OPEN ACCESS

Original Article

Comparative Effects of Dried Aloe Vera Gel on Blood Sugar (glucose) in Type-I and Type-II Diabetic Patients

Noor Younis[1,2], Muneeb Khan[2], Muhammad Adnan Hafeez,[3] Muhammad Imran Hussain[4], Hamza Jan[5]

[1] School of Health Sciences, University of Management and Technology, Lahore, Pakistan
[2] National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan
[3] Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan
[4] Riphah College of Rehabilitation and Allied Health Sciences, Riphah International University, Lahore, Pakistan
[5] Department of Allied Health Sciences, Al-Razi Institute, Lahore, Pakistan

Author`s Contribution

NY, MK Conception and design, Collection and assembly of data, Preparation of article MA,MI,HJ Analysis and interpretation of the data, Statistical expertise, MI Final approval and guarantor of the article

Article Info.

Received: March 04, 2022
Acceptance: April 25, 2022

Conflict of Interest: None
Funding Sources: None

Address of Correspondence

Noor Younis
nooryounis000@gmail.com

DOI: 10.53389/RJAHS.2022010107

A B S T R A C T

Background: The interest of using medicinal plants is getting publicity now a day. This may be due to the increased awareness regarding pharmaceutical products made synthetically and about side effects that occurs by using them against specific disease. One such medicinal plant i.e., Aloe vera holds many properties like healing of wounds. Curing joints pain, treating peptic ulcers and digestive problems, wounds and cuts are healed by employing Aloe on it. Aloe vera holds ability to work against inflammatory responses as well as being antifungal, antibacterial, anti-tumor, and anti-cancerous properties due to presence of active compounds.

Objective: The purpose of conducting this study was to estimate the effect of dried Aloe vera gel powder on blood glucose level of diabetic (Type-I and Type-II) patients.

Methodology: The current study was conducted in the National Institute of Food Science and Technology, Faculty of Food Nutrition and Home Sciences at University of Agriculture, Faisalabad. Aloe vera (Aloe Barbadensis) for present study was obtained from Botanical Garden, Dept. of Botany, University of Agriculture, Faisalabad. All materials were procured in fresh unprocessed form. The stems were thoroughly washed with tap water and gelt was obtained from the stems by slicing and then dried in an air circulating oven in the laboratory. Among phytochemical testing two tests were carried out involving total phenolics content and total flavonoids content.

Results: Total flavonoids content and total phenolic content of dried Aloe vera gel powder was calculated as 0.21mg (QE)/g and 2.4mg (QE)/g, respectively. Overall T1 (receiving 10mg of dried aloe vera powder) showed significantly reduced blood glucose level (114 mg/dL) in Type-II diabetic patients after four weeks.

Conclusion: It was concluded that Aloe vera is effective for maintaining blood glucose to a great extent, but its response varied between Type-I and Type-II patients. Drastic change in blood glucose concentration was observed in patients who fall under the category of NIDDM. While there is a least effect among patients of IDDM.

Introduction

Aloe vera commonly termed as Barbadensis Miller is considered as one of the major therapeutic plants that possess properties of balancing blood sugar. From long time Aloe and its different species are involved because if their fascinating properties most commonly property against diabetes.[1,2] Herb can work against digestive issues including poor appetite, constipation, irritable bowel syndrome, and more remarkable diabetes mellitus, peptic sorings, immune system improvement, and asthma. This lodge also shows some remedial qualities.[3] Clinically Aloe vera was initially used for curing radiation burns and wounds in 1930 but with passing years it has become an important ingredient in many ointments and other cosmetic products. Aloe vera also

possesses Laxative properties.[4] However, there also exist some negative outcomes of consuming Aloe vera if consumed in a high dosage. Toxicity may be due to the presence of aloin in it.[5–7]

