

Gc-Ms Instrument Analysis Test of Mint Leaf Extract Nanoemulsion (*Mentha Piperita L.*) On the Reduction of NAFLD Scores and Necrosis Levels in Alloxan-Induced Hyperglycemic Wistar Rats and a picture of Histopathology Liver

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ABSTRACT

Study evaluated the effectiveness of mint leaf extract nanoemulsion (*Mentha piperita L.*) in reducing NAFLD scores and necrosis levels in alloxan-induced hyperglycemic Wistar rats. The method used included GC-MS instrument analysis to identify the active compounds in mint extract. Rats were divided into control and treatment groups, where the treatment group received mint extract nanoemulsion. The results showed that treatment with nanoemulsion significantly reduced NAFLD scores and liver necrosis compared to the control group. The content of active substances in mint leaf extract (*Mentha piperita L.*) through Gc Ms Analysis, namely Menthol : 45%, Menthone : 20%, Isomenthone : 10%, Limonene : 5%, Cineole (Eucalyptol) : 3%, Borneol : 2%, Carvone : 1% and Other Compounds : 14% (including fatty acids and other minor compounds). The results showed that administration of mint leaf nanoemulsion significantly reduced NAFLD scores, with an increasing effect at higher concentrations. The 5% group showed no NAFLD symptoms, indicating the most significant protective effect . Microscopic images of the liver of mice in treatment group 3 showed improved histological structure of the liver, so that it experienced improvement entering the score category 1 with no necrotic cells . This study concluded that mint leaf extract nanoemulsion could be a therapeutic alternative for liver disorders related to hyperglycemia.

Keywords: Gc -Ms. Mint leaves, Nafld, Necrosis, Liver.

INTRODUCTION

Diabetes Mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia resulting from abnormalities in insulin secretion, insulin action, or both. Chronic hyperglycemia in DM is closely related to dysfunction or failure of several organs (Setiati S, 2019). Diabetes mellitus (DM) is one of the fastest growing and worst chronic diseases in the classification of non-communicable diseases in developing and newly industrialized countries (Effah Nyarko B, 2019). Predictions from several researchers indicate that the prevalence of diabetes will continue to increase (Nabhani N, 2017) in the future (Javeed N, 2018). DM is a metabolic disease in which glucose levels in a person's body are abnormal as a result of insulin deficiency or resistance. This disease is often referred to as a silent killer because more than 50% of DM sufferers are undiagnosed. There are several types of DM,

but there are two main types that are clinically significant: type 1 DM (DM 1) and type 2 DM (DM 2). DM 2 is the most common form (90% of all diabetes patients) and is primarily characterized by insulin resistance (Al-Saeed AH, 2016).

Previous research on diabetes mellitus has shown (Johannes et al., 2023) that blood sugar levels are the most influential factor in the incidence of diabetes mellitus at the Johar Baru Community Health Center. In other words, individuals with a family history of type 2 diabetes, those of non-productive age, female gender, and overweight can avoid type 2 diabetes if they maintain their blood sugar levels regularly. Normal fasting blood glucose levels in serum are 110-126 mg/dl. However, when fasting blood glucose levels in serum are >126 mg/dl, this condition is called hyperglycemia. Hyperglycemia is a common characteristic of diabetes mellitus (WHO, 2022). Diabetes can be said to be a common metabolic disorder.

The liver is a fascinating organ with many unusual features, both anatomically and functionally. It is also the largest and heaviest solid glandular organ in the body, with a rich blood supply derived from an unusual combination of two sources: one artery and the other vein. The liver is remarkably versatile in its function. A normal liver has a good capacity for regeneration (Mahadevan, 2020). The liver performs over 500 functions in the body. The liver's primary function is filtration, removing harmful substances from the blood. It receives blood from the stomach, small intestine, spleen, pancreas, and gallbladder. The liver contains the digestive system, the immune system, and the endocrine system. Fat digestion is one of the liver's functions. Bones produced by the liver are converted into fat in the small intestine and used for energy (Mirzaali o'g'li, 2022).

