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Modulation of Lipid and Glucose Profiles in Hyperglycemic and Hypercholesterolemic Animals by Nanocapsules of Purple Yam Anthocyanin Extract

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***Abstract*— Purple yam, rich in anthocyanins, has potential benefits for dyslipidemia and diabetes. Encapsulation into nanocapsules improves its stability and bioavailability. This study aimed to evaluate the effects of purple yam anthocyanin extract (PYAE) nanocapsules on high-fat diet and streptozotocin (STZ)-induced diabetic rats. Diabetic rats induced with high-fat diet and streptozotocin (STZ) were divided into control and treatment groups receiving simvastatin, metformin, or purple yam anthocyanin extract (PYAE) nanocapsules (80-240 mg/200 g bq) for four weeks. Various parameters were observed, including body weight, blood glucose, serum insulin, lipid profile, and histopathology of the liver and pancreas. The results indicated that treatment with purple yam anthocyanin extract nanocapsules improved body weight, blood glucose levels, insulin levels, and lipid profiles compared to the diabetic rat group. Specifically, the blood glucose level in the group receiving 240 mg/200 g bw decreased significantly from 264.26 mg/dL to 91.70 mg/dL (p<0.05). In addition, body weight and insulin level increased, with insulin rising by 529.89 pg/mL from an initial level of 469.71 pg/mL. Furthermore, PYAE nanocapsules improved the lipid profiles of dyslipidemic rats by reducing triglycerides, cholesterol, and LDL levels while increasing HDL levels (p<0.05). Histopathological examination revealed that PYAE nanocapsule alleviated damage to pancreatic and liver tissues in diabetic rats.**

***Keywords*— anthocyanin nanocapsules, diabetes mellitus, dyslipidemia, lipid profile, purple yam**

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I. INTRODUCTION

High blood glucose (hyperglycemia) is characteristic of the chronic metabolic disease diabetes mellitus (DM). It is caused by deficient insulin production by the pancreas, the body's inability to use insulin effectively, or both [1,2]. This disorder interferes with protein, fat, and carbohydrate metabolism, resulting in complications that affect multiple body systems. Hyperglycemia induces oxidative stress, producing reactive oxygen species (ROS) and subsequent tissue damage, including pancreatic β-cell death, further exacerbating blood glucose levels [3,4]. Dyslipidemia, a complication of type 2 diabetes, involves increased triglycerides and LDL particles in the blood, along with reduced HDL levels [5]. Insulin resistance leads to higher triglyceride levels and lower HDL due to decreased enzyme activity that binds cholesterol to HDL [4]. The causes of DM are varied, including genetic and physiological factors, sedentary lifestyles, obesity, poor dietary choices, high intake of sugar and saturated fats, and impaired lipid metabolism due to oxidative stress [6].

Diabetes prevalence can be reduced by increasing the consumption of foods with antidiabetic properties. Anthocyanins are antioxidant compounds that help protect against heart damage and prevent diabetes [7]. They also possess anticholesterol and antilipidemic effects, combating LDL cholesterol oxidation [8]. Mechanisms of anthocyanins in reducing insulin insensitivity and abnormal lipid levels include the following: First, anthocyanins suppress the activation of the HMG-CoA reductase gene, which contributes to the reduction of cholesterol synthesis. Second, they inhibit cholesteryl ester transfer protein (CEPT), decreasing LDL concentration. Third,

anthocyanins diminish the impact on triglycerides by lowering apolipoprotein B and apolipoprotein C-III levels, which are the primary transporters of triglycerides. Additionally, anthocyanins facilitate the excretion of cholesterol through feces. An increase in serum cholesterol is linked to high levels of proinflammatory cytokines. Still, anthocyanins alone can reduce the levels of several inflammatory cytokines, such as IL-6 and interleukin-1β (IL-1β) in HepG2 cells [9]. In Indonesia, a food source rich in anthocyanins is purple yam, known locally as purple *uwi* (*Dioscorea alata* L.), which can be easily found and contains approximately 31 mg of anthocyanins per 100 g of dry matter [10].