Most widespread illness in recent century is diabetes mellitus. Huge number of populations has been diagnosed with diabetes at upsetting rate in tropical regions due to increased ratio of in active living style and obesity.[8,9] Diabetes mellitus disease comes with several complications CVDs, atherosclerosis, neuropathy, and nephropathy.[10] Oxidative stress is most obvious linked complication of Diabetes Mellitus that result due to increased concentration of sugar in blood. The amplified oxidative load in body tissues and its cells take place due to decline in synthesis of antioxidants in different body parts and due to unnecessary reactive oxygen free groups.[11,12]

Aloe vera is very popular among all medicinal plants from a very long period. Its Grey- green leaves of lance shape contain pulp in the form of clear gel that contains a lot of health-giving compounds. Previous research related to orally administered Aloe vera gel in extreme glucose load had shown positive results especially in STZ induced diabetes.[13] Back to 15 years from 2001 aloe vera was extensively used for treating diabetes.[14–17] The optimistic result of Aloe class on balancing Diabetes Mellitus was most probably due to presence of 5 bioactive present in it. These health-giving bioactive compounds are separated and recognized experimentally classified as I phenol, cycloartanol, 24-methylene-cycloartanol, 24-methyl-lophenol, 24-ethyl-lophenol. These experimentally determined 5 phytosterols showed anti-hyperglycemic property on patients having diabetes Type-II. Occurrence of Polyphenols makes Aloe vera a renowned plant for harmonizing blood glucose and therefore used for treating diabetes mellitus.[18] Several studies have shown formation of free radicals during diabetes that result in glucose autoxidation. All these processes cause damage to body organs and systems. Contents of aloe vera have potency to combat such issues that occurs during diabetes.[19] The latex portion of Aloe plant contains some important components namely anthraquinone glycosides which is somewhat different from gel polysaccharides. Many phenolic compounds having antioxidant property were experimentally isolated and were given the name aloe resin derivatives.[20] China, Japan, Mexico and Egypt are the countries where there is extensive use of aloe vera because of its medicinal properties. These countries taking benefit from the pharmacological property of this plant.[2] Aloe vera is extensively used in medicine and as a preservative. It is commercially available as ointments, jelly, creams, drinks, pills, and lotions. These products are used for different health related conditions ranging from dermatitis to cancer. Except it these products also possess anticancer, antimicrobial, anti-diabetic, and hepatoprotective activities. All these are due to presence of polysaccharides in the gel portion of plant.[21] The present study was designed to check the shelf stability of aloe vera powder and to investigate the effects of aloe vera gel powder on the blood glucose level in diabetic patients (Type-I and Type-II).

Methodology

The study was performed in the National Institute of Food Science and Technology, Faculty of Food Nutrition and Home Sciences at University of Agriculture, Faisalabad.

Aloe vera (Aloe Barbadensis) for present study was obtained from Botanical Garden, Dept. of Botany, University of Agriculture, Faisalabad. All materials were procured in fresh unprocessed form. The stems were thoroughly washed with tap water and gelt was obtained from the stems by slicing and then dried in an air circulating oven in the laboratory. The powder was than sieved through mesh 300um and stored in an airtight bag as stock sample until required for analysis.

Total phenolic content (TPC) in Aloe vera gel powder was estimated by using Follin Ciocalteu method as explained by Hachkova et al.,[22] In this method phosphotungstic acid was converted to phototungstic blue and as a result there occurs increase in number of aromatic phenolic group. For that purpose, 50uL prepared extract was added separately in 9 test tubes each having 250 uL of Folin-Ciocalteu's reagent and 20% Na_2CO_3 (sodium carbonate) 750uL solution and add distilled water to make final volume of 5 mL. The absorbance was measured after 2 h at 765 nm on UV/Vis

spectrophotometer (CECIL CE7200) by running control in against. Total polyphenols were calculated, and their values were expressed as gallic acid equivalent (GAE; mg gallic acid/g).

$$C = c \times {}^{V}/_{m}$$

Where,

C = Total phenolic contents (mg/g aloe vera extract, in GAE)

c = Concentration of gallic acid (mg/mL)

V = Volume of extract (mL)

m = Weight of aloe vera gel powder (g)

Total flavonoid was calculated by using prescribed method of Maduwanthi et al.,[23] with some minute modifications. Conc. KOH of 1mL was mixed with aqueous extract sample of 2mL and noticed the change in color from green to yellow. 0.5mL of diluted form of ammonia was than mixed to the extracts further 0.2mL conc. H2SO4 was added. Finally, yellow color at the end indicates presence of flavonoids.

