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The Potential of Dutch Eggplant (*Solanum betaceum*) as a Protector of Bcl-2 Expression in the Hearts of Mice (*Mus musculus*) Exposed to Lead Acetate

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Cardiovascular disease; lead acetate; BCl2; *Solanum betaceum*; Musculus.

ABSTRACT
Cardiovascular disease resulting from atherosclerosis, which is triggered by oxidative stress, can result from lead exposure in the body, as this increases the production of reactive oxygen species (ROS). This study aimed to prove the potential of tamarillo (*Solanum betaceum*) as a protector of Bcl-2 expression in the hearts of mice exposed to lead acetate. This study employed a true experimental laboratory design using stored raw materials (BBT) consisting of male mouse (*Mus musculus*) hearts, with a completely randomized design (CRD). A total of 40 BBT samples were divided into 5 treatment groups, with each group containing 8 samples. Significant results ($p<0.05$) were obtained in each treatment group, with the highest Bcl-2 expression found in the group exposed to lead acetate alone, and the lowest Bcl-2 expression found in the group given the highest dose of tamarillo extract. The dosage of tamarillo extract had an inversely proportional effect on the level of Bcl-2 expression in the hearts of mice. The hearts of mice exposed to lead acetate alone (K2) had a median value of 32.97, while the hearts of mice dosed with 400 mg/kg BW/day (P3) had a median value of 5.97.

INTRODUCTION

Cardiovascular disease remains a significant health concern today, due to its increasing prevalence and its continued status as the leading cause of death worldwide (WHO, 2021). Oxidative stress, which has increased in the modern era, is one of the causative factors that warrants attention. Oxidative stress caused by reactive oxygen species (ROS) in mitochondria has been shown to be a key factor in the atherosclerosis process, which manifests clinically as cardiovascular disease. In addition to promoting the formation of atherosclerosis, ROS can also interfere with lipid metabolism and play a role in plaque rupture, thrombosis, myocardial injury, apoptosis, fibrosis, and heart failure (Pashkow, 2011).

Cardiovascular disease was responsible for 17.9 million deaths worldwide in 2016, accounting for 31% of all global deaths. In addition, the prevalence of cardiovascular disease increased from 257 million in 1990 to 550 million in 2019, and the number of deaths related to cardiovascular disease also showed a significant increase (Lennon, Claussen and Kuersteiner, 2018; WHO, 2021). In Indonesia, cardiovascular disease is the leading cause of morbidity and mortality, accounting for one-third of all causes of death (Maharani et al., 2019). Data from the 2008 Indonesian Family Life Survey (IFLS4) found that less than one-third of the Indonesian population at moderate to high risk of cardiovascular disease received appropriate and adequate risk prevention and treatment (Maharani and Tampubolon, 2014).

Lead is a toxic heavy metal that can be found in air, water, soil, and even food, as it is one of the pollutants present in nature (Ibrahim et al., 2012). When lead is present in the body, it can trigger oxidative stress due to the excessive production of reactive oxygen species (ROS) (Lopes et al., 2016). There are several types of ROS, with the superoxide anion ($O2^{-}$), hydrogen peroxide (H2O2), and hydroxyl radical (OH·) being the most common (Schieber and Chandel, 2014). The oxidative stress that occurs leads to reduced Bcl-2 expression (Pohl et al., 2018). Bcl-2 is an anti-apoptotic protein that functions as an inhibitor of cell apoptosis (Vartak et al., 2017). One approach to protecting Bcl-2 expression from oxidative stress is to reduce ROS concentrations through the use of antioxidants.

One source of antioxidants found in Indonesia is Dutch eggplant (*Solanum betaceum*). *Solanum betaceum* contains several bioactive compounds, such as anthocyanins, flavonols, phenols, and carotenoids (Khaerunnisa et al., 2019). The phenolic content in *Solanum betaceum* can reduce the risk of several types of cancer, cardiovascular disease, and diabetes. In addition, phenols and anthocyanins, which are antioxidants, can also reduce oxidative stress and have antiobesity, anticancer, and antibacterial effects (Diep et al., 2020). Dutch eggplant fruit extract is believed to have a protective effect on the heart due to its anthocyanin content (Alam et al. 2021; Alighadri et al. 2023; Câmara et al. 2022; Krga et al. 2019; Xiang et al. 2025). Until now, information regarding *Solanum betaceum* as an exogenous antioxidant to protect heart cells remains very limited, making it necessary to conduct research on the potential of Dutch eggplant (*Solanum betaceum*) as a protector of Bcl-2 expression in the hearts of mice exposed to lead acetate.