Anthocyanins are known for their limited stability and susceptibility to damage under certain environmental conditions, such as temperature, pH, and light exposure [11-13]. Because of their perishable nature and the fact that they cannot be directly applied to food products, it is essential to use nanoencapsulation. This technique can enhance the nutritional value, color, shelf life, bioavailability, and stability of anthocyanins. By improving the stability of anthocyanins through nanoencapsulation, their application in the food industry can be expanded. This method helps maintain the color of food ingredients and increases the absorption of anthocyanins in the body. Additionally, nanoencapsulation can prevent interactions between anthocyanins and other food components, making it a promising approach for use in foods with various matrix compositions [14]. Despite the documented therapeutic potential of anthocyanins and the well-established benefits of nanoencapsulation, including improved bioavailability, enhanced delivery efficiency, and protection of bioactive compounds during digestion, studies evaluating nanoencapsulated anthocyanins specifically derived from purple yam (*Dioscorea alata* L.) remain limited. This gap is particularly relevant given the potential of nanoencapsulation to enhance bioavailability and delivery efficiency of anthocyanins in vivo. Moreover, the extent to which PYAE nanocapsules improve integrated metabolic outcomes, including glucose regulation, lipid profile, and tissue-level recovery, and whether their effects are comparable to standard pharmacological agents such as simvastatin and metformin, has not been fully explored. Therefore, this study aimed to evaluate the in vivo effects of PYAE nanocapsules on blood glucose, serum insulin, lipid profiles, and pancreatic and hepatic tissue integrity in high-fat diet and streptozotocin (STZ)-induced diabetic rats.

II. MATERIAL AND METHODS

A. Anthocyanin Encapsulation

Write This research used purple yam from Sleman, Yogyakarta, Indonesia. The preparation of purple yam flour, extraction, and nanoencapsulation of anthocyanin extract was performed according to [15]. A ratio of maltodextrin (MD) and whey protein isolate (WPI) of 1:3 with 30% (w/w) anthocyanin extract was used for nanoencapsulation. The spray dryer was set at an inlet temperature of 100 °C, an outlet temperature of 60 to 62 °C, and a drying airflow of 350 mL per hour. The purple yam anthocyanin extract (PYAE) nanocapsules contained 30.68 mg/L of anthocyanin.

B. Experimental Design with Animals

Thirty-five male Sprague-Dawley (SD) rats weighing 170-185 g were provided by the Center for Food and Nutrition Studies (PSPG) Universitas Gadjah Mada, Indonesia. Procedures and experiments in this study were conducted in the nutrition laboratory at the same institution. All animals received standard feed and acclimatized for 7 days before the experiment in a cage under controlled laboratory conditions. In addition, the rats were divided into two groups: the normal diet group as healthy control (n = 5) and the high-fat diet (HFD) group (n = 30) were fed for 1 week. Streptozotocin (STZ) at a dose of 100 mg/kg body weight (bw) (Cayman, USA) was then induced in the high-fat diet group. After 10 days, it becomes hyperlipidemia and diabetes mellitus (DM). Subsequently, the hyperlipidemic and diabetic rats were split into 6 groups, one group as disease control, while the other groups were treated with simvastatin (0,18 mg/200 g bw), metformin (9 mg/200 g bw), PYAE80 (PYAE nanocapsule 80 mg/200 g bw), PYAE160 (PYAE nanocapsule 160 mg/200 g bw), PYAE240 (PYAE nanocapsule 240 mg/200 g bw). Treatments were administered orally for 4 weeks, with food and water given ad libitum.

C. Body Weight and Fasting Blood Glucose

Body weight was measured weekly for 4 weeks, and fasting blood glucose after treatment. Blood from the sinus orbitalis vein (inner corner of the eye) for blood sugar measurement using a glucometer.

D. Insulin Level and Lipid Profile

During the dietary treatment period, blood samples were collected at baseline (3 days after streptozotocin induction) and post-treatment (4 weeks after intervention) in hyperlipidemic and diabetic animals. Blood was collected from the sinus orbitalis vein up to ± 1.5 ml. Blood was then centrifuged at 4,000 rpm for 15 minutes to obtain serum. The serum was analyzed for insulin level and lipid profile, including triglyceride content, total cholesterol, HDL, and LDL cholesterol. The experimental procedure and animal welfare were approved by the Ethical Approval by KE/AA/XI/10112082/EC/2024.