Human subjects having Type-I and Type-II diabetes were selected from different localities of Faisalabad. Efficacy study was performed on 15 patients among them seven falls under the category of IDDM and 8 falls under the category of NIDDM. Study period was 28 days.

Four treatments having different potency of dried Aloe vera powder was used in this study. At initiation 15 patients was advocated to check their random blood glucose level 3 hours after breakfast for complete 1st week. For proceeding next 3 weeks they were asked to take 3 treatments periodically in capsules starting from 2nd treatment 1 hour before breakfast and record their results randomly on daily basis.

Table I: Treatments to be used in study

Groups	Treatments
T_0	Controlled group (diseased)
T_1	Receiving 10mg of dried Aloe vera Powder
T_2	Receiving 15mg of dried Aloe vera powder
T_3	Receiving 20mg of dried Aloe vera powder

Blood Glucose was measured by taking blood sample 3 hours after breakfast for complete 28 days. To check the impact of different potencies of Ale Vera gel powder on blood glucose level. For this purpose, blood glucose monitoring system (On Call EZ II) was used. This is advance method of measuring blood glucose level in mg/dL.[24] Data for each parameter was subjected to statistical analysis to determine the level of significance and comparison of means was also carried out according to method as described by Montgomery.[25]

The purpose of conducting such study was to estimate the effect of dried Aloe vera gel powder on blood glucose level. For this purpose, capsules were made with varying potencies of Aloe powder because they were easy to consume and time consuming. Moreover, it was easy for the subjects to store Aloe vera gel after dehydration and improved shelf life. Total Phenolic Compounds (TPC) and total flavonoids were assessed also to explore therapeutic effect of Aloe gel powder against Diabetes Mellitus. Oxidative stress is the cause of many health-related issues in human life, and it had put high morbidity burden on society therefore it is intense need at that time to reduce this rate and for this purpose phytochemicals play a very important role.[26] There include many compounds in this category like polyphenols, phytosterols, alkanes, organic acids, indoles, and aldehydes. All these health-giving compounds possess some sort of pharmacological qualities and hence useful to study.

Different studies have been done in past to check the presence and rate of Phenolic contents in dried aloe vera gel. One such study shows that Total Phenolic contents of gel extracted by soxhlets method showed presence of 2.06mg (GAE)/g. Study also showed that different extraction techniques in turn affect the value of Polyphenols hence varying extraction method in turn will give different value of TPC.[27] The value mentioned in above study is much closer to the value calculated above in dried Aloe vera gel powder. Another study was performed in which 13 phenolic compounds were identified by using the technique of chromatography by using methanol. These Phenolic compounds were known to possess good antioxidant properties. Difference in two species of Aloe vera due to seasonal variation was also checked by this study.[28] In one study aloe vera plants of different age were studied to check the difference of TPC among them. For this purpose, Aloe vera plant of 3 ages specifically 2, 3 and 4 years were used. All the results

showed significant antioxidants property on the other hand plant of age 3 showed more concentration as compared to plant of age 2 year and 4 years. So, it was proved that number of antioxidants in Aloe Berbadensis depends also on the age of that plant.[29]

Results

Total flavonoids of dried Aloe vera gel powder was checked, and value calculated was 0.21mg (QE)/g. They are the most diversifying photochemical that possess strong property of antioxidation and also works as anti-inflammatory compounds. Many studies were performed to check the level of total flavonoids in Aloe vera gel on such study showed that the gel of Aloe vera contains 0.29mg (QE)/g and this value is much closer to the calculated value mentioned above. It is evident from a study that Total flavonoids in commercially prepared sample are considerably less as compares to the fresh samples. Graphical representation of phytochemicals is shown in Figure 1.

