Antihyperglicemic and Antioxidant Potential of *Aloe vera* Juice Supplementation in the Type-II Diabetic Rats Model

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Abstract: To evaluate the potential effects of *Aloe vera* supplementation on blood glucose and antioxidant enzymes (Glutathione peroxidase, GPx; Superoxide dismutase, SOD) as well as lipid peroxides (Malondialdehyde, MDA) in the kidneys of experimental type-II Diabetic rats model. This was an experimental study with post-test only control group study design. Type-II diabetes rats were induced by streptozotocin (60 mg/kg, ip) and nicotinamide (230 mg/kg, ip) to Wistar rats. The diabetic rats were randomized into three groups, as follows: (i) Diabetic control rats (received CMC-Na 1 % vehicle only); (ii). Diabetic rats received glibenclamide 0,18 mg/200g orally once daily; (iii) diabetic rats group received glibenclamide (0,18 mg/200g body weight) as well as *Aloe vera* juice supplementation (3,6 mL/200 g body weight) orally once daily for 30 days. Rats fasted over night and the blood was withdrawn by retro-orbital puncture under light ether anesthesia on the pre-induction and 1st, 7th, 14th and 28th post induction to determine blood glucose. The kidney tissues of rats were taken under anesthesia at the end of 30 days. In the third group showed the decrease of blood glucose level significantly ($p<0,05$) compare to others. In addition to that, the third group has lower MDA levels and higher GPx and SOD enzyme levels compared to other groups ($P<0,05$). Aloe vera juice supplementation has antidiabetic and antioxidant potentials for type-II diabetes mellitus rats model being treated with standard medicine, glibenclamide.

Keywords: Antioxidant, Aloe vera, diabetes mellitus, antihyperglycemic, streptozotocin-nicotinamide.

INTRODUCTION

In chronic hyperglycemia condition, which is a characteristic of diabetes mellitus, tissue damages caused by increased oxidative stress are bound to happen [1-3]. Oxidative stress is thought to contribute to the development and progressivity of diabetic complication, either micro or macrovascular. The increase of oxidative stress is triggered by the formation of *reactive oxygen species* (ROS) that cannot be counterbalanced with antioxidant defense. The imbalance between ROS and antioxidant defense would cause damage to many vital organs in human body, and in consequence, would also increase the development and progressivity of either micro or macrovascular complication of diabetes mellitus [4]. These effects need to be prevented so that further damages can be avoided.

Majority of currently available hyperglycemia medication have not been able to prevent complications that are caused by oxidative stress. Even though the antioxidant properties of some antidiabetic medication had been researched, complications caused by oxidative stress in type 2 DM is still unavoidable [5]. Because of these reasons, a solution needs to be developed. One of the possible solutions is the administration of natural antioxidant supplementation that can assist in balancing the formation of ROS with the defense of antioxidant.

Aloe vera (*Aloe barbadensis Miller*) is a natural ingredient that can easily be found in Indonesia. This plant is a herbaceous plant that resembles a cactus, triangular shaped, with fleshy leaves, shiny, the edge of the leaf is often spiked with the pointed tip, varying length, and contain a clear viscous gel [6]. This plant is known to have a lot of health benefits, such as anti-inflammation, anti-bacterial, anti-rheumatic, antiseptic, and anti-diabetic [7]. Many studies have shown that *Aloe vera* can increase antioxidant defense and prevent oxidative damages in Diabetes Mellitus animal models [8-10].

This study is designed to determine the differences of antioxidant enzyme levels and lipid peroxide levels in the kidneys of type 2 Diabetes Mellitus Rats Model treated with glibenclamide who received *Aloe vera* juice supplementation compare to those who did not receive *Aloe vera* juice supplementation.