The problem formulation in this study is whether Dutch eggplant (*Solanum betaceum*) has the potential to protect Bcl-2 expression in the hearts of mice (*Mus musculus*) exposed to lead acetate. This study aims to determine the potential of Dutch eggplant as a protector of Bcl-2 expression in the hearts of mice exposed to lead acetate, with the specific objectives of determining Bcl-2 expression in the hearts of mice exposed to lead acetate before and after administration of Dutch eggplant extract, and analyzing the difference in Bcl-2 expression before and after treatment. This study is expected to provide theoretical benefits in the form of additional references and research data on Bcl-2 expression in the hearts of mice exposed to lead acetate, as well as practical benefits as foundational data for further research in humans on the benefits of Dutch eggplant for heart health.

METHOD

This study employed a true experimental design with a completely randomized posttest-only control group design, using stored raw materials (BBT) consisting of male mouse (*Mus musculus*) hearts embedded in paraffin blocks. The study population consisted of 40 BBT samples from healthy mice aged 8–12 weeks and weighing 25–30 grams, divided into 5 groups of 8 samples each: K0 (negative control, distilled water [*aquades*]), K1 (positive control, lead acetate 0.075 g/kg BW/day), and P1, P2, and P3 (lead acetate 0.075 g/kg

BW/day + Dutch eggplant extract at doses of 100, 200, and 400 mg/kg BW/day, respectively). The independent variable was the dose of Dutch eggplant extract, while the dependent variable was Bcl-2 expression in the heart, as measured by immunohistochemistry (IHC), with sex, body weight, age, and animal care and maintenance conditions controlled as control variables. The study was conducted at the Medical Biology Laboratory and the Anatomical Pathology Laboratory, Faculty of Medicine, Universitas Airlangga, Surabaya, from July 2023 to January 2024.

The study procedures included group allocation, preparation of immunohistochemical specimens (fixation, dehydration, clearing, paraffin infiltration, sectioning, and staining with hematoxylin-eosin [H&E] and IHC using anti-Bcl-2 primary antibodies), and observation of Bcl-2 expression under a light microscope at 400x magnification across 5 fields of view per specimen, with brown staining indicating a positive reaction and blue staining indicating a negative reaction. Data were analyzed using the Shapiro-Wilk test (normality) and Levene's test (homogeneity of variance), followed by one-way ANOVA with LSD post hoc testing for normally distributed data, or the Kruskal-Wallis and Mann-Whitney U tests for non-normally distributed data, with a significance level set at $p<0.05$. This study utilized BBT samples from previous research and therefore did not require new ethical approval for the treatment of experimental animals.

RESULT AND DISCUSSION

This study is a true experimental study aimed at determining Bcl-2 expression in the hearts of mice exposed to lead acetate before and after administration of Dutch eggplant extract, and at comparing the two conditions. In this study, there were 5 groups, each consisting of 8 samples of male mice. In the K1 group, the mice's hearts were exposed to distilled water (*aquadest*) only. The K2 group was given lead acetate at a dose of 0.075 g/kg BW/day. The P1 group was given *Solanum betaceum* extract at a dose of 100 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day. The P2 group was given *Solanum betaceum* extract at a dose of 200 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day. The P3 group was given *Solanum betaceum* extract at a dose of 400 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day, bringing the total number of samples to 40.