Enzymatic analysis of triglycerides (glycerol-3-phosphate-oxidase = GPO method) [16], total cholesterol (CHOD-PAP method) [17], and HDL cholesterol through precipitation of LDL, VLDL, and chylomicrons [18] was used. LDL cholesterol was determined based on the formula as follows [16].

LDL cholesterol (mg/dl) =
Total cholesterol – HDL cholesterol – (triglycerides/5) eq (1)

The dose of simvastatin in this study was determined by converting the human hypercholesterolemic dose of 10 mg/day to the Sprague-Dawley rat dose using [19] conversion table, as follows: 10 mg/day x 0.018 = 0.18 mg/day/200 g BW.

Simvastatin suspension was prepared by dissolving 0.18 mg of simvastatin powder into 1 mL of distilled water.

E. Histopathological Analysis

Pancreas and liver samples from experimental rats were fixed with 10% paraformaldehyde (PFA), then dehydrated and embedded in paraffin blocks. The tissues were then cut with a 5 mm thick microtome and stained using hematoxylin-eosin (HE). Pancreas and liver slides were examined under a light microscope (CX23, Olympus) to analyze the number of necrosis cells in the tissues.

F. Statistical Analysis

All experimental data were tested for normality (Shapiro-Wilk) and homogeneity (Levene), then compared with One-Way ANOVA and followed by Duncan's Multiple Range Test (DMRT) ($p < 0.05$) using IBM SPSS Statistics 23.

III. Result and Discussion

G. Effect of PYAE nanocapsule on body weight, blood glucose, and insulin level

Body weight measurements of the rats were presented in **Table 1**. Rats in the disease control group, treated with streptozotocin, exhibited a significant reduction in body weight compared to the healthy control rats. In contrast, hyperlipidemic and diabetic rats treated with streptozotocin showed a significant weekly increase in body weight. Weight loss is a common characteristic of diabetes, particularly when induced by a high-fat diet followed by streptozotocin administration [20,21]. Elevated blood glucose and lipid levels in diabetic rats lead to oxidative stress by stimulating the production of reactive oxygen species in mitochondria. These free radicals can react with unsaturated fatty acids, damaging the integrity of cell membranes and resulting in apoptosis of body cells, which contributes to weight loss [22,23] Moreover, insulin resistance and insulin deficiency, associated with pancreatic β-cell damage, further contribute to weight loss in diabetic individuals.

TABLE 1
EFFECTS OF PURPLE YAM ANTHOCYANIN EXTRACT NANOCAPSULES ON BODY WEIGHTS OF STZ/HFD-INCLUDES DIABETIC RAT

Treatment	Week(s)			
	1	2	3	4
Healthy control	214.8±5.54^{aA}	221.4±5.94^{abB}	229.2±6.10^{bcB}	236.2±5.89^{cB}
Disease control	217±4.30^{dA}	207.4±3.58^{cA}	198.4±3.36^{bA}	189.2±2.77^{aA}
Simvastatin	229.6±2.70^{aB}	233.2±2.86^{abC}	236.8±2.86^{bC}	242.6±2.88^{cC}
Metformin	229.6±2.07^{aB}	232.6±2.70^{aC}	237.2±2.39^{bC}	242±2.92^{cC}
PYAE80	225.8±3.77^{aB}	229.2±2.59^{abC}	232.4±3.51^{bcBC}	236.4±3.51^{cB}
PYAE160	225.8±4.92^{aB}	230.2±5.93^{abC}	236.4±5.32^{bC}	243.6±5.03^{cC}
PYAE240	227.8±3.49^{aB}	231.2±1.92^{aC}	237.6±3.21^{bC}	244±3.67^{cC}

Different lowercase letters in the same row indicate significant differences among the 4 weeks treatments for a single group ($p > 0.05$). Different capital letters in the same column indicate significant differences between the seven groups ($p < 0.05$). Values are expressed as mean±standard deviation (SD) for rats in each group (n=5).