MATERIALS AND METHODS

Chemical and Reagents

The *Aloe vera* plants were collected from cultivation agricultural center in Purworejo, Central Jawa in early 2015. Glibenclamide in the form of pharmagrid powder (PT.IFARS), Streptozotocin (*Nacalay tesque Inc*.,

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Kyoto, Japan) and nicotinamide (N3376 Sigma Aldrich, molecular weight (MW) 122.12 and other chemical substances that are used to analyze the activities of SOD dan GPx enzymes comes from Pusat Antar Universitas (PAU) Universitas Gadjah Mada (UGM), and chemicals that are used to measure MDA is obtained from PAU UGM Yogyakarta.

Preparation of *Aloe vera* Juice

The *Aloe Vera* used in this study is riped ones, which are those located at the bottom and weigh around 0,90 – 1,5 kg. Plant determination has been done in Laboratorium Penelitian dan Pengujian Terpadu (LPPT), Gadjah Mada University, Yogyakarta, Indonesia. *Aloe vera* is rinsed with clean water, and then the skin is removed. Next, it is rinsed with warm water to remove its bitter exudates. Then, the *Aloe vera* is blended and its puree is filtered. New *Aloe vera* juice is made every time. The concentration of *Aloe vera* juice given to type 2 Diabetes Mellitus rats model is used only one concentration which is 3,6 mL/200 g BW/day, that refers to the concentration commonly used by society.

Preparation of Glibenclamide

Glibenclamide is given in the dose of 10 mg. Dosage conversion in human with body weight (BW) 70 kg, in rats model with BW 200g is 0,018, hence the dosage for 200 g rats, is : 0,018 x 10 mg = 0,18 mg/ 200 g BW. Glibenclamide is given in suspension from. The suspension agent is CMC-Na 1 %. Every 0,5 mL glibenclamide suspension contains 0,18 mg (0,5 mL/200 g BW/rats/day).

Experimental Animals

Male albino Wistar rats (180-250 g) comes from Pangan dan Gizi Pusat Antar Universitas (PAU) laboratory, Gadjah Mada University, Yogyakarta, Indonesia. Rats model is acclimatized in clean polypropylene cage for 7 days. Rats are given standard food (PT Japfa Comfeed Indonesia, Tbk) and drink *ad libitum*. Rats general condition and body weight are monitored. This study is done in accordance with the rules and guidelines for the use and care of laboratory animals and has been approved by the Research Ethics Committee of the Medical Faculty of Muhammadyah University Yogyakarta, Indonesia (No. 019/EP-FKIK-UMY/I/2015).

Induction of Experimental Diabetes

After rats model have been acclimatized for 7 days, they fast for 10-12 hours before their Fasting Blood Glucose levels are measured. Rats are induced with type 2 Diabetes Mellitus using Nicotinamide (NAD) 230 mg/kg diluted in PBS *(phosphate buffered saline)* intraperitoneally (IP), and 15 minutes after, induced with streptozotocin (STZ) 65 mg/kg diluted in citrate buffer pH 4,5.

Experimental Design

Rats were randomized into 4 groups, in which each groups contain 5 rats:

Group-I: Normal control rats (received 1% Na-CMC vehicle only)

Group-II: Negative control rats (received 60mg/kg body weight of STZ and 230 mg/kg body weight of NAD)

Group-III: Diabetic rats + Glibenclamide (0,18 mg/200g body weight)

Group-IV: Diabetic rats + Glibenclamide (0,18 mg/200g body weight) + Aloe vera juice (3,6 mL/200 g body weight).

Sample Collection

Biochemical Parameters

Blood samples are taken from retro-orbital plexus. Blood samples are taken before induction, day-0 post induction, day-14 post induction, and day-28 post induction. Biochemical parameters being measured are blood glucose level and triglycerides level. Blood glucose is measured using glucose oxidation biosensor by *blood glucose test meter*.

Preparation of Kidney Sample

Intervention is given for 30 days. After that, kidneys sample preparation is done according to Singh *et al.* method, (2002) [11]. After rats are being anesthetized, kidneys are removed and minced into small pieces in cold condition in 5 ml PBS solution (*phosphate buffer saline,* PBS) which contain 11.5 g/L KCl. The resulting homogenates are centrifuged 1074xg until the clear supernatant is obtained. Supernatants are used to measure the concentration of MDA, and the activities of SOD and GPx.

