INTERNATIONAL CONFERENCE
ON LIFESTYLE DISEASES AND NATURAL MEDICINE (ICOLIFEMED)
Nomor ISSN: 3124-1115

Gc-Ms Instrument Analysis of Turmeric Rhizome Extract Nanoemulsion Preparation (Curcuma Domestica Val.) on Amylase, Lipase Levels and Pancreatic Beta Cell Damage Scoring in Male Rats with Diabetes Mellitus and Histopathological Images of the Pancreas

Khoirul Bariyah[1] , Alinapiah Nasution [2] , Maya Sari [3]
[1] Faculty Medicine , Dentistry and Knowledge Health , Prima Indonesia University , North Sumatra
[2] Department of XYZ, College/University Name, Place-Pin Code, (State) Country

*E-mail : dr.khoirulb@gmail.com

ABSTRACT

Study This aim For analyze stock nanoemulsi extract rhizome turmeric (Curcuma domestica Val .) uses GC-MS instruments , as well as the impact to level amylase , lipase, and damage scoring pancreatic beta cells on mouse males who suffer from diabetes mellitus . In addition that , research This Also evaluate description histopathology pancreas.

Results study show that The results of GC-MS (Gas Chromatography-Mass Spectrometry) analysis for turmeric compound content usually include a number of chemical compounds that have various health benefits. Here are some of the main compounds often found in turmeric: Curcumin (30%): The main active compound that gives turmeric its yellow color and has anti-inflammatory and antioxidant properties, demethoxycurcumin (15.3%): A variant of curcumin with anti-inflammatory properties, bisdemethoxycurcumin (8.2%): Other compounds that play a role in the biological activity of turmeric, turmerone (5.7%): Compounds that contribute to aroma and have potential therapeutic effects, zingiberene (41%), beta-turmerone (2.8%) and volatile compounds (33.4): Such as zingiberene and beta-turmerone, which also have health benefits. Nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.) was proven to be effective in reducing amylase and lipase levels in alloxan-induced male white rats (Rattus norvegicus). The treatment group given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.) at a dose of 180 mg/kgbb showed the most optimal results, with a significant decrease in amylase and lipase levels, approaching the values shown by the control group. In histopathological examination of the pancreas, the group given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.) at a dose of 180 mg/kgbb also showed minimal tissue damage, marked by reduced β cell necrosis, reduced vacuosis, and increased islet density. Score 1 because the number of degenerative cells with a degree of damage (<1-25%) of the entire LP (Field of View), the number of necrotic cells <25% of the entire LP. and the number of inflammatory cells <10 in the entire space.

Keywords: *Nanoemulsi Turmeric , GC-MS, Amylase , Lipase, Pancreas .*

Nomor ISSN: 3124-1115

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose levels caused by impaired insulin secretion from pancreatic β cells. Pancreatic β cell damage is caused by viral infections, genetic disorders, or the induction of toxic agents such as steptozotocin and alloxan (Roosdiana, 2019). Alloxan is a compound that has diabetogenic properties and is toxic, especially to pancreatic beta cells. When administered to experimental animals, namely mice, it will cause the mice to become diabetic. The mechanism of action of alloxan that causes pancreatic beta cell damage is that it first enters the pancreatic beta cells and is then absorbed by the pancreatic beta cells. The ability of alloxan substances to be absorbed by pancreatic beta cells will determine the level of toxicity and also diabetogenic properties. After absorption of the substance, pancreatic beta cells will experience damage through several processes that occur simultaneously, namely through oxidation of sulfhydryl groups and the formation of free radicals (Prameswari and Widjanarko, 2014). One of the typical pathological features and is often found in patients and animal models of Diabetes Mellitus is changes in the histological structure of the pancreas.

The pancreas is closely related to diabetes. Diabetes is a disorder of carbohydrate metabolism characterized by the body's inability to produce sufficient insulin or respond appropriately to it. Furthermore, irregular glucagon secretion by alpha cells is a key feature of both type 1 and type 2 diabetes. Therefore, the endocrine pancreas's importance lies in its secretion of two key hormones, glucagon and insulin, which play a central role in regulating energy metabolism (Atkinson et al., 2020).

Normally, glucose levels are regulated by a balance between insulin secretion and action. For example, insulin reduces glucose production in the liver, increases glucose uptake in skeletal muscle and adipose tissue, and decreases fatty acid release in adipose tissue. However, abnormally reduced insulin secretion suppresses insulin signaling in target tissues. In insulin resistance, insulin action in target tissues primarily increases circulating fatty acids and glucose levels. Ultimately, persistently elevated blood glucose and fatty acids exacerbate insulin secretion and resistance (Li et al., 2020).

Nowadays , people prefer alternative medicine using herbal remedies derived from plants or plant extracts to treat illnesses. The use of herbal remedies is an effective and relatively safe treatment option that can be used to treat various ailments and is also often used to prevent illness and boost the body's resistance to disease.