A lack of glucose forces the body to accelerate the breakdown of carbohydrates, fats, and proteins for energy [24]. A study reported increased mRNA expression levels of leptin and adiponectin in diabetic rats, which resulted in both adipogenesis and lipolysis, potentially leading to reduced body weight [25]. In this study, purple yam extract nanocapsules demonstrated the ability to inhibit free radicals that damage body cells, evidenced by a significant increase in the weight of treated rats compared to the disease control group. This finding aligns with previous studies which used anthocyanin extracts from black soybean seed coats and blueberries, respectively, to improve weight loss in rats, thereby enhancing the quality of life for diabetic rats [20], [26].

The high blood glucose level consistent with the significantly decreased insulin in the disease control group compared with the healthy control group showed that STZ induction successfully interfered with insulin secretion in diabetic model rats (**Figure. 1a**). Streptozotocin induces diabetes in two ways: 1. Because of its structure similar to glucose, STZ enters pancreatic beta cells through glucose transporter 2 (GLUT2) on the plasma membrane and then damages beta cells by alkylating DNA in proteins involved in glucose uptake and metabolism, 2. STZ stimulates the synthesis of polynucleotide (ADP-ribose), NAD, and NADP, which inhibits proinsulin synthesis and also activates reactive oxygen such as superoxide, hydrogen peroxide, and hydroxyl radicals [4]. However, supplementation with PYAE nanocapsules resulted in a significant recovery, as shown by a decrease in blood glucose from 264.26 mg/dL at disease control to 91.70 mg/dL at a concentration of 240 mg/200 g bw. It even lowered blood glucose more than simvastatin and metformin, which were 107.80 and 108.30 mg/dL, respectively. The previous studies showed that anthocyanins from blueberry extract could inhibit GLUT2 activity, which reduces glucose transport, and increase GSK3β activity, which plays a role in glycogenolysis activity, thereby decreasing blood glucose levels [26]. Through molecular docking simulations found that the active compound in purple yam has amino acid residues that are also found in acarbose, which acts as an α-glucosidase inhibitor, so it inhibits carbohydrate absorption in the small intestine [4].

Insulin levels of disease control were significantly lower than healthy control (**Figure. 1b**), indicating the possibility of decreased insulin secretion due to pancreatic β-cell damage as characteristic of type 1 diabetes. Treatment with PYAE nanocapsules at 240 mg/200 g bw can increase insulin levels close to healthy control, reaching 529.87 pg/mL from 469.71 pg/mL. This recovery in circulating insulin is consistent with the histopathological observations presented in **Figure 3a**, where PYAE nanocapsule-treated groups exhibited a marked increase in the number of intact pancreatic β-cells within the islets of Langerhans. This is evidenced by the higher density of dark purple granules and improved islet morphology compared to the disease control. The improved islet architecture observed in groups receiving PYAE nanocapsules, particularly at 240 mg/200 g bw, therefore directly supports the increased insulin

secretory capacity reflected in **Figure 1b**. Anthocyanins as antioxidants have a mechanism of hydrogen atom transfer (HAT) or providing electrons by single electron transfer (SET) to stabilize free radicals [27]. Therefore, anthocyanins can neutralize reactive oxygen species (ROS) so that β-cell damage due to oxidative stress can be reduced [28]. The previous studies found that anthocyanins in purple yam, purple sweet potato, and taro could suppress the production of pro-inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α) and interleukin-1 beta (IL-1β), which also promote the formation of oxidative stress [4]. Another study using *Hibiscus trionum* tea showed similar results of decreased blood glucose and increased serum insulin in type 1 diabetic rats [22]. The components contained in *Hibiscus trionum* synergistically and independently have the potency to restore pancreatic β-cells by stimulating insulin release or inhibiting glucose absorption in the intestine.

