug intake. However, AL300 could only increase the level of HDL-C in 60 days than before. For the first time, Agrawal studied the effect of Aloe vera on 5000 patients with type 2 diabetes for 5 years. After this period, a significant reduction was shown in the level of total cholesterol and triglycerides [21] that is consistent with our data. In another study, Aloe vera extract in dose of 300 mg was given on a daily basis to patients with type 2 diabetes for two months. The results indicated a significant reduction in the level of total cholesterol and LDL-C that are similar to our results. However, Aloe vera did not affect the level of HDL-C and triglycerides [24]. The reason may lie with the fact that only the 300-mg capsules of Aloe vera were used in that study on a population of type 2 diabetic patients who had high levels of blood glucose where, we know, that high levels of blood glucose can cause complex problems such as stress oxidative that will lead to the development of type 2 diabetes [33].

Also, it has been demonstrated that acute and chronic increase in the levels of blood glucose could increase the level of serum lipids (cholesterol, triglycerides, LDL, VLDL and decreased levels of HDL) [34]. The researcher believes that the reason for lack of response to this dose of Aloe vera (300 mg) capsules in this study was high chronic level of blood glucose in patients or the low dose of Aloe vera. It is conjectured that Aloe vera can bring the distribution of fatty acids in the blood to normal status by controlling the metabolism of lipids in the liver. In fact, Aloe vera extract can construct non-saturated fatty acids that remove free radicals from blood stream and control the metabolism of lipids in the body [27].

It is known that beta Sistrostrol, Campesterol, and Stigmasterol are of close similarity to Phytosterols. Besides, it is found that beta Sistrostrols chain available in some plants such as Aloe vera can significantly decrease the level of plasma total cholesterol, LDL-C, and triglycerides by inhibiting activation of fat absorption mechanisms [33]. In one study, it was shown that the use of Aloe vera extract as much as 200 mg/kg on a daily basis for as long as 100 days can significantly reduce the level of cholesterol, Triglycerid, free fatty acids, and phospholipids in normal mice [34]. It is also shown that taking Aloe vera extract for 8 weeks in diabetic rats can lower the level of cholesterol and TG [28]. Nonetheless, Aloe vera is beneficial even in short-term intakes (21 days) of 300 mg dose [33]. Some studies have mentioned that maximal dose of 50 mg Aloe vera could not improve the level of cholesterol in diabetic rats [31]. This suggests that the dose of Aloe vera that is required to reduce the level of cholesterol of serum is higher than the dose needed for reducing the level of blood glucose.

In a clinical trial conducted on 36 patients with type 2 diabetes, it was found that Aloe vera could reduce the level of triglycerides but had no effects on the level of cholesterol after daily use of one tablespoon of Aloe vera along with glibenclamide for 6 weeks [22] which are not similar to the results of our study. Perhaps, high blood glucose which may in turn lead to increased levels of blood lipid in the patients may suggest that they were taking lipid-lowering drugs instead of complementary medicine. The patient took Aloe vera juice which was not of sufficient accuracy to determine the exact amount of medication received. Devaraj and colleagues also showed, that taking two 500 mg capsules of Aloe vera (AC952) on a daily basis was effective in lowering the level of LDL and total cholesterol, is consistent with the results of our study. However it was not found to be effective in reducing the level of triglyceride and increasing the level of HDL-C of the serum [23]. Perhaps, it was because of the small number of participants in each group (n =15) or the little amount of active ingredients in the gel of, which can be as a result of the specific method of pasteurization and separation of the extract.

It was also reported that a high intake of Aloe vera (2 tablespoons three times daily for 12 weeks) could reduce the level of triglyceride of serum without effect on the levels of cholesterol, while no renal or hepatic toxicity was observed [39]. Increased activity of hormone-sensitive lipase during insulin secretion defect, increased release of free fatty acids from fat tissue. Thus, it produces more phospholipids and cholesterol in the liver due to accumulation of fatty acids in plasma. These two substances are released into the bloodstream as triglycerides which can increase the level of lipoproteins in the blood. It is suggested that can reduce the level of lipids in blood by controlling the fat metabolism in the liver [37]. Another theory is that the Aloe vera extract can lower the level of blood glucose and lipid in diabetic rats by improving sensitivity of cells to insulin [28,38]. It is well known that Aloe vera extract can suppress the adipogenesis gene and suggested that the plant can improve insulin resistance by reducing toxic effects of fat in the liver [28].