Turmeric rhizome also has pharmacological activities as an analgesic, antioxidant, antibacterial, antifungal, anti-inflammatory and digestive disorder (Anand *et al* , 2010; Hayakawa *et al* , 2011). Turmeric rhizome (*Curcuma domestica Val* .) Turmeric is a traditional medicine known for its antioxidant effects that lower blood glucose levels. It is also known to have antibacterial, anti-inflammatory, immune system stimulating, analgesic, antipyretic, heat-relieving, and detoxifying properties. Turmeric rhizome also has pharmacological activities as an analgesic, antioxidant, antibacterial, antifungal, anti-inflammatory, and anti-digestive agent (Anand *et al* ., 2010; Hayakawa *et al.* , 2011).

The flavonoid components found in turmeric rhizomes have the ability to prevent beta cell damage in the pancreas. This is due to the antioxidant activity contained in it, namely by capturing or neutralizing free radicals associated with phenolic OH groups. Thus, flavonoid compounds can help repair the condition of damaged tissue (Hossain MS, 2014). Turmeric (*Curcuma domestica Val* .) is known to contain various bioactive compounds, including

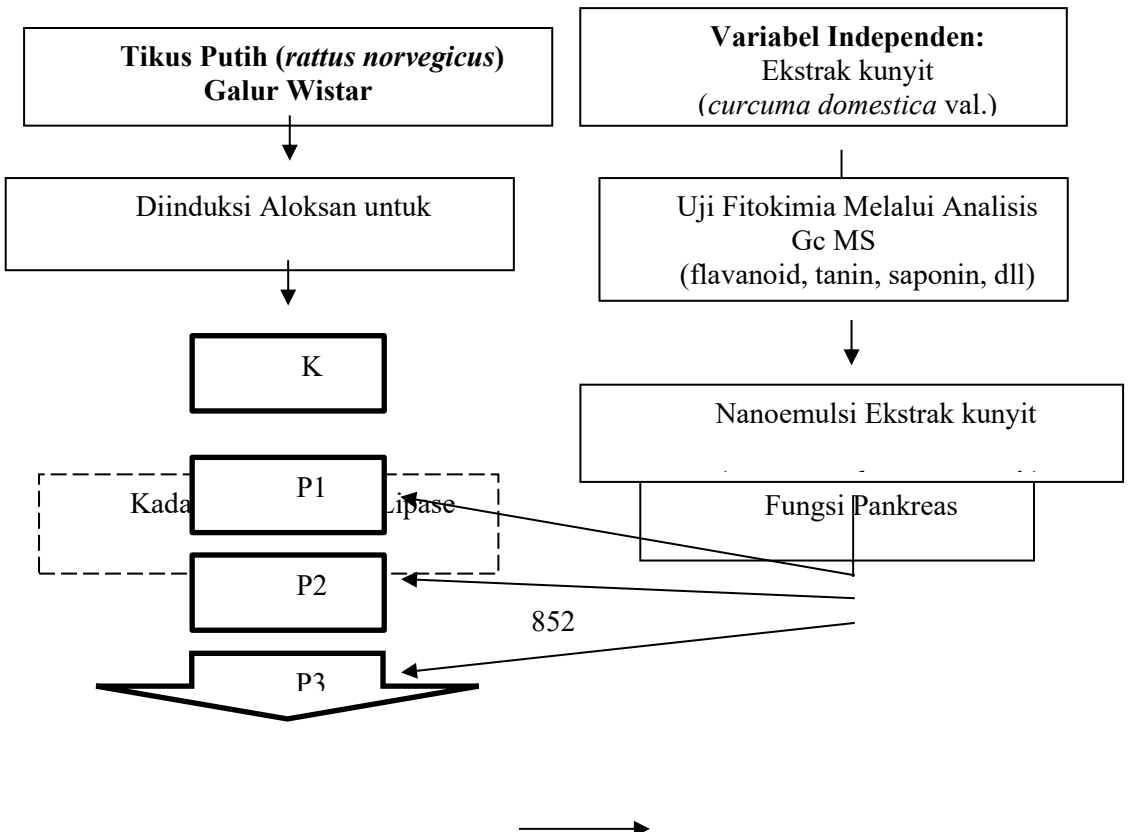
Nomor ISSN: 3124-1115

curcumin, which has anti-inflammatory and antioxidant properties. Previous research has shown that turmeric rhizome extract can potentially reduce pancreatic beta cell damage and improve the function of digestive enzymes such as amylase and lipase. Amylase is an enzyme that plays a role in the breakdown of carbohydrates, especially starch, into glucose and maltose. Amylase levels in the blood are usually measured to assess pancreatic function and diagnose conditions such as pancreatitis. Lipase is an enzyme responsible for the breakdown of fats into fatty acids and glycerol. Lipase levels are also measured in the context of pancreatic health, and elevated lipase levels are often associated with acute pancreatitis.

In addition, it is known that the most active compound found in turmeric is curcumin, which is 3-4%. The low bioavailability of curcumin is caused by rapid metabolism and low absorption along with rapid elimination and excretion, including things that limit its bioavailability (Anand *et al* ., 2007). Based on research conducted by Yadaf *et al* . (2012), nanoparticle preparations are made to increase bioavailability and metabolism in the body. Nano-sized delivery systems are useful for protecting, carrying and releasing bioactive compounds and increasing the bioavailability of lipophilic compounds in aqueous media (Sari *et al* ., 2015). Nanotechnology is an effective method for releasing active ingredients such as curcumin. One pharmaceutical preparation that can be used to overcome problems due to the bioavailability of the active ingredient in turmeric is nanoemulsion. Nanoemulsion is defined as a colloidal dispersion system with an average diameter of less than 500 nm containing lipophilic materials such as curcumin in an aqueous medium (Otoni *et al* , 2016). Nanoemulsion preparations have promising potential in the pharmaceutical industry because of their transparent color, can increase bioavailability and are thermodynamically stable in a mixture of water, oil, surfactants and cosurfactants (Mishra *et al* , 2014).