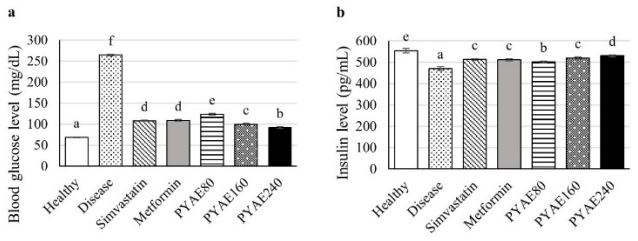

Fig 1. Effects of PYAE nanocapsule on blood glucose and serum insulin of HFD/STZ induced diabetic rat in control and experimental groups. (a) Blood glucose; (b) Serum insulin. Different letters indicate significant differences ($p < 0.05$). Values are expressed as mean±standard deviation (SD) for rats in each group (n=5).

H. Lipid Profile

The effect of PYAE nanocapsules on lipid profile abnormalities in diabetic rats is shown in Figure 2. The disease control group had significantly higher levels of triglycerides, total cholesterol, and LDL, while HDL was lower than healthy control. Furthermore, 4 weeks of treatment with PYAE nanocapsules revealed reduced triglycerides, total cholesterol, and LDL in diabetic rats. In addition, there was an increase in HDL, showing that PYAE nanocapsule treatment can improve lipid profile. PYAE nanocapsule doses of 80, 120, and 240 mg/200 g bw can significantly improve lipid parameters, even approaching normal levels at higher doses. PYAE nanocapsules treatment significantly decreased triglycerides and reached its lowest at a concentration of 240 mg/200 g bw, by 82.85 mg/dL, which was below the simvastatin and metformin groups of 88.09 and 89.59 mg/dL, respectively (**Figure. 2a**). Total cholesterol in the disease control group reached 197.56 mg/dL, significantly decreased to 98.47 mg/dL, close to the healthy control group at the highest PYAE extract level (**Figure. 2b**). This result was also lower than the use of simvastatin, which resulted in total cholesterol of 109.01 mg/dL.

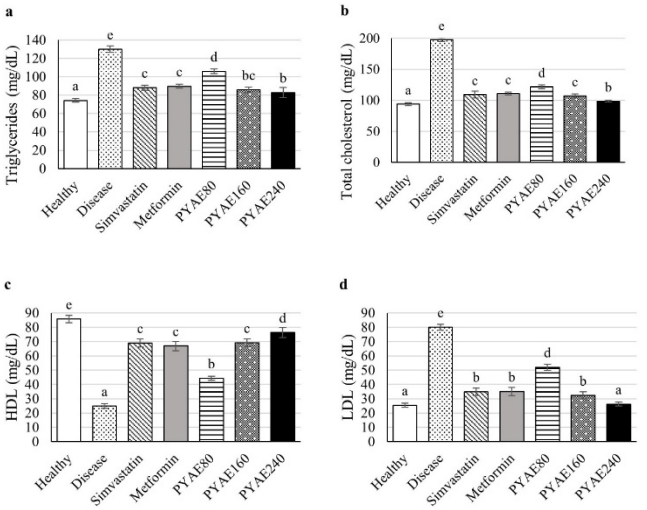

Fig 2. Effects of PYAE nanocapsule on lipid profile of STZ/HFD induced diabetic rat in control and experimental groups. (a) Triglyserides; (b) Total cholesterol; (c) HDL; (d) LDL. Different letters indicate significant differences ($p < 0.05$). Values are expressed as mean±standard deviation (SD) for rats in each group (n=5).

High-density lipoprotein (HDL) contains a higher proportion of protein compared to lipid content. HDL is responsible for transporting excess cholesterol from peripheral tissues, including cholesterol found in atherosclerotic plaques, to the liver for excretion. In contrast, low-density lipoprotein (LDL) has a higher lipid content than protein and transports cholesterol to peripheral tissues and hepatocytes. Elevated levels of LDL can increase metabolic risks associated with cholesterol accumulation in peripheral tissues and the liver, contributing to conditions such as atherosclerosis [4]. This study found that HDL levels increased significantly at higher concentrations of PYAE nanocapsules, peaking at 240 mg/200 g bw, reaching 76.32 mg/dL and surpassing the levels observed with simvastatin and metformin (**Figure. 2c**). Conversely, LDL levels decreased dramatically from 80 mg/dL to 26.16 mg/dL, comparable to the levels in the healthy control group (**Figure. 2d**). These results suggest that PYAE nanocapsules may serve as an alternative to simvastatin and metformin in preventing hypercholesterolemia, hypertriglyceridemia, and cardiovascular complications often associated with metabolic disorders related to diabetes mellitus.