Conclusion

It was concluded that aloe vera gel has an important role in lowering the level of sugar, lowering the level of LDL, lowering the level of VLDL, lowering the level of triglycerides, lowering the level of cholesterol, and increasing the level of HDL

References

1. Agarwal, O. (1985). Prevention of atheromatous heart disease. *Angiology*;36(8):485–92.
2. Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., ... & Smith Jr, S. C. (2009). Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, lung, and blood institute; American heart association; world heart federation; international atherosclerosis society; and international association for the study of obesity. *Circulation*, 120(16), 1640-1645.
3. Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., ... & Smith Jr, S. C. (2009). Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, lung, and blood institute; American heart association; world heart federation; international atherosclerosis society; and international association for the study of obesity. *Circulation*, 120(16), 1640-1645.
4. Alonso-Magdalena, P.; Ropero, A.B.; Soriano, S.; Quesada, I. and Nadal, A., (2010). Bisphenol-A: a new diabetogenic factor? *Hormones (Athens)* 9: 118–126.
5. AOAC (Association of Official Analytical Chemists) (2000). Official method of analysis (17th ed.). Gaithersburg, MD, USA: Association of Official Analytical Chemists (no. 967.21 ascorbic acid in vitamin preparation and juice).
6. Beppu, H., Shimpo, K., Chihara, T., Kaneko, T., Tamai, I., Yamaji, S., ... & Sonoda, S. (2006). Antidiabetic effects of dietary administration of Aloe arborescens Miller components on multiple low-dose streptozotocin-induced diabetes in mice: investigation on hypoglycemic action and systemic absorption dynamics of aloe components. *Journal of ethnopharmacology*, 103(3), 468-477.
7. Bramley, P. M., Elmadfa, I., Kafatos, A., Kelly, F. J., Manios, Y., Roxborough, H. E., et al. (2000). Review: Vitamin E. *Journal of the Science of Food and Agriculture*, 80(7), 913–938.
8. Bunyapraphatsara, N., Yongchaiyudha, S., Rungpitarangsi, V., & Choekchaijaroenporn, O. (1996). Antidiabetic activity of Aloe vera L. juice II. Clinical trial in diabetes mellitus patients in combination with glibenclamide. *Phytomedicine*, 3(3), 245-248.
9. Bunyapraphatsara, N., Yongchaiyudha, S., Rungpitarangsi, V., & Choekchaijaroenporn, O. (1996). Antidiabetic activity of Aloe vera L. juice II. Clinical trial in diabetes mellitus patients in combination with glibenclamide. *Phytomedicine*, 3(3), 245-248.
10. Casal, S., Amaral, J., & Oliveira, B. (2006). Effects of food thermal processing on vitamin E contents. In M. Braunstein (Ed.), *Vitamin E: New research* (pp. 39–67). Nova Science Publishers Inc.

11. Devaraj, S., Yimam, M., Brownell, L. A., Jialal, I., Singh, S., & Jia, Q. (2013). Effects of Aloe vera supplementation in subjects with prediabetes/metabolic syndrome. *Metabolic syndrome and related disorders*, 11(1), 35-40.
12. Devaraj, S., Yimam, M., Brownell, L. A., Jialal, I., Singh, S., & Jia, Q. (2013). Effects of Aloe vera supplementation in subjects with prediabetes/metabolic syndrome. *Metabolic syndrome and related disorders*, 11(1), 35-40.
13. FALLAH, H. H., Kianbakht, S., Hajiaghaee, R., AFKHAMI, A. M., Bonakdaran, A., & HASHEM, D. F. (2012). Aloe vera leaf gel in treatment of advanced type 2 diabetes mellitus needing insulin therapy: a randomized double-blind placebo-controlled clinical trial.
14. Fasce, F. (1982). BENI CULTURALI, RICERCA STORICA E IMPRESA. *Quadernistorici*, 17(51 (3), 1192-1194.
15. Fossati, P., & Prencipe, L. (1982). Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. *Clinical chemistry*, 28(10), 2077-2080.
16. Friedwald, W. T. (1972). Estimation of the concentration of low density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. *Clin. Chem*, 18, 499-502.
17. Grove, T. H. (1979). A fully enzymatic colorimetric method for determination of HDL-cholesterol in the serum. *Clin. Chem*, 25, 560-565.
18. Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., ... & Costa, F. (2005). Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*, 112(17), 2735-2752.
19. Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., ... & Costa, F. (2005). Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*, 112(17), 2735-2752.
20. Kamal-Eldin, A., & Moazzami, A. (2009). Plant sterols and stanols as cholesterol-lowering ingredients in functional foods. *Recent Patents on Food, Nutrition & Agriculture*, 1(1), 1-14.
21. Kim, K., Kim, H., Kwon, J., Lee, S., Kong, H., Im, S. A., ... & Kim, K. (2009). Hypoglycemic and hypolipidemic effects of processed Aloe vera gel in a mouse model of non-insulin-dependent diabetes mellitus. *Phytomedicine*, 16(9), 856-863.
22. Kim, K., Kim, H., Kwon, J., Lee, S., Kong, H., Im, S. A., ... & Kim, K. (2009). Hypoglycemic and hypolipidemic effects of processed Aloe vera gel in a mouse model of non-insulin-dependent diabetes mellitus. *Phytomedicine*, 16(9), 856-863.
23. Kim, K., Yun, S. H., Choi, B. Y., & Kim, M. K. (2008). Cross-sectional relationship between dietary carbohydrate, glycaemic index, glycaemic load and risk of the metabolic syndrome in a Korean population. *British journal of nutrition*, 100(3), 576-584.
24. Koo, M. W. L. (1994). Aloe vera: Antiulcer and antidiabetic effects. *Phytotherapy Research*, 8(8), 461-464.
25. Koo, M. W. L. (1994). Aloe vera: Antiulcer and antidiabetic effects. *Phytotherapy Research*, 8(8), 461-464.
26. Martinez, B. B., Pereira, A. C. C., Muzetti, J. H., Telles, F. D. P., Mundim, F. G. L., & Teixeira, M. A. (2016). Experimental model of glucocorticoid-induced insulin resistance. *Acta Cirurgica Brasileira*, 31, 645-649.