Estimation of Antioxidant Levels

Measurement of *superoxide dismutase* (SOD) enzymes is done according to measurement methods by Wijeratne *et al.* (2005) [12] which is modified accordingly. Estimation of *glutathion peroxidase* (GPx) enzyme levels is analyzed according to Pigeolet *et al*. (1990) method [13].

To measure the concentration of Malondialdehyde (MDA), 0,5 mL samples is added with 2 mL of cold HCl 0,25 N which contain 15% trichloro acetic acid (TCA), 0,38% thiobarbituric acid (TBA), and 0,5% butylated hydroxytoluene (BHT). This mixture is heated in 80^0C for 1 hours. Once cool, the mixture and standard solution are centrifuged 3.500 rpm for 10 minutes. The absorbance of the supernatants is measured at λ 532 nm. 1,1,3,3-tetraetoksipropana (TEP) is used as the standard solution. Preparation of analysis materials and standard solution is done as follows:

1. HCl solution (0,25 N) with 15% TCA 0,38% TB and 0,5% BHT is created by inserting concentrated HCl solution (37%) 5,2 mL into 250 mL volumetric flask, then added 37,5 g TCA, 0,95 g TBA, 1,25 g BHT and added with distilled water until the calibration mark. All mixture is homogenized in a vortex.

2. Standard solution 1.1.3.3 tetraetoxypropane (TEP) is created by preparing 10 µl TEP 97% solution (density: 0,919 g/mL; 4,046 M) into 250 mL volumetric flask, then added with distilled water until the calibration mark. This solution is used as the main solution, and then diluted until work solution in the concentration of 0,5 µM is achieved. From this work solution, a series of standard solution is created in the concentration of 0,50,75,100,125,150,175,200 and 250 mmol/500 µL.

Statistical Analysis

Data is analyzed using SPSS Version 21. Data analysis includes the descriptive analysis will include calculation of mean and standard error (SEM) and if data distribution is normal and homogenous, will be done using *One Way ANOVA* to compare between groups, and followed with *Fishers Least Significant Difference* (LSD)**.**

RESULTS

Visually, all rats model showed normal behavior during the study, including active movement. Rats body weight had been periodically measured for 41 days and the results of the average body weight can be seen in Table **1**.

Table **1** showed that rats model being utilized had met the criteria to be used as test animals in this study. Rats body weight post induction day-0 until day-28 of intervention showed the increase in body weight of group 1,3, and 4. Group 2 showed the decrease in body weight during each measurement. Comparison test using One Way ANOVA showed the significant difference in body weight in minimum two (2) groups.

Results of Blood Glucose Measurement

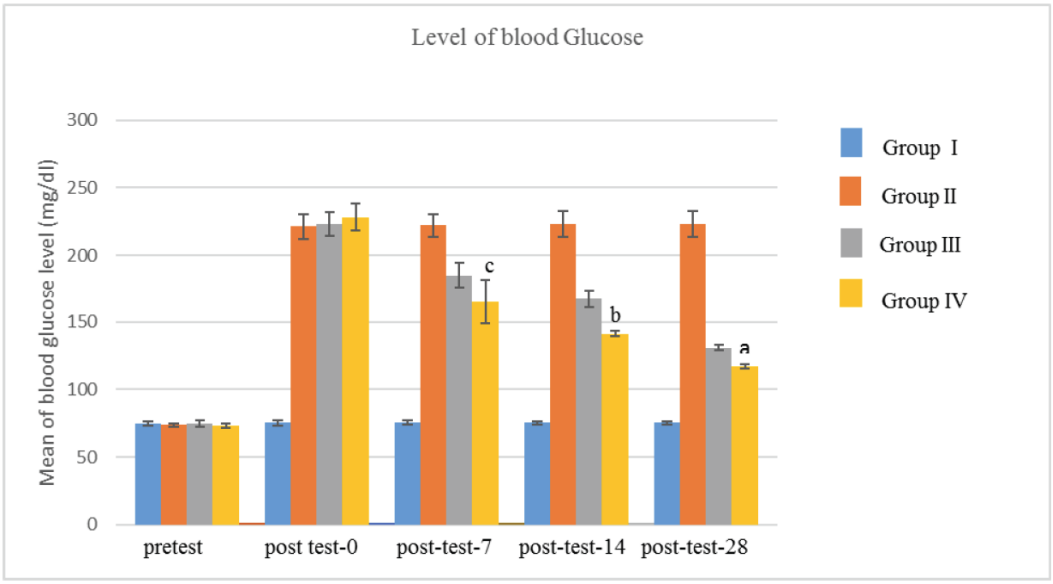
According to Picture **1**, after being induced by STZ-NAD, the fasting blood glucose levels of group I (control normal) did not change significantly (p>0,05) during the study period, within day-0 until day-28 post test. While rats model that was induced with type 2 Diabetes Mellitus, which was group II, showed significantly higher fasting blood glucose level (p<0,00) compare to control normal group on each measurement point.