Table 1. BCl_2 expression in 5 groups of male mice

Group	n	BCl2 Expression		Description
		Mean ± SD	Median (*Range*)	
K1	8	15,43 ± 4,47		Normal distribution
K2	8		32,97 (32,12-36,64)	Normal distribution
P1	8	22,62 ± 4,72		Normal distribution
P2	8	22,3 ± 16,73		Normal distribution
P3	8	5,96 ± 1,19		Normal

	distribution

Source: Authors' analysis of immunohistochemical staining data, 2025

BCl2 expression in the hearts of mice exposed to lead acetate before being given Dutch eggplant extract

In the control group given only distilled water (*aquadest*) (K1), the following results for Bcl-2 expression were obtained (Table 1). Bcl-2 expression data from the 8 mice in the K1 group were normally distributed; therefore, Bcl-2 expression in this group was described as the mean ± standard deviation. The expression of Bcl-2 in the hearts of mice not exposed to lead acetate and given only *aquadest* was 15.43 ± 4.47.

Meanwhile, Bcl-2 expression in the control group given only lead acetate at 0.075 g/kg BW/day, prior to administration of Dutch eggplant extract (K2), was not normally distributed; therefore, Bcl-2 expression in the K2 group was expressed as the median (range). The following is the Bcl-2 expression data for the K2 group (Table 2). Bcl-2 expression in the hearts of mice exposed to lead acetate, prior to administration of Dutch eggplant extract, had a median of 32.97, with a range of 32.12–36.64.

In comparing Bcl-2 expression at baseline (prior to lead acetate exposure) with Bcl-2 expression following lead acetate exposure, a normality test was conducted using the Shapiro-Wilk test, and the data were found to be not normally distributed. The difference between the two groups was subsequently tested using the Kruskal-Wallis test, which revealed a significant difference (Table 3).

Table 5.2. Differences in BCl2 expression in the control group using *aquadest* and the control group given lead acetate exposure

	BCl2 Expression K1	BCl2 Expression K2	Statistical Test Kruskal-Wallis
Sample size	8	8	p = 0.001 ($p < 0.05$)*
Median (Range)	14.07 (10.86–22.59)	32.97 (31.92–38.43)	

Source: Authors' analysis using Kruskal-Wallis test, 2025

The results of this study showed that exposure to lead acetate could significantly increase BCl2 expression (p=0.001). The median expression of BCl2 when given *aquadest* alone was 14.07, while in the group given lead acetate exposure of 0.075 g/kgBB/day, the median expression of BCl2 was higher at 32.97 as shown in figure 5.1.

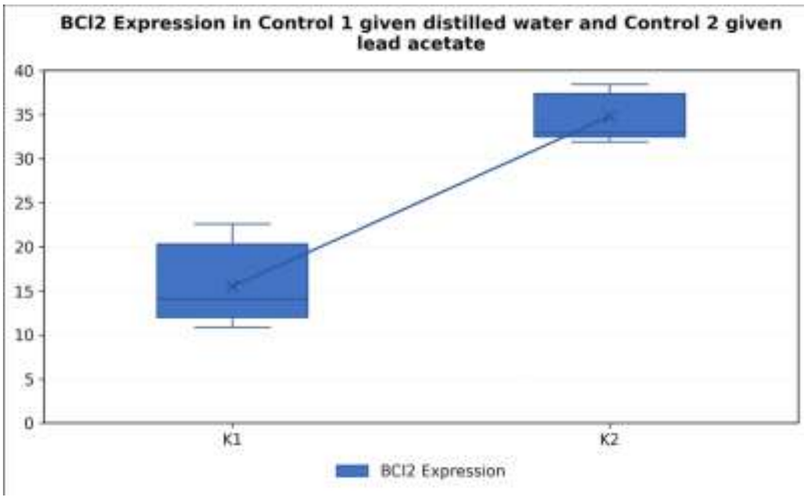

Figure 1. Median plot of BCl2 expression in the K1 and K2 groups

Source: Authors' data visualization using SPSS 26, 2025

BCl2 expression in the hearts of mice exposed to lead acetate after being given Dutch eggplant extract.