Diabetes mellitus (DM) is a risk factor for the development of cardiovascular disease (CVD) and can be exacerbated by uncontrolled hyperglycemia, dyslipidemia, hypertension, and obesity associated with elevated plasma triglycerides, total cholesterol, and LDL [7],[29] . The key to reducing CVD risk is to lower LDL and increase the "good cholesterol" HDL-C. Other than its role in reverse cholesterol transport, HDL is antioxidant by inhibiting LDL lipid peroxidation, anti-inflammatory by inducing TGF-β2 cytokine expression, pro-survival, inhibits platelet activation by removing excess plasma

membrane cholesterol, and has vasodilatory and vasoprotective properties [30]. This study shows that purple yam anthocyanins extract supplemented in rats induced with HFD/STZ for 4 weeks can provide cardiovascular protection by improving lipid homeostasis, as manifested by a decrease in triglycerides, total cholesterol, LDL, and an increase in HDL. Other studies have also demonstrated the normalization of serum lipid profiles using anthocyanins from black soybean seed coats [20], pigmented black rice [1],[31], blueberries [26], and raspberries [32].

The main mechanisms in diabetic cardiovascular disease include oxidative stress (leading to inflammation), fibrosis, and apoptosis pathways [7]. Anthocyanins' antioxidant capacity against oxidative stress directly, including hydrogen atom transfer (HAT) and single electron transfer (SET), and indirectly, by activating nuclear factor erythroid 2-related factor 2 (Nrf2), which regulates endogenous liver antioxidants [27,33]. Anthocyanins have the potential to provide antioxidant capacity under conditions of high oxidative stress, such as obesity and hypercholesterolemia, by inhibiting or reducing ROS in the adenosine monophosphate-activated protein kinase (AMPK) pathway [34,35]. Anthocyanins from blueberry extract effectively reduce ROS, thereby increasing AMPK regulation [26]. AMPK inhibits lipid synthesis factors, such as: 1. 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMGCR), which plays a role in sterol and isoprenoid synthesis; 2. Sterol regulatory element-binding protein-1c (SREBP-1c), which promotes fatty acid synthesis; and 3. acetyl coenzyme A carboxylase (ACC), which is active in lipogenesis. In addition, AMPK promotes the activity of hormone-sensitive triglyceride lipase (HSL), which plays a role in lipolysis. The active compound from the purple tuber has amino acid residues resembling simvastatin [4], so it may be an alternative to HMGCR inhibitor drugs.

A double-blind, parallel-arm, randomized controlled trial involving 52 men with type 2 diabetes mellitus (DM) found that consuming 22 grams of blueberries daily for 8 months could significantly reduce serum triglycerides, HbA1c, and fructosamine levels [36]. Similarly, a clinical trial on 58 adults with type 2 DM, which administered 320 mg/day of anthocyanins for 6 months, demonstrated a decrease in serum LDL cholesterol, triglycerides, apolipoprotein (apo) B-48, and apo C-III, and an increase in HDL cholesterol [35]. The other research reported that consuming 320 mg of anthocyanins in workers aged 25 to 75 years resulted in a 24.9% reduction in triglycerides [37]. The other researcher also suggested that the reduced cholesterol levels associated with anthocyanin consumption are due to increased fecal excretion of neutral and acidic sterols [38]. Furthermore, anthocyanins may downregulate the expression of the HMGCR gene in the liver, which inhibits cholesterol synthesis. The beneficial effects of anthocyanins on lowering LDL cholesterol concentrations in patients with dyslipidemia could be partly mediated by cholesteryl ester transfer protein (CEPT) inhibition. Anthocyanins may also reduce LDL cholesterol levels by activating the AMPK pathway, which inhibits the regulation of HMGCR enzymes involved in cholesterol synthesis and suppresses ACC, thereby decreasing cholesterol esterification in the intestine and liver [39]. This study is consistent with other study which stated that giving anthocyanins to cardiovascular patients will reduce LDL-C [40].