Based on the above phenomenon, researchers are interested in analyzing the GC-MS analysis of nanoemulsion preparations of turmeric rhizome extract (*Curcuma domestica* val.) on amylase, lipase levels and pancreatic beta cell damage scoring in male rats with diabetes mellitus and pancreatic histology. This research is considered important to study further considering that.

The conceptual framework in this study can be described as in the following figure.



Nomor ISSN: 3124-1115

Figure 1 Conceptual Framework

METHODS

This research is a true experimental study, with the research design used being a Pre -*Post Test Only Control Group Design* , which is a type of research that only observes the control and treatment groups after being given a treatment. The research design uses a pre-*post-test with control group design* or controls the sample based on the treatment group to analyze the activity test. The effect of nanoemulsion preparation of turmeric rhizome extract (*Curcuma domestica* val.) on amylase, lipase levels and pancreatic beta cell damage scoring in male rats with diabetes mellitus and pancreatic histology . This research was conducted at the Laboratory of the Department of Pharmaceutical Pharmacology, Faculty of Medicine, University of North Sumatra and the Laboratory of Anatomical Pathology, University of North Sumatra. This research was conducted from June to August 2025.

The tools used during the research were rotary vacuum evaporator, homogenizer, UV-Vis spectrophotometer, PSA (Particle Size Analyzer) tester, Brookfield viscometer, pH-meter, vacuum pump, 40 mesh sieve, thermometer, magnetic stirrer, spatula, pipette, Erlenmeyer flask, beaker, glass bottle, test tube, measuring cup, digital scale, knife, cutting board, filter paper. The materials needed in this research were turmeric (*Curcuma longa* Linn) (Research Institute for Spice Plants), 96% ethanol, methanol, tween 80, sodium hydroxide, potassium phosphate, distilled water, DPPH powder and vitamin C.

The parameters used to assess pancreatic function are the enzymes amylase and lipase. Amylase hydrolyzes carbohydrates to form simple sugars, while lipase hydrolyzes fats to form fatty acids. Amylase and lipase are enzymes secreted by the exocrine portion of the pancreas. Amylase and lipase levels are used as biochemical markers of pancreatic dysfunction. On the 15th day, the mice were anesthetized and 3 cc of blood was taken from the orbital vein using a capillary pipette, collected in an EDTA (*Ethylenediamine Tetraacetic Acid*) tube and placed in a cool box. The blood samples were then examined at the University of North Sumatra Laboratory to determine amylase and lipase levels.

The results obtained from histopathological observations through microscopic examination were collected and then scored. Analysis was performed to identify the changes found, and then presented descriptively.

Next, the research data were analyzed using the Statistical Package for the Social Sciences (SPSS) 25.0 for Windows. To assess data normality, the Kolmogorov-Smirnov test was used ($p > 0.05$). Furthermore, significance between experimental groups was tested using One-Way ANOVA or one-way analysis of variance at a 95% confidence level. Post-hoc tests or follow-up tests were conducted using the LSD method.

RESULTS AND DISCUSSION

The active substance content in turmeric rhizome extract *(Curcuma Domestica val.)*

Secondary metabolites such as flavonoids, tannins, saponins, alkaloids, and phenolic compounds are known to play a crucial role in the bioactivity mechanisms of medicinal plants, including antioxidant, antimicrobial, anti-inflammatory, and antidiabetic activities. Turmeric rhizome extract *(Curcuma Domestica val.)* was also tested for key compounds commonly found in medicinal plants, namely flavonoids, saponins, tannins, alkaloids, and steroids. The following screening results were obtained:

Nomor ISSN: 3124-1115

Table 1 Test Phytochemicals

Secondary Metabolites	Color	Results
Flavonoid	Pink	+
Saponin	Yellow and foamy	+
Tannin	turquoise	+
Alkaloid	Yellow sediment	+
Steroids/Triterpenoids	Green	+

Information: (+) = Contain group compound Which tested
(-) = Does not contain the tested compound

Phytochemical testing was conducted to identify the secondary metabolite compounds present in turmeric rhizome *(Curcuma Domestica val.) nanoemulsion extracts* , which are suspected to have potential as natural therapeutic agents. GC-MS analysis results for turmeric rhizome content typically present data as percentages of the various compounds detected. Here's a common way to present and understand these results:

Table 2 Analysis of Compound Content of Turmeric Rhizome Extract *(Curcuma Domestica val .)*

Compound	Percentage (%)
Curcumin	30.5
Demethoxycurcumin	15.3
Bisdemethoxycurcumin	8.2
Tumeron	5.7
Zingiberene	4.1
Beta-turmerone	2.8
Other Volatile Compounds	33.4

GC-MS (Gas Chromatography-Mass Spectrometry) analysis results for turmeric's compound content typically include a number of chemical compounds with various health benefits. Here are some of the main compounds commonly found in turmeric:

1. Curcumin : The main active compound that gives turmeric its yellow color and has anti-inflammatory and antioxidant properties.
2. Demethoxycurcumin : A variant of curcumin with anti-inflammatory properties.
3. Bisdemethoxycurcumin : Another compound that plays a role in the biological activity of turmeric.
4. Tumerones : Compounds that contribute to aroma and have potential therapeutic effects.
5. Volatile compounds : Such as zingiberene and beta-turmerone, which also have health benefits.