In this study, there were 3 treatment groups given Dutch eggplant extract (*Solanum betaceum*). Treatment group 1 was given *Solanum betaceum* extract at 100 mg/kg BW/day and lead acetate at 0.075 g/kg BW/day (P1). Treatment group 2 was given *Solanum betaceum* extract at 200 mg/kg BW/day and lead acetate at 0.075 g/kg BW/day (P2). Treatment group 3 was given *Solanum betaceum* extract at 400 mg/kg BW/day and lead acetate at 0.075 g/kg BW/day (P3). Thus, the difference in treatment among the groups lay in the dose of *Solanum betaceum* extract, while the dose of lead acetate exposure remained the same across all groups.

In treatment group 1, *Solanum betaceum* extract was administered at 100 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day (P1). The data obtained were normally distributed; therefore, Bcl-2 expression in this group was presented as the mean ± SD (Table 3). Based on the table, Bcl-2 expression in the hearts of mice given *Solanum betaceum* extract at 100 mg/kg BW/day was 22.62 ± 4.72.

In treatment group 2, *Solanum betaceum* extract was administered at 200 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day (P2); the data were also normally distributed. The following are the Bcl-2 expression results obtained (Table 3). Bcl-2 expression in the hearts of mice given *Solanum betaceum* extract at 200 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day, was 22.33 ± 16.73.

In treatment group 3, *Solanum betaceum* extract was administered at 400 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day (P3). The data obtained were likewise normally distributed; therefore, Bcl-2 expression results were presented as the mean ± SD (Table 3). Accordingly, Bcl-2 expression in the hearts of mice given *Solanum betaceum* extract at 400 mg/kg BW/day, along with lead acetate at 0.075 g/kg BW/day, was 5.96 ± 1.19.

Bcl-2 expression data from the P1, P2, and P3 groups were statistically tested to assess data distribution, and the Shapiro-Wilk test results were significant, indicating that the P1, P2, and P3 data were normally distributed. Differences among the three groups were subsequently analyzed using one-way ANOVA, and the results showed a significant difference (Table 4).

Table 3. Differences in BCl2 expression in P1, P2, and P3 treatment groups exposed to lead acetate and Dutch eggplant extract

	BCl_2 ExpressionT1	BCl_2 ExpressionT2	BCl_2 ExpressionT3	Statistical Test ANOVA
Total Sample	8	8	8	p = 0.004 ($p < 0.05$)*
Median (Range)	22.62 ± 4.72	22.33 ± 16.73	5.96 ± 1.19	

Source: Authors' analysis using ANOVA test, 2025

After the ANOVA test, a further test was carried out with a statistical LSD test to see the differences between groups and the results were obtained as shown in table 5.4. In the table, no significant differences were found in the P1 and P2 groups. Meanwhile, significant differences were found in the differences between the P1 and P3 groups and P2 and P3.

Table 4. Analyze the differences between the P1, P2, and P3 groups using the test LSD statistics

Inter-group post hoc analysis		LSD Statistical Test
Group T1	Group T2	p = 0.954 ($p < 0.05$)**
Group T1	Group T3	p = 0.003 ($p < 0.05$)*
Group T2	Group T3	p = 0.004 ($p < 0.05$)*

Source: Authors' analysis using LSD post-hoc test, 2025

Comparison of BCl2 expression in mice before and after administration of Dutch eggplant extract

Comparative data on BCl2 expression between before and after Dutch eggplant extract was first analyzed using the Shapiro-Wilk test to see the normality of the data. The test results showed that the data was abnormally distributed, so statistical analysis was carried out with the Kruskal-Wallis test. The results of the Kruskal-Wallis test are presented in table 5 which shows significant differences in each group before and after exposure to lead acetate and after Dutch eggplant extract.

Table 5. Differences in BCl2 expression in each group and test results Statistics Kruskal-Wallis

	BCl2 ExpressionC1	BCl2 ExpressionC2	BCl2 ExpressionT1	BCl2 ExpressionT2	BCl2 ExpressionT3	Statistical TestKruskal-Wallis
Sample Total	8	8	8	8	8	P = 0.0001 ($p < 0.05$)*
Median (Range)	14.07 (10.86–22.59)	32.97 (31.92–38.43)	21.15 (15.12–29.44)	23.27 (0.85–42.49)	5.97 (3.58–7.49)	

Source: Authors' analysis using Kruskal-Wallis test, 2025

It appears that the highest expression of BCl2 was found in the control group given lead acetate alone. Meanwhile, the lowest BCl2 expression was found in the group given lead acetate and Dutch eggplant extract with the largest dose of 400 mg/kgBB/day.