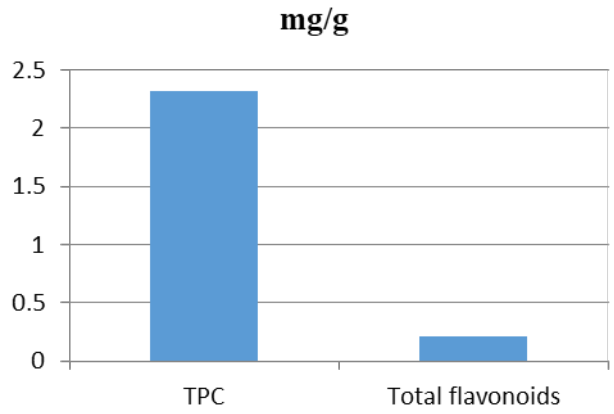

Figure 1: Concentrations of phytochemicals in dried Aloe vera gel powder.

Trial duration was 28 days or 4 weeks. Among them 7 subjects fall under the category of Type-I diabetes on the other hand 8 Patients falls under the category of Type-II diabetes. BMI was calculated and then they were asked to check their random blood glucose 3 hours after breakfast for the first week of trial. For the next three weeks they were restricted to take 3 treatments periodically and to check their blood glucose level 3 hours after breakfast every day. Three doses of 10mg, 15mg, and 20 mg were given in three treatments periodically and then their impact was checked on blood glucose level. Many studies have been performed in past that is the evidence that Aloe vera gel is responsible to manage hyperglycemia to some extent. Diabetes Mellitus is most common disease of the era. A large number of populations have been suffering from the complications linked with diabetes and the condition is very pathetic.

Firstly, mean was calculated individually for all the weeks and then comparative result was calculated by applying proper statistical techniques. Mean values for blood glucose level in Type-I diabetes mellitus patients have been shown in Table II.

Above mentioned result clearly depicts that the effect of all treatments of Aloe vera gel powder given for 4 weeks to Type-I diabetic patient did not affect the blood glucose level to a great extent. The result shows variation in blood glucose during all weeks of treatment. The blood glucose concentration remains almost similar throughout the study plan there in no difference shown by the graphical representation as well. Thus, it was concluded from the trends observed in Type-I patient after consuming treatment for 28 days that Aloe vera is not effective in Type-I diabetic patients. the reason is still unknown, but it may be due to complete resistance of insulin production in the body or due to related complications of the disease. Type-I diabetes is immune mediated disease in which body's immune system attacks its very own Pancreas and retard the secretion of insulin.[30] Externally providing insulin will ease the complications of diabetes.[31]

At the end research concluded that groups of subjects treated with aloe gel or leaf showed a drastic improvement in liver damage on the other hang it ultimately maintained their blood sugar.[32] In both acute

Table II: Mean values for blood glucose level of Type-I and Type-II diabetic patients

Treatments	Patient type	Weeks			
		1st	2nd	3rd	4th
T_0	Type-I	194.57±5.44[a]	193±5.06[a]	192.29±4.60[a]	193.71±4.64[a]
T_0	Type-II	223.14±5.08[a]	223±5.88[a]	222.43±5.50[a]	220.71±5.93[a]
T_1	Type-I	261±20.41[a]	254±6.82[a]	251±14.84[b]	243±7.67[c]
T_1	Type-II	194±7.52[a]	194±9.50[a]	154±14.33[b]	114±6.96[c]
T_2	Type-I	191±8.01[a]	173±13.27[a]	147±8.98[b]	144±5.85[c]
T_2	Type-II	188±5.95[a]	168±4.49[b]	156±3.73[b]	135±5.25[b]
T_3	Type-I	204±8.82[a]	177±6.82[b]	157±7.25[c]	137±4.77[d]
T_3	Type-II	179.00±4.76[a]	167±4.64[a]	162±5.52[a]	161±3.55[a]

[abcd] Mean values in each column followed by different letters are significantly different (p≤0.05)

T_0 = No treatment
T_1 = Received 10mg of dried aloe vera gel powder
T_2 = Received 15mg of dried aloe vera gel powder
T_3 = Received 20mg of dried aloe vera gel powder

and chronic state of Type-II diabetes Aloe vera is effective.[33] Another study revealed that consuming Aloe juice significantly decreased blood glucose, triglyceride, and cholesterol level from first week of treatment and it goes on until whole study is ended on the other hand no change can be seen in these 3 parameters in the subjects not treated with Aloe juice thrice a week.[34] Reviews from the past favors the present study and thus prove it right that Aloe vera is very beneficial and useful for the patients suffering from non-insulin dependent diabetes mellitus.