Nomor ISSN: 3124-1115

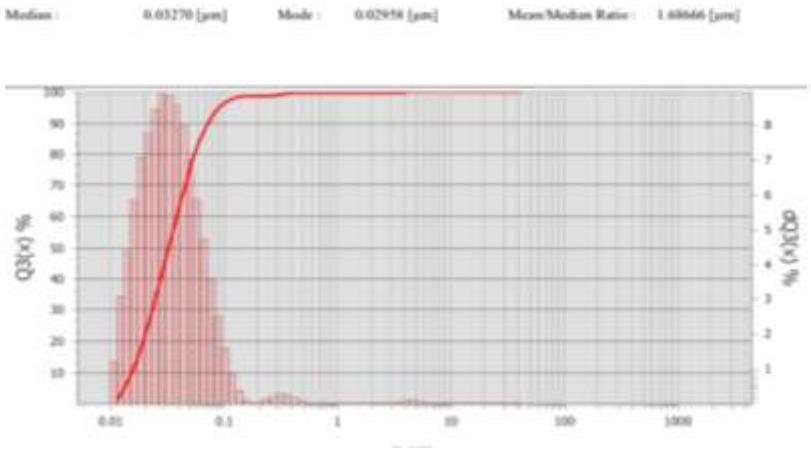


Figure 2 PSA Graph of Nanoemulsion Turmeric rhizome extract

Analysis and interpretation of the PSA graph above is the median and mode is in the range of **20–200 nm** , indicating that this system is indeed **a nanoemulsion** , The **median value of 32.7 nm** indicates that the main particles are very small in size, which is ideal for increasing the solubility and bioavailability of curcumin (the main active compound in turmeric rhizome), The distribution curve (Q3(x)) shows a fairly narrow distribution and the majority of particles are below 100 nm, there is no significant spike at sizes > 1 µm, indicating **not much aggregation** or large particles and this value is slightly higher than ideal (around 1), indicating the possibility of **slight asymmetry** or the presence of a small fraction of larger particles, but still **acceptable** for a nanoemulsion system.

The above analysis can be concluded that the PSA measurement results show that the turmeric rhizome nanoemulsion has a very small particle size and is homogeneously distributed **, with a median of 32.7 nm and a mode of 29.6 nm. This size is considered very good for pharmaceutical or food applications, because it can increase** the solubility, stability, and bioavailability **of the active compounds of turmeric. This system can be categorized as** a stable and effective nanoemulsion **based on particle size**.

Pancreatic Observation Results Through Serum Amylase and Lipase Levels

Male white mice weighing 200 to 300 grams were adapted to the environment for one week. Before the treatment of turmeric rhizome extract nanoemulsion, the initial step was to measure the blood glucose levels of the mice before being induced by alloxan to induce diabetes mellitus. Then, in order to induce diabetes mellitus in the experimental mice, the mice were induced by alloxan with 30 mg/kgBW by injection 3 times a week through intraperitoneal. After 14 days, the mice were again observed for amylase and lipase levels after being induced by alloxan. Then, after the 28th day, the mice were again observed for amylase and lipase levels after being given turmeric rhizome extract nanoemulsion (curcuma domestica val.) at a dose of 100 mg/kgBW, 140 mg/kgBW, 180 mg/kgBW.

Parameters for examining pancreatic function are the enzymes amylase and lipase. Amylase works by hydrolyzing carbohydrates and forming simple sugars, while lipase works by hydrolyzing fats to form fatty acids. Amylase and lipase are enzymes secreted by the exocrine part of the pancreas. Amylase and lipase levels are used as biochemical markers of pancreatic

Nomor ISSN: 3124-1115

dysfunction. Observations of changes in amylase levels were carried out after alloxan induction and after administration of turmeric rhizome extract (Curcuma domestica val.). **Normal amylase levels in mice** are 500-700 U/L. and **normal levels Lipase** : 10-100 U/L. Alloxan causes oxidative stress and damage to pancreatic beta cells and disrupts carbohydrate and fat metabolism. After alloxan induction, amylase levels are 800–1200 U/L and lipase levels are 150–300 U/L. Increased amylase and lipase may indicate **mild to moderate pancreatitis** , which often accompanies induced diabetes. Observations on amylase levels on the first day showed that the control group that was not induced by alloxan had an average value of 599 ± 36.38 mg/dl. Treatment group 1 had an average value of 647.3 ± 52.96 mg/dl and treatment group 2, namely, 625.5 ± 49.48 mg/dl. Treatment group 3, namely, 632.83 ± 44.71 mg/dl.