In individuals with diabetes mellitus, fat accumulation is distributed in many organs, one of which is the liver. Fatty liver disease is the most common liver disease found in obese individuals. This condition is classified as *non-alcoholic fatty liver disease* (NAFLD) if it is independent of alcohol consumption. NAFLD is closely associated with features of metabolic syndrome, including obesity, insulin resistance, type 2 diabetes, and dyslipidemia. Risk factors associated with the development of NAFLD include poor dietary habits associated with a sedentary lifestyle (Divella et al., 2019). Research on the effects of diet on the risk and management of NAFLD has found that long-term consumption of sugar-sweetened beverages is positively correlated with NAFLD, and many individuals with NAFLD tend to consume higher levels of sugar-sweetened beverages than others. (Siddiqi, 2017)

NAFLD can be divided into two distinct types. The first type is associated with metabolic syndrome and insulin resistance. The second type is associated with infectious pathologies that can lead to hepatic steatosis. Infections such as hepatitis C and HIV can be the cause, but it is also associated with medications (total parenteral nutrition, glucocorticoids, tamoxifen, tetracycline, amiodarone, methotrexate, valproic acid, vinyl chloride) and specific toxins or innate/acquired metabolic diseases (e.g., lipodystrophy or cachexia or intestinal bypass surgery). (Pouwels, 2022)

There is no specific drug therapy for NAFLD, but it is believed that a combination of lifestyle adjustments, increased physical activity, and smoking/alcohol cessation may be beneficial (Romero-Gomez, 2017). Individuals with NAFLD, including those living with obesity, should be encouraged to participate in a healthy lifestyle approach, regardless of weight loss. A healthy diet, including reduced caloric intake and high-glycemic index foods, increased consumption of monounsaturated fatty acids, omega-3 fatty acids, fiber, and

specific protein sources such as fish and poultry, is recommended to manage this condition. (Pouwels, 2022.)

Consuming plant extracts also offers health benefits, particularly for NAFLD. Plants and extracts from their various parts have been used for their medicinal properties and to cure certain diseases and boost immunity and strength since ancient times (Ullah et al., 2020). The use of plant extracts has become a necessity today to harness the vital power of nature to combat growing diseases such as cancer, heart attacks, diabetes, and rapid skin aging (Bhalla, 2021). One plant whose entire part can be used as medicine is the mint plant.

Mint plant is plant originate from subtropical regions And known with Name Latin that is *Mint piperita* L included in family *Lamiaceae* . Mint plants are producer oil essential oils with menthol compounds whose properties used as aroma and flavor enhancer food , drinks , medicine , perfume , cosmetics And product refresher other (Fitri, 2023). Mint leaves have various esters especially menthyl acetate And monoterpenes in form extract that produces a distinctive aroma and taste (*minty*) . These mint leaves Also used as decoration food And drinks , as well as these mint leaves known as gives a cool feeling on product food or drink Because menthol compounds from mint leaves . Mint leaves too contain compound sufficient antioxidants tall (Nareshwari, 2019).

This antioxidant activity shows the potential to protect cells from oxidative damage, which may contribute to the prevention of various diseases (Chrismis Novalinda Ginting, 2020). Antioxidants play a crucial role in improving liver function, particularly in NAFLD , which is a key indicator of liver function. The following key points regarding the relationship between NAFLD and hyperglycemia highlight the importance of managing both conditions simultaneously to prevent further complications. Prevention and early detection are crucial in treatment strategies, and antioxidants play a crucial role in combating oxidative stress associated with NAFLD. The use of antioxidant-rich foods and supplements may help protect the liver and improve patient outcomes.

Objective study This is to know the process of making mint leaf extract (*Mentha piperita* L) in nanoemulsion preparations , knowing the active substance content in mint leaf extract (*Mentha piperita* L) through Gc analysis , to determine the effect of administering nano preparations of mint leaf extract (*Mentha piperita* L) with concentrations of 2.5%, 3.5% and 5% on reducing NAFLD scores and necrosis levels in alloxan-induced hyperglycemic Wistar rats and liver histology images. and analyze the histopathological image of the liver by looking at necrosis in the liver and scoring values.

Based on the explanation above, the researcher is interested in examining the GC-MS instrument analysis test of mint leaf extract nanoemulsion (*mentha*). *piperita* l) on the reduction of NAFLD scores and necrosis levels in alloxan-induced hyperglycemic Wistar rats. and histopathological features of the liver.