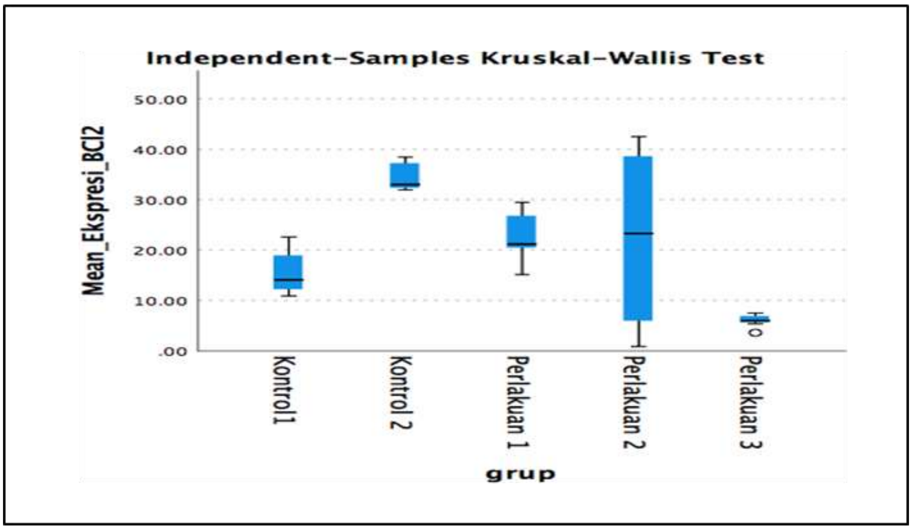

Figure 2. BCl2 expression in the Kruskal-Wallis assay of the whole group

Source: Authors' data visualization using SPSS 26, 2025

After the Kruskal-Wallis test was performed and significant results were obtained, the difference in BCl2 expression between groups was compared using the Dunn test to determine which group was the most different.

Table 6. Differences in BCl2 expression between groups and statistical analysis results using the Dunn test

	K1	K2	P1	P2	P3
K1	-	-	-	-	-
K2	p = 0.004 ($p < 0.05$)*	-	-	-	-
P1	p = 0.305 ($p > 0.05$)**	p = 0.060 ($p > 0.05$)**	-	-	-
P2	p = 0.358 ($p > 0.05$)**	p = 0.047 ($p < 0.05$)*	p = 0.915 ($p > 0.05$)**	-	-
P3	p = 0.080 ($p > 0.05$)**	p = 0.0001 ($p < 0.05$)*	p = 0.005 ($p < 0.05$)*	p = 0.008 ($p < 0.05$)*	-

Source: Authors' analysis using Dunn's post-hoc test, 2025

From table 6, it appears that there is a significant difference between the K1 group (which is given *aquadest* only) and K2 (i.e. given lead acetate only). Significant differences were also found in the K2 group with the P2 group (which was given lead acetate and Dutch eggplant extract 200 mg/kgBB/day) and the K2 group with the P3 group (which is given lead acetate and Dutch eggplant extract 400 mg/kgBB/day). In the P2 group compared to P3, there was also a significant difference.

Description of BCl2 expression in immunohistochemical painting performed on mouse heart tissue. BCl2 expression is characterized by a yellowish-green color. It appears from the immunohistochemical picture that the K2 group has the strongest green density or density. This shows that in the K2 group exposed to lead acetate alone, BCl2 expression has the highest expression. Meanwhile, in the P1, P2 and P3 groups where the mice's hearts were exposed to lead acetate and Dutch eggplant, the green color density resembled that of the K1 group which was only given *aquadest*. This *immunoochemical* picture shows that Dutch eggplant extract can neutralize the effects of giving or exposure to lead acetate.