I. Histopathology

Tissue damage in pancreatic and liver samples from the rat study groups was shown in **Figure. 3**. In the healthy control group, a complete pancreatic islet structure composed of numerous pancreatic β-cells was observed (**Figure. a1**). On the other hand, the disease control group exhibited significant damage to the islet cells, characterized by vacuolization and necrosis (**Figure. a2**). Many acinar cells appeared irregular, and the connective tissue capsule surrounding the islet cells was poorly defined. Each group of PYAE nanocapsules demonstrated varying levels of effectiveness in reducing this damage (**Figure. 3a5-7**). The number of pancreatic β-cells and the morphology of the islets were nearly restored, as indicated by the increased presence of dark purple granules [41].

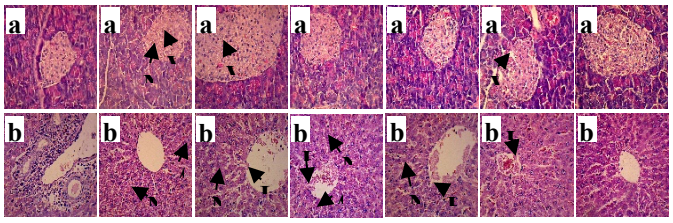

Fig 3. Histopathological appearance of PYAE nanocapsule on the pancreas and liver of STZ-induced diabetic rats after 4 weeks. (a) Pancreas (HE stain, 400×): a1 (healthy control); a2 (disease control); a3 (simvastatin); a4 (metformin); a5 (PYAE80); a6 (PYAE160); a7 (PYAE240). (b) Liver (HE stain, 400×): b1 (healthy control); b2 (disease control); b3 (simvastatin); b4 (metformin); b5 (PYAE80); b6 (PYAE160); b7 (PYAE240). V=vacuolization; A=apoptosis; N=necrosis; H=hemorrhage.

Liver histology showed liver damage such as necrosis, and apoptosis was observed in the disease control group (**Figure 3b2**). Additionally, hemorrhage was observed in the tissue of the rat treatment group (**Figure. 3b3-6**). However, the PYAE nanocapsule significantly reduced these histopathological changes, with no noticeable abnormalities in the group receiving 240 mg of PYAE per 200 g body weight (**Figure. 3b7**). The histopathological results indicated that the PYAE nanocapsule could delay and treat pancreatic and liver damage, providing protective effects in STZ-induced diabetic rats. Therefore, PYAE nanocapsule is a promising resource for DM prevention and treatment in the future. In patients with hyperglycemia, increased reactive oxygen species (ROS) impact large molecules such as polyunsaturated fatty acids at the onset of the lipid peroxidation process. This mechanism leads to impaired permeability and fluidity of cell membranes. Additionally, lipid peroxidation causes inflammatory infiltration, resulting in liver inflammation and necrosis [42].

The study findings indicate that TNF-α is highly expressed in cases of significant cell necrosis [4]. TNF-α is a proinflammatory cytokine that regulates apoptosis and the inflammatory process, ultimately inducing liver damage.

IV. CONCLUSION

The results indicate that purple yam anthocyanin extract (PYAE) nanocapsules may normalize blood glucose levels in HFD/STZ-induced diabetic rats. These nanocapsules mitigate the toxic effects of STZ by maintaining pancreatic β-cell integrity and reducing damage to islets of Langerhans. That is evidenced by increased body weight and serum insulin levels in the rats. PYAE nanocapsules significantly improve hyperlipidemia by lowering triglycerides, total cholesterol, and LDL while enhancing HDL. A concentration of 240 mg/200 g bw showed promising and, in several parameters, comparable or more pronounced effects on blood glucose, serum insulin, and lipid profile relative to simvastatin and metformin. Histopathological examination revealed that PYAE nanocapsule alleviated damage to pancreatic and liver tissues in diabetic rats. These valuable findings suggest a promising candidate for DM treatment or functional food for prevention. Future studies should focus on elucidating more specific mechanisms of action and exploring the optimal dose for clinical trials.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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