Picture **1** also shown the significant difference in blood glucose levels (p<0,05) between group IV compare to group II-III on post-test day-7 until day-28. Supplementation of *Aloe vera* juice 3,6 ml/200 g BW in rats model group who received glibenclamide 0,18 mg/200 g BW (group IV), were able to decrease blood glucose level on day-7, compare to group III who was only given glibenclamide 0,18 mg/200 g BW (p<0,05).

Table 1: The Body Weight of Control and Experimental Group

Group	n	Average body weight (gram)				
		Pre-induction	Post-induction			
			Day-0	Day-7	Day-14	Day-28
I	5	208,40±11,4	217,20±10,8	227,80±11,7	237±11,4	257,00±05,41[a]
II	5	207,60±11,2	203,60±10,6	199,60±12,7	198,40±12,7	190,80±04,37[b]
III	5	202,00±06,5	199,00±06,7	197,06±06,7	203,80±06,5	218,20±02,46[c]
IV	5	195,80 ±10,3	194,00±10,4	195,80±09,8	204,20±09,4	222,20±03,49[d]

Note: Group I (Control normal): healthy rats model without induction which were given placebo CMC 0,5 %, group II (control positive): rats model with diabetes mellitus which were givem placebo CMC 0,5 %, group III: rats model with diabetes mellitus which were given glibenclamide 0,18 mg/200g BW, and group IV: rats model with diabetes mellitus which were given glibenclamide 0,18 mg/200g BW and 3,6 ml/200 g BW/days *Aloe Vera* juice supplementation. Results are presented in mean±SEM. [a]:p<0,000 vs group II,III,&IV; [b]:p<0,000 vs group III & IV ; [C]: p<0,000 vs group IV; [d]: p=0,499 vs group III.



Picture 1: Mean fasting blood glucose levels on rats model.

Note: Group I (Control normal): healthy rats model without induction which were given placebo CMC 0,5 %, group II (control positive): rats model with diabetes mellitus which were givem placebo CMC 0,5 %, group III: rats model with diabetes mellitus which were given glibenclamide 0,18 mg/200g BW, and group IV: rats model with diabetes mellitus which were given glibenclamide 0,18 mg/200g BW and 3,6 ml/200 g BW/days *Aloe Vera* juice supplementation. Results are shown in mean±SEM. [a,b,c]: p<0,05 vs group I,II and III.

Similar result was also seen on blood glucose measurement at day-14 and day-28, in which *Aloe vera* juice supplementation 3,6 ml/200 g BW on rats model who also received glibenclamide 0,18 mg/200 g BW (group IV), were able to decrease blood glucose level compared to those who only received glibenclamide alone (group III) (p<0,05).