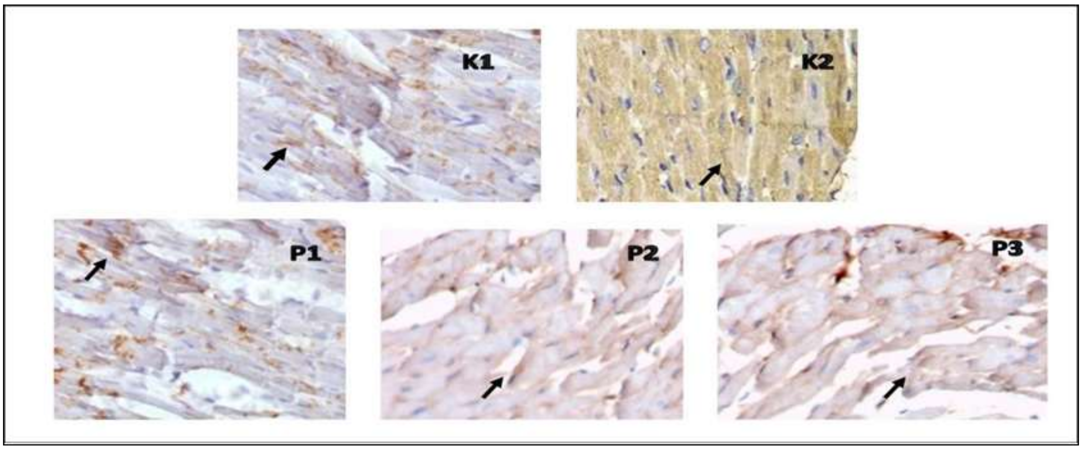

Figure 3. BCl2 expression on immunohistochemical examination in the hearts of mice exposed to lead acetate. Observations using a light microscope with a magnification of 200x.

Source: Authors' documentation of immunohistochemical examination, 2025

The interesting thing about the results of this study is that there is no significant difference between K1 (the group that is only given *aquadest*) and the P1, P2 and P3 groups. This shows that the administration of Dutch eggplant extract either at a dose of 100 mg/kgBB/day, 200 mg/kgBB/day or 400 mg/kgBB/day can provide a protective effect of lead acetate exposure to BCl2 expression. It is evident from the absence of significant differences between the negative control group in this case only *aquadest* and the treatment group given lead acetate with Dutch eggplant extract. The administration of Dutch eggplant extract of 400 mg/kgBB/day had the lowest median BCl2 expression (table 5.5).

Lead or lead (Pb) is a heavy metal that is widely used in the environment for industrial and household purposes. Continuous use will lead to the accumulation of increased levels, thus posing a serious threat to human health (Singh et al., 2018). Lead poisoning can cause neurological, hematological, gastrointestinal, and cardiovascular dysfunction in humans and test animals. Several epidemiological and experimental reports have documented that lead exposure is one of the factors contributing to cardiovascular disorders. Several epidemiological and experimental reports have documented that lead exposure is one of the factors contributing to cardiovascular disorders. (Lai et al., 2002; Reza et al., 2008).

In this study, the subjects used were mice hearts to see the effects of lead toxicity on the heart muscle. In general, mice were chosen as experimental animals in this study because of their short gestation period, short life cycle, easy maintenance, and the similarity of genes between mice and humans that are 99% identical. In this study, there were 5 sample groups consisting of negative control groups, namely mice that were only given *aquadest*, positive control groups, namely mice that were given lead exposure of 0.075 g/kgBB/day, treatment groups consisting of 3 groups each of which were given exposure to lead acetate of 0.075 g/kgBB/day and Dutch eggplant extract (*Solanum betaceum*) with different doses of 100 mg/kgBB/day, 200 mg/kgBB/day, and 400 mg/kgBB/day. The number of samples according to the sample size formula is a minimum of 7 mice per group and in this study the number of samples for each group is 8 mice so that the total sample is 40 mice hearts.