Hypothesis in study namely there is an influence of the nanoemulsion preparation of mint leaf extract (*Mentha piperita* L) through Gc Ms Analysis t on the reduction of NAFLD scores and necrosis levels in alloxan-induced hyperglycemic Wistar rats and histopathological features of the liver. The conceptual framework in this study is as follows:

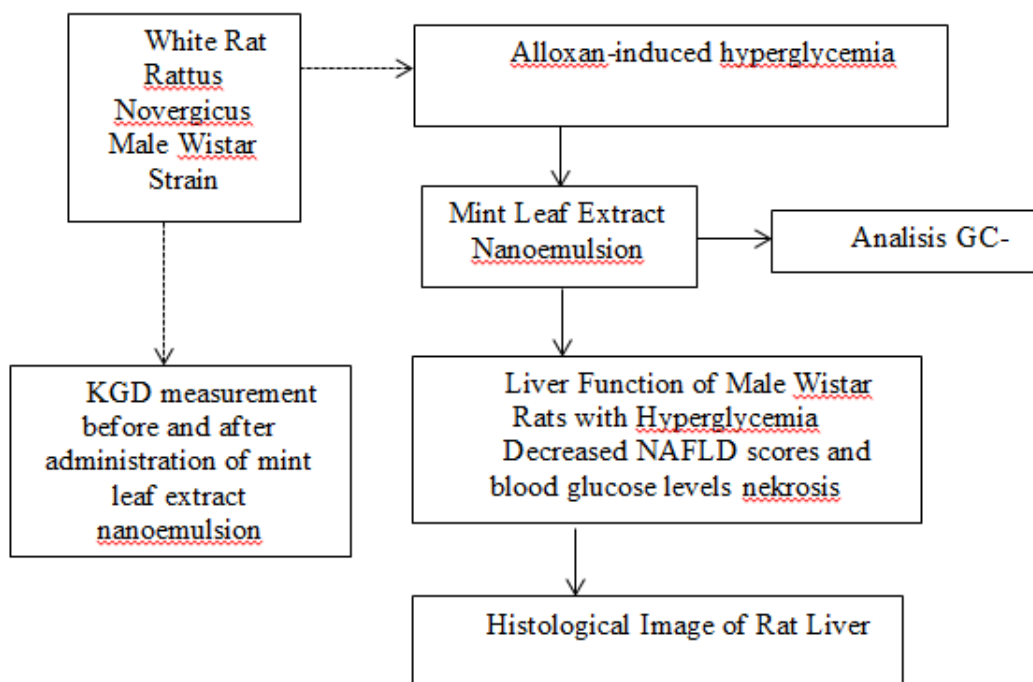


Figure 1. Conceptual Framework 1

METHODS

This research is a True experimental research, with the research design used is *Post Test Only Control Group Design*, which is a type of research that only observes the control and treatment groups after being given an action. The research design uses a *post-test with control group design* or controls the sample based on the treatment group to analyze the effectiveness of the nanoemulsion preparation of mint leaf extract (*Mentha piperita L*) through Gc Ms Analysis t on the reduction of NAFLD scores and necrosis levels in alloxan-induced hyperglycemic Wistar rats and liver histology. This research was conducted at the Department of Pharmaceutical Pharmacology Laboratory, Faculty of Medicine, University of North Sumatra, and the Anatomical Pathology Laboratory, University of North Sumatra, from June to August 2025. Ethical clearance will be submitted to the Health Research Ethics Commission (KPEK) of Prima Indonesia University No. 175/KEPK/UNPRI/VI/2025.. All procedures adhere to animal welfare guidelines to address any ethical issues related to animal handling and care. Researchers used 6 Wistar rats for each group, so a total of 24 test animals were used in this study. The tested animals were randomly assigned to 4 test groups, namely: Positive Control group (K+), rats induced by alloxan + Hyperglycemia drug, Treatment group-1 (K-1), rats experiencing hyperglycemia and given nanoemulsion of mint leaf extract with a concentration of 2.5%,./day/head orally using a sonde, for 14 days, Treatment group-2 (K-2), rats experiencing hyperglycemia and given nanoemulsion of mint leaf extract with a concentration of 3.5%,./day/head orally using a sonde, for 14 days and Treatment group -3 (K-3), rats experiencing hyperglycemia and given mint leaf extract nanoemulsion, concentration 5%, /day/rat orally using a tube, for 14 days.