Discussion

It is a fact that Type-II diabetes is incurable although it is possible to treat it successfully. Many factors are involved in it like healthy lifestyle, healthy diet, weight management etc.[35] Due to inactive lifestyle and obesity the cases of NIDDM are increasing at increasing rate specially in western countries of the world.[36] In 2010 almost 220 million humans were suffering from D. Mellitus and their number was expected to raise.[10,37] NIDDM is further linked with many complications including retinopathy, atherosclerosis, neuropathy and nephropathy.[38] It is obvious that the major complication that occurs most probably with diabetes is the production of free radicals. That started doing auto oxidation in the body and many organs and linings were affected by it.[39]

Polyphenols and flavonoids from plant sources enhance insulin secretions and moreover by maintaining insulin sensitivity they are effective.[40] The antioxidant property of Aloe is also due the presence of polyphenols presents in it. The Soxhlet extraction had most obvious results as compared to others. So, it was clear from the following fact that the free hydrogen ions present in structure of phenol are responsible for free radical capturing activity.[41] Aloe vera possesses many biologically active constituents in it they are listed as saponins, minerals. Sugars, enzymes, vitamins, Polyphenols, phytosterols etc.[42] Different studies showed different percentages of blood glucose reduction after consumption of Aloe vera. There occur 30% and 34% reduction in blood sugar after intake of Aloe extract for 2 to 3 hours.[43] On the other hand, chronic treatment by using same extract causes 7% reduction in blood sugar.[40]

After confirmation of chemically active compounds Aloe vera was allowed to consume by human subjects with increasing potency for the proceeding 3 weeks. 28 days trial fruitfully gave accurate results and illustrates the comparative effect of dry powder Aloe vera gel on blood sugar level between IDDM and NIDDM. The difference was clear and noticeable. Aloe vera brought immense reduction in glucose concentration of non-insulin dependent patients, especially during the 3rd week of the trial. In first and second week the impact was random. There were ups and down in peaks of grid. It seems that the body was adjusting itself during these 1st two weeks. On the other hand, consequence of consuming dry Aloe vera was not so obvious among subjects of Type-I that were dependent on Insulin for regulating cellular functions.[44] Peaks of the grid showed no drastic change in height because of minor variation in blood sugar level. Not even the highest potency did work for it in last week. So, it was concluded that there occurs little or no change in

blood sugar amount by consuming Aloe gel in IDDM patients.

Conclusion

From the study it was concluded that Aloe vera is effective for maintaining blood glucose to a great extent, but its response varied between Type-I and Type-II patients. Drastic change in blood glucose concentration was observed in patients who fall under the category of NIDDM. While there is a least effect among patients of IDDM.