The mechanism of toxicity caused by lead is complex and requires further explanation. One of the important mechanisms of lead toxicity is the induction of apoptosis. The BCl2 family is a regulator of apoptosis as well as other intracellular pathways that have a significant impact on cell survival (Pulido et al., 2003; Ahmed et al., 2013). Therefore, in this study, the effect of lead toxicity on cardiovascular was seen from the expression of BCl2 in the hearts of mice exposed to lead acetate.

In the results of this study, it was found that the administration of lead acetate in the K2 control group gave significantly higher results in BCl2 expression than the K1 control group which was only given *aquadest*. This is similar to the study conducted by Ahmed et al. which obtained results in a study with rats exposed to lead acetate at different doses (low dose 25 mg/kgBB/day, moderate dose 50 mg/kgBB/day and high dose 100 mg/kgBB/day) on BCl2 expression in liver, kidneys and brain obtained a significant increase in lead exposure at high doses of 100 mg/kgBB/day. Meanwhile, in low and moderate doses, no significant increase in BCl2 expression was found (Ahmed et al., 2013). This is in line with this study conducted on mouse heart tissue, where BCl2 expression was significantly increased compared to controls with lead acetate exposure of 0.075 g/kgBB/day or 75 mg/kgBB/day.

Oxidative stress characterized by an imbalance between free radical production and the ability of biological systems to detoxify reactive intermediates or repair the resulting damage is a major mechanism of lead-induced toxicity (Flora et al., 2012; Sani and Amanabo, 2021). Lead-induced oxidative stress will cause lipid peroxidation of cell membranes and sulfhydryl groups in proteins leading to DNA damage (Jurdziak et al., 2018). Xu et al. in their experiments proved an increase in the number of DNA lesions caused by oxidative stress induction, as well as an increase in the expression of p53 protein and BCl-associated X protein (BAX) resulting in an imbalance between Bax and BCl2 expression (Xu et al., 2008). BCl2 protein also acts as a regulator of apoptosis by maintaining the permeability of the outer membrane of mitochondria. BCl2 as an anti-apoptosis protein will inhibit pro-apoptosis proteins such as BCl-associated X protein (BAX) and BCl-homologous antagonist/killer (BAK). BAX and BAK proteins will increase mitochondrial permeability and secrete apopgenic factors resulting in apoptosis (Birkinshaw et al., 2017).

Reactive oxygen species and lipid peroxidation will stimulate the synthesis of various pro-inflammatory cytokines and pro-apoptotic proteins, which cause intracellular inflammatory processes in the visceral organs. In this regard, various drugs have been developed with antioxidant and anti-inflammatory properties, and are able to increase the cellular bioenergy of the visceral organs. Currently, what is widely used are phyto-pharmaceutical derivatives such as moringa extract, curcuma extract, vitamin C, L-carnitine and coenzyme Q10. All materials that contain large amounts of ubiquinone, will play an important role for cellular function, including electron and proton transport in the mitochondrial chain and antioxidant defense (Flora et al., 2012).

One of the anti-oxidant substances researched here is Dutch eggplant extract or *Solanum betaceum*. This plant is widely grown in mountainous areas. This ingredient is a rich source of vitamins A, B6, C, dietary fiber and potassium. Phenolics, carotenoids, and anthocyanins are the main bioactive components contained in this ingredient, with 70 volatile compounds and organic acids contributing to its taste. Potential benefits in the health field include antioxidant, anti-obesity, anti-cancer and prebiotic properties (Diep et al., 2022).

In this study, Dutch eggplant extract was given to the hearts of mice who were also exposed to lead acetate. There were 3 groups each of which were given Dutch eggplant extract (*Solanum betaceum*) with different doses, namely the P1 group of 100 mg/kgBB/day, the P2 group of 200 mg/kgBB/day, and the P3 group of 400 mg/kgBB/day. The results of the study obtained the results of significantly different BCl2 expressions. In the P1 group with the lowest dose of Dutch eggplant extract, the highest BCl2 expression was obtained, while in the P3 group with the highest dose of Dutch eggplant extract had the lowest BCl2 expression. This suggests that the effect of Dutch eggplant extract on the suppression of BCl2 expression is determined by its dosage. The larger the dose of Dutch eggplant extract, the greater the suppression effect on BCl2 expression so that the expression is smaller.