Tools used in cage research mouse complete with place Eat and drink, rat scales, probe oral, coda *non-invasive blood pressure*, *occlusion* And *VPR cuff*, plate form, tube extraction, filter, stirrer, syringe 3 cc, *rotary vacuum evaporator*. The materials used in this study were standard rat feed, water, rhizomes ginger, *silk suture* sew operation *absorbable*, aquades,

alloxan, ketamine, ethanol 96%, 2,2-diphenyl-1-picrylhydrazyl (dpph), coconut oil pure/*virgin coconut oil*, tween 80, *polyethylene glycol* 400 (peg 400) . Before making nanoemulsion, mint leaves must be converted into extract first by maceration method. Mint leaves that have been obtained are then taken as much as 2 kg to be made into extract. Mint leaves that have been taken are then cleaned, then dried mint leaves. After the mint leaves are dry, grind the mint leaves by pounding them to get mint leaf powder (*simplicia*) as much as 600g. Next, the *simplicia* powder is mixed with 96% ethanol with a ratio of 1:10 then let stand for 24 hours and stirred every 6 hours. The maceration results are separated then repeat the previous steps with the same amount of 96% ethanol. Next, the macerate formed is put into a *rotary vacuum evaporator* and evaporated to get a crude extract. Next, take 0.2 ml of extract into vial and add 5 ml of 75 μ M 2,2-Diphenyl-1-Picrylhydrazyl (DPPH) solution. Then let the mixture stand for 30 minutes in a light-free room. Mint leaf nanoemulsion was obtained using the *water-titration method* . The oil phase was made from a mixture of virgin coconut oil and Tween 80 as a surfactant, and *polyethylene glycol* 400 (PEG 400) as a co-surfactant in a ratio of 1:8.5:0.5. Then, water at a temperature of 70 °C was added to the oil phase by titration, stirring continuously until a homogeneous nanoemulsion was obtained. The nanoemulsion was then assessed through organoleptic tests, pH, stability, and particle size. In addition, the nanoemulsion was also assessed physically through color, aroma, and several homogeneity parameters. The particle size used in this study was 33 nm (Hanifah *et al.* , 2021).

In this study , the NAFLD score : is seen from the steatosis index : the percentage of the liver area containing fat, the inflammation index : the number of inflammatory cell infiltrations in the liver tissue and the fibrosis index : the level of scar tissue formation in the liver. The level of necrosis is observed from the percentage of hepatocyte necrosis : The proportion of liver cells that experience death and the level of degeneration and apoptosis : Observation of cells that show signs of programmed cell death. On the 15th day, the mice were anesthetized and then blood samples were taken through the orbital vein with a capillary pipette of 3 cc, collected into an EDTA (EthylenediamineTetraacetic Acid) tube and placed in a cool box. The blood samples were then examined at the University of North Sumatra Laboratory to determine ALT (Alanine Aminotransferase) and AST (Aspartate Aminotransferase) levels using a photometric examination method using a production reagent kit (Analyticon®).

Scoring data was then created from histopathological observation data through microscopic examination. The data obtained from the study were tabulated, then analyzed for the changes found, and finally presented descriptively. Next, the research data were analyzed using the Statistical Package for Social Sciences (SPSS) 25.0 for Windows. To assess data normality, the Kolmogorov-Smirnov test was used ($p > 0.05$). In addition, significance between test groups was tested using One-Way ANOVA or one-way analysis of variance at a 95% confidence level. Further analysis or testing was carried out using the Post Hoc Test and LSD techniques.

RESULTS AND DISCUSSION

This research was conducted at the Laboratory of the Department of Pharmacology and Therapeutics, 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. This chapter will describe and outline the results of the research data collection and processing that have been conducted. Subsequently, a discussion will be conducted, starting with the presentation of the results of the overview of the general

objectives of the research and the specific objectives of the research. From the description of the research results, the discussion of the research problems can also be illustrated, and conclusions drawn.

Description of the Results of Measurement of Body Weight and Blood Glucose Levels of Rats

Giving nanoemulsion of mint leaf extract (*Mentha piperita L*) was given for 14 days so that the total overall study This is 28 days . As for dose giving extract each group different namely The control group (P0) was the reference group because it was not given any treatment, only given standard feed in the form of pellets, treatment group 1 (P1) was given nanoemulsion of mint leaf extract (*Mentha piperita L*) with a concentration of 2.5% , treatment group 2 (P2) with a concentration of 3.5% , and treatment group 3 (P3) with a concentration of 5% .