On the 14th day, the amylase levels of the test animals were measured again to see the changes that occurred. The control group that was not induced by alloxan and was only given distilled water showed urea levels with an average of 607.7 ± 36.59 mg/dL. Treatment group 1 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb got an average of 897.33 ± 42.97 mg/dL. Treatment group 2 with the administration of nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 140 mg/kgbb got an average of 943.83 ± 43.85 mg/dL and treatment group 3 with the administration of nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 180 mg/kgbb got an average of 949.67 ± 31.66 mg/dL. On the 14th day, the average creatinine levels in the control group, treatment group 1, treatment group 2, and treatment group 3 increased.

On the 28th day, the amylase levels of the mice were measured again to see the changes that occurred in all treatment groups. Treatment group 1, which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb, got an average of 650.17 ± 55.70 mg/dL. Treatment group 2, which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 140 mg/kgbb, got an average of 630.67 ± 37.67 mg/dL and treatment group 3, which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 180 mg/kgbb, got an average of 620.83 ± 31.26 mg/dL.

Based on the results of amylase level measurements on the 28th day, it can be concluded that treatment group 1 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb and treatment group 2 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 140 mg/kgbb and turmeric rhizome extract (Curcuma Domestica val.), with a dose of 180 mg/kgbb experienced a decrease. Treatment group 3 experienced the most significant decrease and was close to the control group compared to the other groups. Treatment group 1 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb was the group with the least decrease compared to the other groups.

Observations on lipase levels on the first day showed that the control group that was not induced by alloxan had an average value of 64.83 ± 9.51 mg/dl. Treatment group 1 had an average value of 64.3 ± 6.63 mg/dl and treatment group 2, namely, 63.83 ± 9.56 mg/dl. Treatment group 3, namely, 66.5 ± 6.70 mg/dl. On the 14th day, the lipase levels of the test animals were measured again to see the changes that occurred. The control group that was not induced by alloxan and only given distilled water showed lipase levels with an average of

Nomor ISSN: 3124-1115

68.33 ± 6.21 mg/dL. Treatment group 1, which was given a nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb, obtained an average of 228.5 ± 24.14 mg/dL. Treatment group 2 with the administration of nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 140 mg/kgbb got an average of 263.5 ± 29.55 / dL and treatment group 3 with the administration of nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 180 mg/kgbb got an average of 253.67 ± 27.15 mg/ dL. On the 14th day the average lipase levels in the control group of treatment group 1, treatment group 2, treatment group 3 experienced an increase. On the 28th day the rats' lipase levels were measured again to see the changes that occurred in all treatment groups. Treatment group 1 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb got an average of 72.33 ± 6.05 mg/dL. Treatment group 2 with the administration of nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 140 mg/kgbb got an average of 75.67 ± 10.93 mg/dL and treatment group 3 with the administration of nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 180 mg/kgbb got an average of 72.17 ± 9.96 mg/dL. Based on the results of lipase level measurements on the 28th day, it can be concluded that treatment group 1 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb and treatment group 2 which was given nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 140 mg/kgbb and turmeric rhizome extract (Curcuma Domestica val.), with a dose of 180 mg/kgbb experienced a decrease. Treatment group 3 experienced the most significant decrease and was closer to the control group than the other groups. Treatment group 1, which was given a nanoemulsion of turmeric rhizome extract (Curcuma Domestica val.), with a dose of 100 mg/kgbb, was the group with the least decrease compared to the other groups.

Histopathological Observation Results

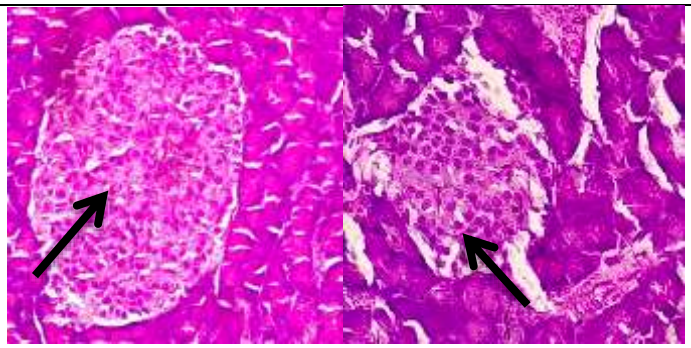
Histopathological observations were conducted using a light microscope at 400x magnification. The purpose of this observation was to observe the structure and morphology of cells in each pancreatic tissue specimen in the control group and the treatment group given turmeric rhizome extract (Curcuma Domestica val.) at doses of 100 mg/KgBW, 140 mg/KgBW, and 180 mg/KgBW. The sambiloto leaf extract was administered daily in the morning.