Results of SOD, GPx, and MDA Measurement

On the last day of intervention (day-31), rats were anesthetized with ketamin-HCL. Then, rats model were dissected and kidneys tissue samples were taken to measure the levels of intracellular antioxidant enzymes like *glutathione peroxidase* (GPx) and *superoxide dismutase* (SOD), as well as membrane lipid peroxide marker (MDA). Data that were obtained from the measurement of enzymes SOD, GPx, and measurement of lipid peroxide MDA was tested by Shapiro-Wilk test of normality. Results showed that data distribution was normal (p>0,05). The same data were also tested with *Levene's test* of homogeneity. Results showed that data were homogenous with p> 0,05.

The mean of SOD levels in group I (control normal) is 82,18±1,56, while the mean in group II (rats with diabetes) is 17,81±1,56, the mean in group III (rats with diabetes who were treated with glibenclamide 0,18 mg/200g BW) is 42,91±2,96, and the mean in group IV (rats with diabetes who were given glibenclamide 0,18 mg/200g BW and *Aloe vera* juice supplementation 3,6 ml/200 g BW/day) is 50,91±2,96 (Table **2**). The result of One way ANOVA significance test, showed the statistically significant difference in the mean of SOD levels in minimal 2(two) groups (p<0,05). The further

Table 2: Level of SOD (%), GPx(U/mg), and MDA (nmol/mg) in Control and Experimental Group

Group	n	SOD	GPx	MDA
I	5	82,18±1,56	72,80±0,26	2,69±0,06
II	5	17,81±1,56	9,28±0,17	9,74±0,04
III	5	42,91±2,96	49,64±0,19	5,46±0,09
IV	5	50,91±2,96[a]	57,88±0,33[b]	3,88±0,11[c]

Note: Group I (Control normal): healthy rats model without induction which were given placebo CMC 0,5 %, group II (control positive): rats model with diabetes mellitus which were givem placebo CMC 0,5 %, group III: rats model with diabetes mellitus which were given glibenclamide 0,18 mg/200g BW, and group IV: rats model with diabetes mellitus which were given glibenclamide 0,18 mg/200g BW and 3,6 ml/200 g BW/days *Aloe Vera* juice supplementation. super oxide dismutase (SOD), Glutathion Peroxidase (GPx). [a,b,c]: p<0,00 vs group III and II. Results are shown in mean±SEM.

test using *Fishers Least Significant Difference* (LSD) showed that the mean of SOD levels in group IV was significantly different compared to group III and II, in which the mean value in group IV was higher than group III and II (p<0,00).

Table **2** showed that the mean of GPx level in group I, which was the control normal group, was higher than any other groups. While the mean of GPx level in IV was significantly different compared to group III and II (p<0,00).

The result of MDA measurement showed that the mean value in group IV was significantly different compared to group III (p<0,00), in which the mean of MDA level in group IV was less than group III.

DISCUSSION

This study utilized male Wistar rats model that was induced with type 2 diabetes mellitus using chemical substances, like streptozotocin (STZ) and nicotinamide (NAD). Streptozotocin is a type of antibiotics derived from *Streptomyces achromogenes* and is a nitrosurea analog. The nature of STZ which is very toxic to pancreatic B cells was the main reason to why it was chosen as the diabetic induction chemicals for test animals in this study [14]. In the other hand, nicotinamide is a niacin derivat with antioxidant capacity, which was hoped to reduce the cytotoxic effects of STZ. The combination of NAD and STZ were chosen to induce type 2 diabetes mellitus in rats model in this study. Rats model with type 2 diabetes mellitus who were previously induced with STZ and NAD, was reported to be an appropriate model to study the pharmacological effects of certain medicine or natural ingredients, as well as to study the complication of diabetes [15]. The selection of induction dosage in this study was based on the research by Masiello *et al.* [16], in which reported that STZ 65 mg/kg and NAD 230 mg/kg was the most appropriate dosage to develop type 2 diabetes mellitus on rats model.

Rats body weight was measured periodically to monitor the effect of diabetes induction towards body weight. In chronic hyperglicemic condition, especially in diabetes mellitus, weight loss usually happens due to the conversion of lipid and protein into energy, hence the fat and protein reserves would decrease. In this research, it was seen that rats model with diabetes showed the significant decrease in body weight compared to negative control group which are healthy rats that were not induced with STZ-NAD. This result is in line with similar study done by Ramachandraiahgari *et al*., 2014, in which significant loss of body weight was found in group of diabetic rats model induced with STZ compare to normal rats group [17].