In the follow-up analysis of the differences between groups, it was found that the BCl2 expression of the P1 and P2 groups did not differ significantly, while the P3 group had significant differences both with the P1 group, and with the P2 group. This shows that the dose of Dutch eggplant extract of 100 mg/kgBB/day does not have a significant difference with the dose of 200 mg/kgBB/day in terms of suppressing BCl2 expression.

Meanwhile, in the analysis of the group of mice before and after being given lead acetate and Dutch eggplant extract, in this study, there was a significant difference between the K1 group (which was given *aquadest* only) and K2 (i.e. those who were given lead acetate only). Significant differences were also found in the K2 group with the P2 group (which was given lead acetate and Dutch eggplant extract 200 mg/kgBB/day) and the K2 group with the P3 group (which was given lead acetate and Dutch eggplant extract 400 mg/kgBB/day). This shows that the effect of Dutch eggplant extract is only obtained at a dose of 200 mg/kgBB/day and the highest effect is obtained at the dose of Dutch eggplant extract of 400 mg/kgBB/day. Meanwhile, at the dose of Dutch eggplant extract of 100 mg/kgBB/day, no significant difference was found with the control group.

A similar thing was also obtained in a study by Wirenviona et al which examined the effect of Dutch eggplant extract on spermatozoa vitality in mice exposed to lead acetate. In this study, the largest effect was found on the level of Dutch eggplant extract of 400 mg/kgBB/day (Wirenviona et al., 2020). Wirenviona also researched spermatozoa motility in mice exposed to lead and also obtained the results of giving Dutch eggplant extract of 400 mg/kgBB/day to provide the largest percentage of spermatozoa motility improvement (Wirenviona et al., 2020).

Somewhat different results were obtained in a study by Wahidah et al. which examined the effect of Dutch eggplant extract on the testicular weight of mice exposed to lead acetate. In the study, it was found that the highest testicular weight was at a dose of 100 mg/kgBB/day. This is likely due to the optimal dose required to prevent testicular weight loss because lead exposure is 100 mg/kgBB/day. Different optimal doses can be due to different needs for specific purposes and organs. This is made possible by the pro-oxidant activity or free radicals of lead administration being eliminated by the antioxidant *Solanum betaceum*, so that the contents of the testicles (spermatogenic cells) are not affected by such free radicals. Uncontrolled amounts of free radicals can result in a loss of homeostasis between free radicals and antioxidants which leads to lipid peroxidation, cell membrane disruption, protein oxidation, and DNA and RNA oxidation which can trigger apoptosis programs (Wahidah et al., 2020).

The interesting thing we found in our study is that, in the follow-up analysis of the difference between groups, it was found that there was no significant difference in BCl2 expression between the K1 group, namely those who were only exposed to *aquadest* and the P1, P2 and P3 groups who were given lead acetate given Dutch eggplant extract of 100, 200 or 400 mg/kgBB/day. This means that administration of Dutch eggplant extract will neutralize lead acetate exposure to BCl2 expression in the hearts of mice. The protective effect of Dutch eggplant extract is due to the high levels of anti-oxidants that prevent apoptosis and cell death which is characterized by decreased BCl2 expression, with the highest protective effect obtained at a dose of 400 mg/kgBB/day (Wirenviona et al., 2020).

CONCLUSION

There was a significant difference in BCl2 expression in the hearts of mice not exposed to lead acetate and the expression of BCL2 in the hearts of mice given lead acetate exposure of 0.075 grams/kgBB/day. There was a significant difference in BCl2 expression in the treatment group with a dose of Dutch eggplant extract of 100, 200 and 400 mg/kgBB/day. However, in the follow-up analysis to see the relationship between groups, it was found that there was no significant difference between the groups with a dose of 100 and 200 mg/kgBB/day, but there was a difference between groups with a dose group of 400 mg/kgBB/day. There were significant differences between groups both before and after being given lead acetate and after being given lead acetate and Dutch eggplant extract. A dose of 400 mg/kgBB/day provided the highest protective effect on lead acetate exposure to BCl-2 expression in mouse heart tissue.

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