The scoring method observed in histopathological changes is seen from the degree of damage in the sum of all types of lesions that occur, the damage is given a score from 0 to 10. The data is obtained from histopathological images analyzed under a light microscope by a pathologist. The average score of the histopathological examination of the pancreas of the test mice where the lesions observed were degeneration, inflammatory cells and necrosis. The following displays the histological images of the pancreatic tissue of each treatment group:

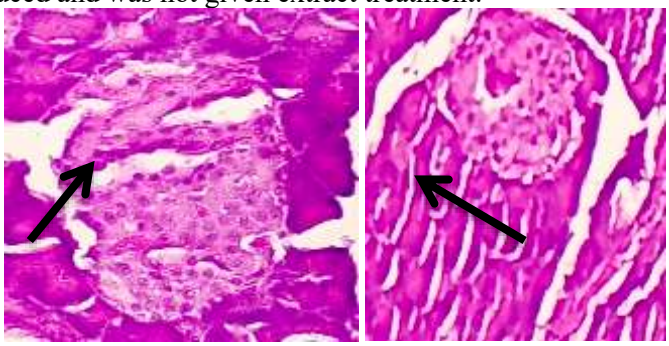
Table 3 Histopathological Description of Pancreatic Tissue

No	Group	Histopathological Image of Pancreatic Tissue

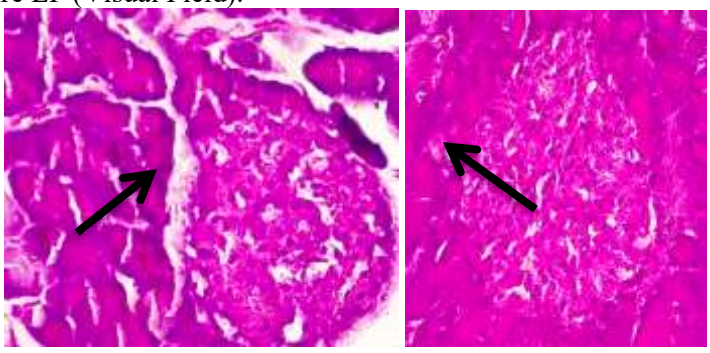
Nomor ISSN: 3124-1115

1	Control (Aquades)	

A score of 0 was obtained because no degenerative changes , no necrotic changes , and no inflammatory cells were found throughout the pancreatic interstitial space. This group was not induced and was not given extract treatment.

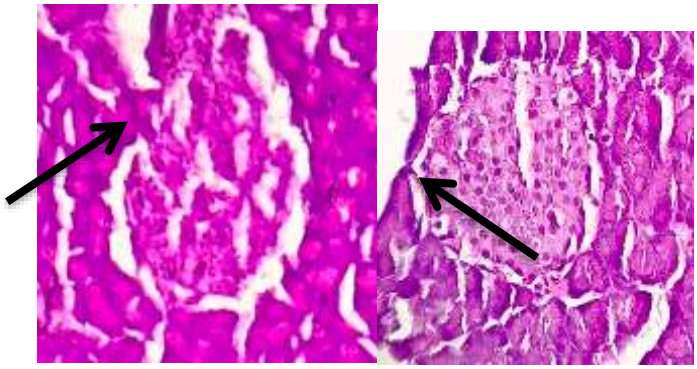
2	Treatment 1 (dose 100mg/KgBW)	

At **a dose of 100 mg/kg body weight ,** a mild regenerative effect may be observed: the islets of Langerhans begin to recover, degeneration decreases, and β-cells begin to organize more regularly. A score of 3 is given by the number of inflammatory cells between 51 and 100 throughout the pancreatic interstitial space. number of cells with degree of damage (51% - 75%) of the entire LP (Visual Field).

3	Treatment 2 (dose (140mg/KgBW)	

At **a dose of 140 mg/kg BW,** β-cell regeneration is more pronounced, the area of necrosis is smaller, and the density of insulin granules increases. Score 2: if the number of degenerative cells with a degree of damage (26-50%) of the entire LP (Visual Field), the number of necrotic cells < 25% of the entire LP and the number of inflammatory cells between 11-50 in the entire pancreatic interstitial space.

Nomor ISSN: 3124-1115

4	Treatment 3 (dose (180mg/KgBW)		At **a dose of 180 mg/kg BW,** it was close to normal control — β-cell necrosis was reduced, vacuolosis was reduced, and islet density was increased. A score of 1 was given for the number of degenerative cells with a degree of damage (<1-25%) of the entire LP (Visual Field), the number of necrotic cells <25% of the entire LP, and the number of inflammatory cells <10 in the entire pancreatic interstitial space.

DISCUSSION

In many ways, it is the most important section in an article (Feldman, 2004:4). Because it is the last thing a reader sees, it can have a major impact on the reader's perceptions of the article and the research conducted (Summers 2001:411).

According to Feldman (2004:5), Perry et al. 2003: 658), and Summers 2001: 411412), the discussion section should:

- Restate the study's main purpose
- Reaffirm the importance of the study be restating its main contributions
- Summarize the results in relation to each stated research objective or hypothesis without introducing new material
- Relate the findings to the literature and the results reported by other researches
- Provide possible explanations for unexpected or non-significant findings
- Discuss the managerial implications of the study
- Highlight the main limitations of the study that could influence its internal and external validity
- Discuss insightful (i.e., non-obvious) directions or opportunities for future research on the topic

The discussion section should not merely restate the findings reported in the result section or report additional findings that have not been discussed earlier in the article. The focus should instead be on highlighting the broader implications of the study's findings and relating these back to previous research. Make sure that the conclusions you reach follow logically from and are substantiated by the evidence presented in your study (Varadarajan 1996: 5).