The level of blood glucose in group I, which did not receive diabetic induction, showed no increase, which means that the increase of blood glucose level in group II, III and IV were caused by STZ and nicotinamide administration. High levels of blood glucose post-induction with STZ and NAD in group II showed that the administration of CMC 0,5 % did not have any hypoglycemic effects. The mean decrease of blood glucose levels in group IV was higher compared to group III and was proven statistically significant. In addition to that, the blood glucose levels in group IV was nearly similar to blood glucose level of healthy rats in group I compared to group III. These showed that *Aloe vera* juice has high potential to work in synergy with glibenclamid. *Aloe vera* has two active ingredients that play the major role in decreasing blood glucose level, which is chromium and alprogen. Chromium (Cr) has similar effects with glibenclamide which can stimulate insulin secretion by Pancreatic B cells. However, the exact mechanism is still unclear. Chromium can also increases serotonin which increases glucose uptake by skeletal muscle [18]. In addition to that, chromium are able to improve insulin resistance by binding into insulin receptors and increase the activity of tirosin kinase IRS-1 (Insulin Receptor Substrate-1) hence increasing the activities of GLUT 4 in glucose uptake and convert it to energy [9,19]. Alprogen in *Aloe vera* is able to decrease blood glucose level by inhibiting glucose absorption in the intestines through Ca^{2+}, where calcium will bring glucose into the intestine cells and then glucose would be exocitoted by SGLT 1 (Sodium Glucose Transporter-1) and taken pass the intestine membrane. If calcium activities are inhibited, glucose absorption would not occur [20]. *Aloe vera* can also prevent the death of β cells and promote healing for damaged β cells [21].

The Effect of *Aloe vera* Juice Supplementation Towards SOD Levels

The comparison test between all four groups, the group I, II, III and IV, with One way ANOVA showed the significant difference in the changing of SOD levels between the control group and experimental group (p < 0,05). This result indicates that *Aloe vera* juice supplementation can increase the level of SOD enzymes in kidney tissues significantly. Even though the level of SOD enzyme in the group that was treated with glibenclamide 0,18 mg/200 g BW also showed the

significant increase, but the effect of increasing SOD enzyme levels were more visible in group IV, which were given glibenclamide 0,18 mg/200 g BW and *Aloe vera* juice supplementation 3,6 ml/200 g BW/day. The similar result was also seen in a study by Rajasekaran *et al.*, 2005 [22] where *Aloe vera* gel extract was proven able to increase the activity of SOD enzymes in diabetic rats model. The ability of *Aloe vera* in increasing the activities of SOD enzymes was also reported by Abo-Youssef & Messiha, 2013 [10]. In their research, it was reported that the administration of *Aloe vera* 10 ml/kg per day for 14 days in diabetic rats model induced with STZ, were able to increase the concentration of blood SOD enzymes.

The ability of *Aloe vera* in increasing the concentration and activities of antioxidant enzymes SOD is related to its active ingredients. *Aloe vera* is known to have a lot of substances with antioxidant properties, including polyphenol, sterol, fatty acids, and indol. Polyphenol contains a big number of molecules with hydroxyl phenol compound that binds to a ring structure, resulting in its antioxidant activities. Polyphenols are thought to have the ability to prevent a lot of diseases, such as diabetes mellitus, cancer, cardiovascular disease, and neurodegenerative diseases [23].

The Effect of *Aloe vera* Juice Supplementation Towards GPx Enzyme Levels

GPx enzyme is an antioxidant enzyme that contain a certain amount of selenium which can reduce hidrogen peroxide and protect against oxidative stress. This characteristic make GPx enzyme a good indicator to determine the level of oxidative stress. This enzyme has a role in every cells that uses oxygen for their metabolism. Cells with high antioxidant concentration are able to prevent and or fix any damage caused by *reactive oxygen species* (ROS). GPx enzyme is mainly synthesize in the kidneys and can widely found in mamals tissues and blood [24].