The following are measurements of the initial body weight of mice after alloxan induction and treatment with mint leaf extract. The data shows that the average initial body weight of all groups of mice falls within the research weight criteria, namely 200-300 grams. Furthermore, glucose levels in all groups of mice were within the normal range of 6.97-97.89 **mg/dl** . study to be continued with give induction alloxan for 14 days monitoring to group P1 , P2 and P3. Then given nanoemulsion of mint leaf extract (*Mentha piperita L*) for 14 days And return seen results the examination in day to 28. From the table it can be seen that there was an increase in average body weight in the treatment group after being induced by alloxan. and an examination was carried out on the 14th day, it was seen that the P1 group had an average of 178 grams, P2 had an average of 182 grams, and P3 had an average of 180 grams. Then a drastic increase in the blood sugar levels of the mice was seen with the P1 group being 347 mg/dl, the P2 group being 323.4 mg/dl, and the P3 group being 325.3 mg/dl. So that alloxan induction can reduce body weight and increase glucose in the treatment group mice so that all groups of mice were declared to have hyperglycemia. For the P0 group, it became the reference group because it was not given any treatment and the results in this group were 200 grams of body weight and 87.3 mg/dl of glucose.

Then all groups were given treatment with mint leaf nanoemulsion (*Mentha piperita L*) for 14 days and the final results were observed on the 28th day with treatment group 1 (P1) given mint leaf nanoemulsion (*Mentha piperita L*) with a concentration of 2.5% , Treatment 2 (P2) with a concentration of 3.5% , and treatment 3 (P3) with a concentration of 5% . The results showed an increase in body weight in the treatment group. The P0 group was the reference group with an average body weight of 216.4 grams and glucose of 94.5 mg/dl. For the P1 group, the average body weight was 239.3 grams and glucose of 97 mg/dl, while the results of body weight were normal although still above the reference group, but glucose levels were still high. In the P2 group, the average body weight was 234 grams and glucose of 93.7 mg/dl, while these results showed that body weight had returned to normal and glucose levels were within normal limits. In the P3 group, the average body weight was 248 grams and glucose levels were 91.4 mg/dl. These results indicated that body weight and glucose levels had returned to normal. Furthermore, the results for the P2 and P3 groups in the test group showed normal results on the 28th day of testing.

So the test results above show the success rate of mint leaf extract nanoemulsion (*Mentha piperita L*) in reducing blood glucose levels in mice that have experienced hyperglycemia.

Making Mint Leaf Extract (*Mentha Piperita L.*) In Nanoemulsion

Before making nanoemulsion, mint leaves must be converted into extract first using the maceration method. 2 kg of mint leaves were then taken to be made into extract. The mint leaves that have been taken were then cleaned, then dried. After the mint leaves are dry, grind the mint leaves by pounding them to get 600g of mint leaf powder (simplicia) . Mint leaf nanoemulsion was obtained using the *water-titration method* . The oil phase was made from a mixture of virgin coconut oil and Tween 80 as a surfactant, as well as *polyethylene glycol 400* (PEG 400) as a co-surfactant with a ratio of 1: 8.5: 0.5. Then water with a temperature of 70 ° c was added to the oil phase by titration, stirring continuously until a homogeneous nanoemulsion was obtained. The nanoemulsion was then assessed through organoleptic tests, pH, stability, and particle size. In addition, the nanoemulsion was also physically assessed through color, aroma, and several homogeneity parameters. The particle size used in this study was 33 nm (Hanifah *et al.* , 2021).



Figure 2. Making Nano Emulsion Mint Leaves Concentration 3%, 4% and 5%

GC-MS Analysis Nano Emulsion Mint Leaves

In the GC-MS analysis of mint leaf extract, some of the common contents and percentages that can be found are as follows:

1. Menthol
 - Percentage : 30-55%
 - The main compound that gives mint its aroma and taste.
2. Menthone
 - Percentage : 10-30%
 - Contributes to aroma and has therapeutic effects.
3. Isomenthone
 - Percentage : 5-15%
 - A variant of menthone that adds to the aroma profile.
4. Limonene
 - Percentage : 1-10%
 - Gives a citrus aroma.