References

1. Can A, Akev N, Ozsoy N, Bolkent S, Pelin ARDA B, Yanardag R, et al. Effect of Aloe vera leaf gel and pulp extracts on the liver in type-II diabetic rat models. Biol Pharm Bull [Internet]. 2004 ;27(5):694-8. https://doi.org/10.1248/bpb.27.694
2. Sahu PK, Giri DD, Singh R, Pandey P, Gupta S, Shrivastava AK, et al. Therapeutic and Medicinal Uses of Aloe vera: A Review. Pharmacology & Pharmacy. 2013 ;04(08):599-610. https://doi.org/10.4236/pp.2013.48086
3. Govindasamy J, Moss S, Parise R, Nadar RM, Pathak S, Ramesh S, et al. Traditional, Cultural, and Nutraceutical Aspects of Cannabis in India. Cannabis/Marijuana for Healthcare. 2022;301-19. https://doi.org/10.1007/978-981-16-8822-5_15
4. Singh B, Yadav R, Singh H, Singh G, Punia A. Studies on Effect of Pcr-rapd Conditions for Molecular Analysis in Asparagus (Satawari) and Aloe Vera" Medicinal Plants. Aust J Basic Appl Sci. 2010;4(12):6570-4.
5. Mossa JS. A study on the crude antidiabetic drugs used in arabian folk medicine. Pharm Biol. 1985;23(3):137-45. https://doi.org/10.3109/13880208509069018
6. Román-Ramos R, Flores-Sáenz JL, Partida-Hernández G, Lara-Lemus A, Alarcón-Aguilar F. Experimental study of the hypoglycemic effect of some antidiabetic plants. Arch Invest Med (Mex. 1991 ;22(1):87-93.
7. Koo MWL. Aloe vera: Antiulcer and antidiabetic effects. Phytotherapy Research. 1994;8(8):461-4. https://doi.org/10.1002/ptr.2650080805
8. Esua MF, Rauwald JW. Novel bioactive maloyl glucans from Aloe vera gel: isolation, structure elucidation and in vitro bioassays. Carbohydr Res [Internet]. 2006 Feb [cited 2022 Sep 30];341(3):355-64. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0008621505005483 https://doi.org/10.1016/j.carres.2005.11.022
9. Boudreau M, and FBJ of ES, 2006 undefined. An Evaluation of the Biological and Toxicological Properties of Aloe Barbadensis (Miller), Aloe Vera. Journal of Environmental Science and Health Part C. 2006;24(1):103-54. https://doi.org/10.1080/10590500600614303
10. Zimmet P, Alberti KGMM, Shaw J. Global and societal implications of the diabetes epidemic. Nature . 2001 Dec [;414(6865):782-7. https://doi.org/10.1038/414782a
11. Rajasekaran S, Sivagnanam K, Rep SSP, 2005 undefined. Antioxidant effect of Aloe vera gel extract in streptozotocin-induced diabetes in rats. Citeseer. 2005
12. Akash MSH, Rehman K, Rasool F, Sethi A, Abrar MA, Irshad A, et al. Alternate therapy of type 2 diabetes mellitus (T2DM) with Nigella (Ranunculaceae). J Med Plants Res. 2011 ;5(31):6885-9. https://doi.org/10.5897/JMPR11.1425