Nomor ISSN: 3124-1115

CONCLUSION

1. The results of GC-MS (Gas Chromatography-Mass Spectrometry) analysis for turmeric compound content usually include a number of chemical compounds that have various health benefits. Here are some of the main compounds often found in turmeric: Curcumin (30%): The main active compound that gives turmeric its yellow color and has anti-inflammatory and antioxidant properties, demethoxycurcumin (15.3%): A variant of curcumin with anti-inflammatory properties, bisdemethoxycurcumin (8.2%): Other compounds that play a role in the biological activity of turmeric, turmerone (5.7%): Compounds that contribute to aroma and have potential therapeutic effects, zingiberene (41%), beta-turmerone (2.8%) and volatile compounds (33.4): Such as zingiberene and beta-turmerone, which also have health benefits.
2. Nanoemulsion of turmeric rhizome extract *(Curcuma Domestica val.)* has been proven to be effective in reducing amylase and lipase levels in male white rats (Rattus norvegicus) of the Wistar strain induced by alloxan.
3. The treatment group given a nanoemulsion of turmeric rhizome extract *(Curcuma Domestica val.)* at a dose of 180 mg/kgbb showed the most optimal results, with a significant decrease in amylase and lipase levels, approaching the values shown by the control group.
4. In histopathological examination of the pancreas, the group given a nanoemulsion of turmeric rhizome extract *(Curcuma Domestica val.)* at a dose of 180 mg/kgbw also showed minimal tissue damage, marked by reduced β cell necrosis, reduced vacuosis, and increased islet density. Score 1 is due to the number of degenerative cells with a degree of damage (<1-25%) of the entire LP (Visual Field), the number of necrotic cells <25% of the entire LP, and the number of inflammatory cells <10 in the entire space.

ACKNOWLEDGEMENT

The Faculty of Medicine, Dentistry, and Health Sciences, as well as the directors of study programs, are acknowledged by the authors for their support of this research at Universitas Prima Indonesia. Additionally, we appreciate the supervisors' insightful comments. The University of North Sumatra, the Faculty of Pharmacy, the Pharmacology Laboratory, and the Nanomedicine Laboratory are all acknowledged by the authors for their invaluable support of this study

REFERENCES

Ahmad, J., Khan, I., & Blundell, R. (2019). Moringa oleifera and glycemic control: A review of current evidence and possible mechanisms. *Phytotherapy research* , *33* (11), 2841-2848.

Albuquerque, D., Nóbrega, C., Manco, L., & Padez, C. (2017). The contribution of genetics and environment to obesity. *British medical bulletin* , *123* (1), 159-173.

Banday, M. Z., Sameer, A. S., & Nissar, S. (2020). Pathophysiology of diabetes: An overview. *Avicenna journal of medicine* , *10* (04), 174-188.

Belayneh, Y.M., Birhanu, Z., Birru, E.M., & Getenet, G. (2019). Evaluation of in vivoantidiabetic, antidyslipidemic, and in vitro antioxidant activities of hydromethanolic root extract of Datura stramonium L.(Solanaceae). *Journal of Experimental Pharmacology* , 29-38.

Chioma, D. L., & Okah, R. (2021). Study of some phytochemicals and functional group analysis in moringa oleifera (leaves and flowers). *Journal of Research in Humanities and Social Science* , *9* (4), 8-12.

Choi, MR, Kwak, SM, Bang, SH, Jeong, JE, & Kim, DJ (2017). Chronic saponin treatment attenuates damage to the pancreas in chronic alcohol-treated diabetic rats. *Journal of ginseng research* , *41* (4), 503-512.

Galicia-Garcia, U., Benito-Vicente, A., Jebari, S., Larrea-Sebal, A., Siddiqi, H., Uribe, KB, Ostolaza, H., et al. (2020). Pathophysiology of Type 2 Diabetes Mellitus. *International Journal of Molecular Sciences* , *21* (17), 6275. MDPI AG. Retrieved from http://dx.doi.org/10.3390/ijms21176275

Ghorbani, A., Rashidi, R., & Shafiee-Nick, R. (2019). Flavonoids for preserving pancreatic beta cell survival and function: A mechanistic review. *Biomedicine & Pharmacotherapy* , *111* , 947-957.

Lau SHA, HMR, 2019. Comparative Study of the Level of Public Knowledge About Herbal Medicines and Synthetic Medicines in Campagayya, Panaikang Village, Makassar City. *J Farm Sandi Karsa* , 5(1), pp.33-37.

Karpińska, M., & Czauderna, M. (2022). Pancreas-Its Functions, Disorders, and Physiological Impact on the Mammals' Organism. *Frontiers in physiology* , *13* , 807632. https://doi.org/10.3389/fphys.2022.807632

Kerkadi, A., Sadig, A.H., Bawadi, H., Al Thani, A.A.M., Al Chetachi, W., Akram, H., & Musaiger, A.O. (2019). The relationship between lifestyle factors and obesity indices among adolescents in Qatar. *International journal of environmental research and public health* , *16* (22), 4428.

Khutami, C., Sumiwi, SA, Khairul Ikram, NK, & Muchtaridi, M. (2022). The effects of antioxidants from natural products on obesity, dyslipidemia, diabetes and their molecular signaling mechanisms. *International Journal of Molecular Sciences* , *23* (4), 2056.