5. Cineole (Eucalyptol)
 - Percentage : 1-5%
 - Known to have antimicrobial properties.
6. Borneo
 - Percentage : 1-3%
 - Has a calming effect and a distinctive aroma.
7. Carvone
 - Percentage : 1-4%
 - Gives a different nuance of aroma.
8. Other Compounds
 - Fatty acids and other minor compounds : <1%
 - Can contribute to the stability and functional properties of the extract.

Table 1. Percentage Results of Mint Leaf Extract Content

No.	Contents	Percentage
1.	Menthol	45%
2.	Menthone	20%
3.	Isomethone	10%
4.	Limonene	5%
5.	Cineole (<i>Eucalyptol</i>)	3%
6.	Borneo	2%
7.	Carvone	1%
8.	Other Compounds : (including fatty acids and other minor compounds)	15%

Nafld Score Calculation

Table 2. NAFLD Score Assessment Results

Group	Steatosis (0-3)	Inflammation (0-3)	Fibrosis (0-3)	Hepatitis (0-3)	Total Score (0-12)
Control	1	1	1	1	4
Mint Leaf Nanoemulsion 3%	1	1	1	0	3
Mint Leaf Nanoemulsion 4%	0	1	1	0	2
Mint Leaf Nanoemulsion 5%	0	0	0	0	0

Interpretation of Results

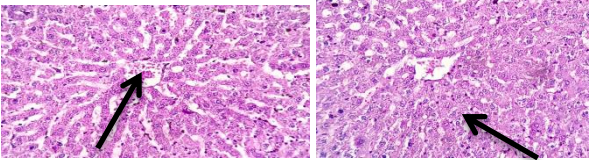
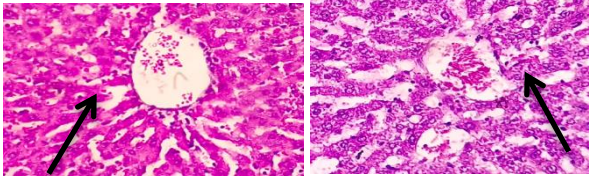
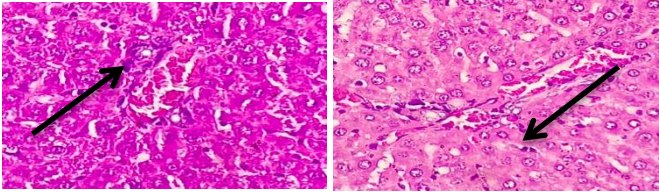
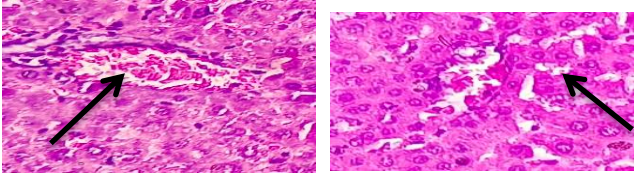
- **The Control group** had the highest total NAFLD score, indicating significant steatosis, inflammation, and fibrosis due to no treatment.
- **The 3% group** showed clear improvement, but still had some symptoms.
- **The 4% group** showed better scores, with reduced steatosis and inflammation.
- **The 5% group** showed no NAFLD symptoms, which showed the most significant protective effect.

The results showed that administration of mint leaf nanoemulsion significantly reduced NAFLD scores, with increasing effects at higher concentrations.

Liver Histopathology by Observing Liver Necrosis

The results of histopathological observations carried out using a light microscope with 400x magnification showed a significant reduction in necrosis scores in the group given mint leaf nanoemulsion, indicating the effectiveness of the treatment in protecting the liver from damage.

Table 3. Liver Histopathology

No	Group	Histopathological Image of Liver Tissue
1	Control	 <p>Microscopic image of the liver of the control group of mice shows that the liver is experiencing fatty degeneration and congestion. The score for this group is 2.</p>
2	Treatment 1 nanoemulsion of mint leaf extract (<i>Mentha piperita L</i>) 3%	 <p>Microscopic images of the livers of mice in treatment group 1 showed a fairly extensive and widespread fatty degeneration of the liver, parenchymatous degeneration or bleeding in the liver cells, inflammatory cell infiltration, the score in this group was 3, meaning there were changes in the form of hydrophilic degeneration.</p>
3	Treatment 2 nanoemulsions of mint leaf extract (<i>Mentha piperita L</i>) 4%	 <p>Microscopic image of the liver of mice in treatment group 2 shows improvement. structure histology heart However Still There is degeneration hydropic , the liver still experiences fatty degeneration, congestion, scoring Mild necrosis (few cells affected) so that enter in category score 2</p>
4	Treatment 3 nanoemulsions of mint leaf extract (<i>Mentha piperita L</i>) 5%	 <p>The microscopic image of the liver of mice in treatment group 3 shows that the histological structure of the liver is improving, so that the improvement falls into score category 1, there are no necrotic cells.</p>