13. Rajasekaran S, Sivagnanam K, Ravi K, Subramanian S. Hypoglycemic Effect of Aloe vera Gel on Streptozotocin-Induced Diabetes in Experimental Rats. J Med Food. 2004 Mar;7(1):61-6. https://doi.org/10.1089/109662004322984725
14. Kumar Student MBA AP, Author Abhishek Kumar G Student MBA CP, Kumar A, Zechariah J, John Stephen A, Tripathi P. Study on Aloe vera leaves farming in Rajasthan. The Pharma Innovation Journal. 2022;11(5):289-91.
15. Hikino H, Takahashi M, Murakami M, Chohachikonno, Mirin Y, Karikura M, et al. Isolation and hypoglycemic activity of arborans a and b, glycans of aloe arborescens var. Natalensis leaves. Pharm Biol. 1986;24(4):183-6. https://doi.org/10.3109/13880208609060897
16. Ghannam N, Kingston M, Al-Meshaal IA, Tariq M, Parman NS, Woodhouse N. The Antidiabetic Activity of Aloes: Preliminary Clinical and Experimental Observations. Horm Res [Internet]. 1986 [cited 2022 Sep 30];24(4):288-94. Available from: https://www.karger.com/Article/FullText/180569 https://doi.org/10.1159/000180569
17. Yongchaiyudha S, Rungpitarangsi V, Bunyapraphatsara N, Chokechaijaroenporn O. Antidiabetic activity of Aloe vera L. juice. I. Clinical trial in new cases of diabetes mellitus. Phytomedicine. 1996;3(3):241-3. https://doi.org/10.1016/S0944-7113(96)80060-2
18. Tanaka M, Misawa E, Ito Y, Habara N, Nomaguchi K, Yamada M, et al. Identification of five phytosterols from Aloe vera gel as anti-diabetic compounds. Biol Pharm Bull. 2006;29(7):1418-22. https://doi.org/10.1248/bpb.29.1418
19. Oberley LW. Free radicals and diabetes. Free Radic Biol Med [Internet]. 1988 Jan [cited 2022 Sep 30];5(2):113-24. Available from: https://linkinghub.elsevier.com/retrieve/pii/0891584988900366 https://doi.org/10.1016/0891-5849(88)90036-6
20. Abouelela ME, Assaf HK, Abdelhamid RA, Elkhyat ES, Sayed AM, Oszako T, et al. Identification of Potential SARS-CoV-2 Main Protease and Spike Protein Inhibitors from the Genus Aloe: An In Silico Study for Drug Development. Molecules [Internet]. 2021 [cited 2022 Sep 30];26(6):1767. https://doi.org/10.3390/molecules26061767
21. Manvitha K and, Bidya B. Aloe vera: a wonder plant its history, cultivation and medicinal uses. J Pharmacogn Phytochem [Internet]. 2014 [cited 2022 Sep 30];2(5):85-8. Available from: http://naturalingredient.org/wp/wp-content/uploads/19.1.pdf
22. Hachkova H, Nagalievska M, Soliljak Z, Kanyuka O, Kucharska AZ, Sokół-Łętowska A, et al. Medicinal Plants Galega officinalis L. and Yacon Leaves as Potential Sources of Antidiabetic Drugs. Antioxidants [Internet]. 2021 Aug 26 [cited 2022 Sep 30];10(9):1362. Available from: https://www.mdpi.com/2076-3921/10/9/1362 https://doi.org/10.3390/antiox10091362