27. Meyer, A. D. (1982). Adapting to environmental jolts. *Administrative science quarterly*, 515-537.
28. Misawa, E., Tanaka, M., Nomaguchi, K., Nabeshima, K., Yamada, M., Toida, T., & Iwatsuki, K. (2012). Oral ingestion of Aloe veraphytosterols alters hepatic gene expression profiles and ameliorates obesity-associated metabolic disorders in Zucker diabetic fatty rats. *Journal of agricultural and food chemistry*, 60(11), 2799-2806.
29. Okyar, A., Can, A., Akev, N., Baktir, G., & Sütülpinar, N. (2001). Effect of Aloe vera leaves on blood glucose level in type I and type II diabetic rat models. *Phytotherapy Research*, 15(2), 157-161.
30. Palermo, F. A., Cocci, P., Angeletti, M., Felici, A., Polzonetti-Magni, A. M., & Mosconi, G. (2013). Dietary Aloe vera components' effects on cholesterol lowering and estrogenic responses in juvenile goldfish, *Carassius auratus*. *Fish physiology and biochemistry*, 39(4), 851-861.
31. Rajasekaran, S., & Aathishsekar, D. (2007). Therapeutic evaluation of Aloe vera leaf gel extract on glycoprotein components in rats with streptozotocin diabetes. *J Pharmacol Toxicol*, 2(4), 380-5.
32. Rajasekaran, S., Ravi, K., Sivagnanam, K., & Subramanian, S. (2006). Beneficial effects of Aloe vera leaf gel extract on lipid profile status in rats with streptozotocin diabetes. *Clinical and experimental pharmacology and physiology*, 33(3), 232-237.
33. Rajasekaran, S., Sivagnanam, K., & Subramanian, S. (2005). Antioxidant effect of Aloe vera gel extract in streptozotocin-induced diabetes in rats. *Pharmacol Rep*, 57(1), 90-96.
34. Rajasekaran, S., Sriram, N., Arulselvan, P., & Subramanian, S. (2007). Effect of Aloe vera leaf gel extract on membrane bound phosphatases and lysosomal hydrolases in rats with streptozotocin diabetes. *Die Pharmazie-An International Journal of Pharmaceutical Sciences*, 62(3), 221-225.
35. Rajasekaran, S., Sriram, N., Arulselvan, P., & Subramanian, S. (2007). Effect of Aloe vera leaf gel extract on membrane bound phosphatases and lysosomal hydrolases in rats with streptozotocin diabetes. *Die Pharmazie-An International Journal of Pharmaceutical Sciences*, 62(3), 221-225.
36. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, 6(1), i-v. <https://doi.org/10.53730/ijhs.v6n1.5949>
37. Tanaka, M., Misawa, E., Ito, Y., Habara, N., Nomaguchi, K., Yamada, M., ... & Higuchi, R. (2006). Identification of five phytosterols from Aloe vera gel as anti-diabetic compounds. *Biological and Pharmaceutical Bulletin*, 29(7), 1418-1422.
38. The American Society of Health-System Pharmacists. [Archived](#) from the original on 31 August 2017. Retrieved 29 July 2015.
39. Yagi, A., Hegazy, S., Kabbash, A., & Abd-El Wahab, E. (2009). Possible hypoglycemic effect of Aloe vera L. high molecular weight fractions on type 2 diabetic patients. *Saudi Pharmaceutical Journal*, 17(3), 209-215.
40. Yeh, G. Y., Eisenberg, D. M., Kaptchuk, T. J., & Phillips, R. S. (2003). Systematic review of herbs and dietary supplements for glycemic control in diabetes. *Diabetes care*, 26(4), 1277-1294.
41. Yuriah, S., Kartini, F., & Isnaeni, Y. (2022). Experiences of women with preeclampsia. *International Journal of Health & Medical Sciences*, 5(3), 201-210. <https://doi.org/10.21744/ijhms.v5n3.1901>