In this research, it was found that the mean of GPx enzyme levels in diabetic rats induced with STZ dan NAD for 30 days had significant decreased compare to healthy control rats model. This showed that hyperglycemic condition in type 2 diabetes mellitus rats model caused an altered in oxidative status by decreasing the concentration of GPx antioxidant enzyme. Previous study by Mansouri *et al*., 2011 [25] also showed similar results, in which diabetic rats model induced with STZ had decreased GPx enzyme concentration.

In this research, the mean of GPx enzyme levels in diabetic rats model group that were given glibenclamide 0,18 mg/200g BW and *Aloe vera* juice supplementation 3,6 ml/200 g BW/days was 57,88±0,33. This number was higher than diabetic rats model group that were only given glibenclamide without *Aloe vera* juice supplementation, where the mean of GPx enzyme level was 49,64±0,19. This result indicates that *Aloe vera* juice supplementation can significantly improve the level of GPx enzyim in the kidney tissues of type 2 diabetes mellitus rats model. The similar result was also seen in previous research by Bahram & Daryoush, 2012 [26] where STZ induced diabetic rats model were given *Aloe vera* extract and their liver tissues were analyzed. The result showed that *Aloe vera* could increase the level of GPx enzyme ($p<0,05$).

The Effect of Aloe vera Juice Supplementation Towards MDA Concentration

The result of this study showed the significant increase in the mean value of lipid peroxidase product, MDA, in the kidneys of diabetic rats model induced with STZ and NAD compare to negative control group. This result was similar to the previous study by Mohapatra *et al*., 2013 [27], in which the level of plasma MDA in diabetic rats model increased significantly compared to normal control group. The increase of MDA concentration indicates the damages of oxidative tissues caused by diabetes.

The kidney is an organ that plays the major role in physiological process. Any damage in this organ would cause changing in metabolic activities, including changes in cellular antioxidant status. Chronic hyperglycemia condition is linked to long-term damage and normal physiological function failure of many organs, one of them is the kidney.

Hyperglycemia contributes to the increase of ROS formation that can cause cell damage through many ways, including non ezymatic protein glycation process, glucose oxidation and increase of lipid peroxidase that would damage enzymes, cellular components, and increase insulin resistance due to oxidative stress [28].

In this research, it was found that the mean of MDA concentration in rats model treated with glibenclamide 0,18 mg/200g BW and *Aloe vera* juice supplementation 3,6 ml/200 g BW/days were lower compared to diabetic rats model group that were only given glibenclamide without *Aloe vera* juice supplementation. This result is in coherence with previous study by Bahram &

Daryoush, 2012 [26], in which the administration of *Aloe vera* extract was proven to lower the concentration of MDA in the liver tissues of STZ induced rats model. These findings indicate that *Aloe vera* juice supplementation is able to improve oxidative stress condition. The decrease of MDA concentration indicates that *Aloe vera* juice supplementation is able to inhibit tissue damage caused by oxidative stress that was mediated by the hyperglycemic condition.

The holistic findings of this study showed that *Aloe vera* juice supplementation is able to improve antioxidant status in kidney tissues. Hence, *Aloe vera* have a big potential to be used as prophylactic treatment against diabetic complication due to its antioxidant properties.

CONCLUSION

Aloe vera juice supplementation 3,6 ml/ 200 g BW/day, in STZ and NAD induced rats model that were given glibenclamide 0,18 mg/200 g BW/days, can decrease blood glucose level significantly compare to groups that did not receive *Aloe vera* juice supplementation. *Aloe vera* juice supplementation can also improve the level of antioxidant enzymes SOD, GPx and the concentration of lipid peroxide MDA in experimental diabetes mellitus rats model. Hence, *Aloe vera* juice supplementation has a lot of potentials to be used as antidiabetic and antioxidants in type 2 Diabetes Mellitus that are treated with standard medicine glibenclamide.

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CONFLICT OF INTEREST

None.

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