23. Maduwanthi SDT, Marapana RAUJ. Total phenolics, flavonoids and antioxidant activity following simulated gastro-intestinal digestion and dialysis of banana (Musa acuminata, AAB) as affected by induced ripening agents. Food Chem [Internet]. 2021 Mar [cited 2022 Sep 30];339:127909. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0308814620317714 https://doi.org/10.1016/j.foodchem.2020.127909
24. Rhoden G, Nelson H,SVIJ of, 2021 undefined. Blood glucose levels in response to 1 hour of esports training: A pilot study. International Journal of Esports. 2021 ;1(1). 25. Montgomery D. Design and analysis of experiments [Internet]. Montgomery D, editor. John Wiley & Sons; 2017
26. Ayoola GA, Coker H, Adesegun SA, Adepoju-Bello AA, Obaweya K, Ezennia EC, et al. Phytochemical screening and antioxidant activities of some selected medicinal plants used for malaria therapy in Southwestern Nigeria. Tropical Journal of Pharmaceutical Research [Internet]. 2008 [cited 2022 Sep 30];7(3):1019-24. Available from: https://www.ajol.info/index.php/tjpr/article/view/14686 https://doi.org/10.4314/tjpr.v7i3.14686
27. Amri A, Bouraoui Z, Balbuena-Pecino S, Capilla E, Gharred T, Haouas Z, et al. Dietary supplementation with Aloe vera induces hepatic steatosis and oxidative stress together with a disruption of cellular signaling pathways and lipid metabolism. Aquaculture.2022;738433. https://doi.org/10.1016/j.aquaculture.2022.738433
28. Cuvas-Limón R, Ferreira-Santos P, Molecules MC, 2022 undefined. Novel Bio-Functional Aloe vera Beverages Fermented by Probiotic Enterococcus faecium and Lactobacillus lactis. Molecules [Internet]. 2022 [cited 2022 Sep 30];27(8):2473. https://doi.org/10.3390/molecules27082473
29. Tawfik E and, Medhat M. Identifications of Aloe vera fractions and application as a cure for diseases. Network [Internet]. 2022;3(7):5-12.
30. Sindhu RK, Madaan P, Chandel P, Akter R, Adilakshmi G, Rahman MdH. Therapeutic Approaches for the Management of Autoimmune Disorders via Gene Therapy: Prospects, Challenges and Opportunities. Curr Gene Ther. 2022 ;22(3):245-61. https://doi.org/10.2174/1566523221666210916113609
31. Pozzilli P, Pieralice S. Early Diagnosis of Type 1 Diabetes - Useful or a Pyrrhic Victory? Clinical Dilemmas in Diabetes. 2021 ;17-36. https://doi.org/10.1002/9781119603207.ch2
32. Wang X, Gasmi A, Kumar Mujawdiya P, Noor S, Lysiuk R, Darmohray R, et al. Polyphenols in Metabolic Diseases. Molecules. 2022 ;27(19):6280. https://doi.org/10.3390/molecules27196280
33. Akinmoladun A, Biotechnology OAAJ of, 2007 undefined. Prevention of the onset of hyperglycaemia by extracts of Aloe barbadensis in rabbits treated with alloxan. Afr J Biotechnol [Internet]. 2007;6(8):1028-30.
34. Chhikara N, Kaur A, Mann S, Garg MK, Sofi SA, Panghal A. Bioactive compounds, associated health benefits and safety considerations of Moringa oleifera L.: an updated review. Nutr Food Sci. 2021 Feb 19;51(2):255-77. https://doi.org/10.1108/NFS-03-2020-0087
35. Bello B. Evaluation of hypoglycaemic and antihyperglycaemic activity of methanolic wholeplant extract of Schwenckia americana (Solanacae) in normal and alloxan-induced diabetic rats. Afr J Pharm Pharmacol [Internet]. 2013;7(39):2662-6. https://doi.org/10.5897/AJPP2013.3676
36. DeFronzo RA, Bonadonna RC, Ferrannini E. Pathogenesis of NIDDM: A Balanced Overview. Diabetes Care [Internet]. 1992;15(3):318-68. https://doi.org/10.2337/diacare.15.3.318
37. King H, Aubert R, care WHD, 1998 undefined. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. Am Diabetes Assoc . 1998 ;21:1414-31. https://doi.org/10.2337/diacare.21.9.1414
38. Reinehr T. Type 2 diabetes mellitus in children and adolescents. World J Diabetes. 2013 ;4(6):270. https://doi.org/10.4239/wjd.v4.i6.270
39. Shakib Z, Shahraki N, Bibi |, Razavi M, Hosseinzadeh H. Aloe vera as an herbal medicine in the treatment of metabolic syndrome: A review. Phytotherapy Research [. 2019;33(10):2649-60. https://doi.org/10.1002/ptr.6465
40. Caponio F, Summo C, Delcuratolo D, Pasqualone A. Quality of the lipid fraction of Italian biscuits. J Sci Food Agric. 2006;86(3):356-61. https://doi.org/10.1002/jsfa.2357
41. Ozsoy N, Candoken E, Akev N. Implications for Degenerative Disorders: Antioxidative Activity, Total Phenols, Flavonoids, Ascorbic Acid, β-Carotene and β-Tocopherol in Aloe vera. Oxid Med Cell Longev. 2009 ;2(2):99-106. https://doi.org/10.4161/oxim.2.2.8493
42. Inan A, Şen M, Koca C, Ergin M, Practice CDS, 2007 undefined. Effects of Aloe vera on colonic anastomoses of rats. Surg Pract. 2007 ;11(2):60-5. https://doi.org/10.1111/j.1744-1633.2007.00339.x
43. Okyar A, Can AA, Akev N, Baktir G, Sütlüpinar N. Effect of Aloe vera leaves on blood glucose level in type I and type II diabetic rat models. Phytotherapy Research [Internet]. 2001;15(2):157-61. https://doi.org/10.1002/ptr.719
44. Sium M, Kareru P, Kiage-Mokua B, Sood K, Langley J, Herniman J. In vitro anti-diabetic activities and phytochemical analysis of bioactive fractions present in Meriandra dianthera, Aloe camperi and a Polyherb. Am J Plant Sci. 2017;8:533-48. https://doi.org/10.4236/ajps.2017.83037