CONCLUSION

The conclusion of this study is:

1. The active substance content in mint leaf extract (*Mentha piperita L*) through Gc Ms Analysis, namely Menthol : 45%, Menthone : 20%, Isomenthone : 10%, Limonene : 5%, Cineole (Eucalyptol) : 3%, Borneol : 2%, Carvone : 1% and Other Compounds : 14% (including fatty acids and other minor compounds).
2. The results showed that administration of mint leaf nanoemulsion significantly reduced NAFLD scores, with the effect increasing at higher concentrations. The 5% group showed no NAFLD symptoms, indicating the most significant protective effect.
3. The microscopic image of the liver of mice in treatment group 3 shows that the histological structure of the liver is improving, so that the improvement falls into the score category 1, there are no necrotic cells.

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REFERENCES

- Al-Saeed AH, CMMLDML-GFLCea, 2016.. An inverse relationship between age of type 2 diabetes onset and complication risk and mortality: The impact of youth-onset type 2 diabetes. *Diabetes Care* , 39, pp.:823–9.
- Bhalla, N..IN.PSV.&.HD, 2021. Phytochemical analysis of Moringa oleifera leaves extracts by GC-MS and free radical scavenging potency for industrial applications. *Saudi Journal of Biological Sciences* , 28(12), pp. 6915-6928.
- Chrimis Novalinda Ginting, INELEGDRHSWKWW, 2020. Antioxidant Activities of Ficus elastica Leaves Ethanol Extract. *Mol Cell Biomed Sci* , 4(1), pp.27-33.
- Effah Nyarko B, ARCA, 2019. *Boosting diabetes and pre-diabetes detection in rural Ghana*. F1000Res.
- Javeed N, MA, 2018. Circadian etiology of type 2 diabetes mellitus. *Physiology (Bethesda)* , 33(138-150).
- Johannes, Gi, E., Suci, T. & Ginting, CN, 2023. Early detection system of risk factors for diabetes mellitus type 2 utilization of machine learning-random forest. *Journal of Family and Community Medicine* , 30(3), pp.171-79.
- Mahadevan, V., 2020. Anatomy of the liver. Surgery (Oxford). *Anatomy of the liver. Surgery (Oxford)*, 38(8), pp. 427-431.
- Mirzaali o'g'li, AJ.BoMM.EoSX.&.RoSA, 2022. Liver Anatomy, Histology And Physiology. *Intellectual Education Technological Solutions And Innovative Digital Tools* , 1(11), pp.8-11.
- Nabhani N, WY, 2017. The effect of honey on the healing process of gangrene wounds in patients with diabetes mellitus. *Research Publication Media* , 15(69).
- Pouwels, S..SN.GY.LA.PT.YW.&.RD, 2022. Non-alcoholic fatty liver disease (NAFLD): a review of pathophysiology, clinical management and effects of weight loss. *BMC endocrine disorders* , 22(1), pp.1-9.

- Pouwels, S..SN.GY.LA.PT.YW.&.RD, 2022. Non-alcoholic fatty liver disease (NAFLD): a review of pathophysiology, clinical management and effects of weight loss. *BMC endocrine disorders* , 22(1), pp.1-9.
- Romero-Gomez, M..Z.-SS.&.TM, 2017. Treatment of NAFLD with diet, physical activity and exercise. *Journal of hepatology* , 67(4), pp.829-46.
- Setiati S, AISAwSB, 2019. *Textbook of Internal Medicine* . 6th ed. Jakarta: Internal Publishing.
- Siddiqi, Z..KR.FJ.KS.VS.&.ASS, 2017. Soft Drinks Consumption and the Risk of Nonalcoholic Fatty Liver Disease. *The Journal of the Association of Physicians of India*, 65(5), pp.28-32.