Lian Li, Ning Sun, Lina Zhang, Guodong Xu, Jingjing Liu, Jingcen Hu, Zhiying Zhang, Jianjun Lou, Hongxia Deng, Zhisen Shen & Liyuan Han (2020) Fast food consumption among young adolescents aged 12–15 years in 54 low- and middle-income countries, Global Health Action, 13:1, DOI: 10.1080/16549716.2020.1795438

Longnecker, D.S., Gorelick, F., & Thompson, E.D. (2018). Anatomy, histology, and fine structure of the pancreas. *The pancreas: an integrated textbook of basic science, medicine, and surgery* , 10-23.

Mahendra, B., 2005. *"13 Types of Powerful Medicinal Plants"* . Self-Help Spreader.

Naghavi M, Abajobir AA, Abbafati C, Abbas KM, Abd-Allah F, Abera SF, Aboyans V, Adetokunboh O, Afshin A, Agrawal A et al. 2017. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980−2016: A systematic analysis for the global burden of disease study 2016. Lancet 390(10100):1151-1210.

Oktaria, 2013. *Blood Glucose Levels and Histological Features of the Pancreas of Mice (Mus Musculus L.) Induced by Alloxan After Treatment with Mango Rhizome Extract (Curcuma Mangga Val.)* . Journal of Biology. 20(2): 64-68.

Paramitha MD, RS, 2016. Ethanol Extract of Turmeric Herb (Andrographis Paniculata) as an Antidiabetic for Alloxan-Induced Wistar Mice. *Med J Lampung Univ* , 5(5).

Prapanza, I..dLAM, 2019. *Efficacy and Benefits of Herbal Medicine, The Bitter King Conquers Diseases* . Jakarta: Agro Media Pustaka.

Panuganti KK, Nguyen M, Kshirsagar RK, Doerr C. (2022) Obesity (Nursing). In: StatPearls. StatPearls Publishing, Treasure Island (FL); 2022. PMID: 33760461

Petersmann, A., Müller-Wieland, D., Müller, U.A., Landgraf, R., Nauck, M., Freckmann, G., Heinemann, L., & Schleicher, E. (2019). Definition, Classification and Diagnosis of Diabetes Mellitus. *Experimental and clinical endocrinology & diabetes: official*

journal, German Society of Endocrinology [and] German Diabetes Association , *127* (S 01), S1–S7. https://doi.org/10.1055/a-1018-9078

Roosdiana, A., Sutrisno, Mahdi, C., & Safitri, A. (2019). The influence of ethanolic root extracts of Ruellia tuberosa L. on pancreatic protease activity and MDA levels of rats (*Rattus norvegicus*) induced by MLD-STZ. In *IOP Conference Series: Earth and Environmental Science* (Vol. 217, p. 012041). IOP Publishing.

Rachdaoui, N. (2020). Insulin: The Friend and the Foe in the Development of Type 2 Diabetes Mellitus. *International Journal of Molecular Sciences* , *21* (5), 1770. MDPI AG. Retrieved from http://dx.doi.org/10.3390/ijms21051770

Roglic, G. (2016). WHO Global report on diabetes: A summary. *International Journal of Noncommunicable Diseases* , *1* (1), 3-8.

Rani, N.Z., Husain, K., & Kumolosasi, E. (2018). Moringa genus: a review of phytochemistry and pharmacology. *Frontiers in pharmacology* , *9* , 108.

Rawshani, A., Rawshani, A., Franzén, S., Eliasson, B., Svensson, A.M., Miftaraj, M., ... & Gudbjörnsdottir, S. (2017). Mortality and cardiovascular disease in type 1 and type 2 diabetes. *New England journal of medicine* , *376* (15), 1407-1418.

Basic Health Research (Riskesdas) (2018). Health Research and Development Agency, Ministry of the Republic of Indonesia, 2018. http://www.depkes.go.id/resources/download/infoterkini/materi_rakorpop_2018/Hasil%20Riskesdas%202018.pdf – Accessed August 2023

Sharma, N., & Bora, K.S. (2021). Role of Medicinal Plants in the Management of Diabetes Mellitus: A Review. *Journal of Pharmaceutical Research International* , *33* (60B), 2196-2207.

Singh, A.K., Rana, H.K., Tshabalala, T., Kumar, R., Gupta, A., Ndhlala, A.R., & Pandey, A.K. (2020). Phytochemical, nutraceutical and pharmacological attributes of a functional crop Moringa oleifera Lam: An overview. *South African Journal of Botany* , *129* , 209-220.

Trigo, C., Castello, M.L., Ortola, M.D., Garcia-Mares, F.J., & Desamparados Soriano, M. (2020). Moringa oleifera: An unknown crop in developed countries with great potential for industry and adapted to climate change. *Foods* , *10* (1), 31

WHO. 2020. Constitution of the World Health Organization, 49th edition. Geneva: p. 1. ISBN 978-92-4-000051-3

Wolfenshn, S., and Llpyd, M. 2013. *Handbook of Laboratory Animals, Management and Care, 4th ed.* Wiley-Blackwell. West Sussex. 234.

Yau, M., Maclaren, N. K., & Sperling, M. A. (2021). Etiology and pathogenesis of diabetes mellitus in children and adolescents. *Endotext [Internet]* .

Zheng, Y., Ley, S. H., & Hu, F. B. (2018). Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nature reviews endocrinology* , *14* (2), 88-98.