

Hypolipidemic Activity Of Red Fruit (*Pandanus conoideus* Lam.) Extract In Diabetic Wistar Rats and Its Development As A Supplementary Book

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Abstract

Diabetes mellitus is frequently accompanied by dyslipidemia, which increases cardiovascular risk. Red fruit (*Pandanus conoideus* Lam.), an indigenous Papuan food rich in tocopherols and carotenoids, may modulate oxidative stress and lipid metabolism. This study investigated the hypolipidemic activity of red fruit extract in diabetic male Wistar rats and evaluated the feasibility of presenting the findings in a supplementary book. A completely randomized laboratory experiment involved 24 rats allocated to six groups: a negative control, simvastatin at 0.72 mg/rat/day, and red fruit extract at 0.12, 0.24, 0.36, or 0.48 mL/rat/day. Diabetes was induced by intravenous alloxan at 70 mg/kg body weight. After fasting blood glucose exceeded 200 mg/dL, the interventions were administered orally for 21 days. Fasting glucose, total cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) were measured before induction, after induction, and after treatment. Data were analyzed using one-way analysis of variance followed by Duncan's test ($\alpha=0.05$). The extract contained alpha-tocopherol at 399.10, delta-tocopherol at 250.65, gamma-tocopherol at 108.59, and beta-tocopherol at 32.06 mg/100 g. Treatment significantly affected all final metabolic outcomes (glucose, total cholesterol, triglycerides, and LDL, $p<0.001$; HDL, $p=0.001$). The 0.12 mL/rat/day dose produced the greatest reductions in fasting glucose (53.1%), triglycerides (57.4%), and LDL (56.9%), whereas 0.24 mL/rat/day produced the greatest reduction in total cholesterol (40.5%) and best preserved HDL. The highest dose increased fasting glucose. Expert validation and readability scores for the supplementary book were 82.36% and 87.50%, respectively. Red fruit extract demonstrated preclinical hypolipidemic potential, particularly at lower doses; however, the response was nonlinear and cannot be extrapolated as a human therapy without extract standardization, safety assessment, and further investigation.

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INTRODUCTION

Diabetes mellitus is a chronic metabolic disease characterized by hyperglycemia resulting from impaired insulin secretion, insulin action, or both. Its growing burden is not limited to glycemic control. Altered fatty-acid and lipoprotein metabolism in diabetes may produce elevated triglycerides, reduced HDL, and more atherogenic LDL particles. Lipid management is therefore central to preventing cardiovascular disease in people with diabetes. The 2026 Standards of Care in Diabetes emphasize integrated cardiovascular risk assessment and lipid management, while evidence-based pharmacological and lifestyle therapies in humans remain the standard of care (American Diabetes Association Professional Practice Committee, 2026).

At the pathophysiological level, insulin deficiency or insulin resistance increases adipose-tissue lipolysis and the delivery of free fatty acids to the liver. These changes stimulate very-low-density lipoprotein production, delay the clearance of triglyceride-rich lipoproteins, and modify lipid exchange among lipoprotein classes. Diabetes may consequently be accompanied by hypertriglyceridemia, altered HDL metabolism, and increased concentrations of atherogenic LDL particles (Hirano, 2018). Persistent hyperglycemia also promotes reactive oxygen species formation, protein glycation, inflammation, and endothelial dysfunction. Because oxidative stress intersects with beta-cell injury and impaired lipid metabolism, antioxidant-rich foods are scientifically relevant candidates for preclinical testing. Nevertheless, claims of benefit must remain proportional to the level of evidence.

Red fruit (*Pandanus conoideus* Lam.) is a traditional food crop native to Papua and New Guinea. Its intensely colored oil contains several carotenoids, tocopherols, and fatty acids. Analyses of different accessions have shown that genotype, ripening stage, and processing influence carotenoid and tocopherol concentrations, free fatty acids, and overall oil quality (Sarungallo et al., 2019). Carotenoid profiling has identified beta-carotene, alpha-carotene, beta-cryptoxanthin, and additional carotenoid groups in the fruit (Takaichi et al., 2021). These variations indicate that the term red fruit extract does not necessarily describe chemically equivalent products. Biological findings should therefore be interpreted together with botanical authentication, extraction procedures, and compositional data.

Tocopherols are lipid-soluble antioxidants capable of interrupting lipid peroxidation by donating hydrogen atoms to peroxy radicals. Carotenoids may also interact with reactive species, although their activity depends on molecular structure, concentration, the surrounding lipid environment, and the oxidative conditions. The combination of tocopherols, carotenoids, and unsaturated fatty acids in red fruit oil provides a plausible basis for limiting lipid oxidation and tissue damage. Antioxidant activity in a chemical or experimental system, however, does not automatically establish a clinical effect. Bioavailability, metabolism, dose, oil composition, dietary context, and interactions with medicines all determine the biological response (Kaye et al., 2025).

Recent evidence supports continued investigation of red fruit. Lestari et al. (2024) reported that red fruit oil improved markers related to streptozotocin-induced diabetic peripheral neuropathy through oxidative and inflammatory pathways. A contemporary review also described the experimental biological potential of red fruit carotenoids (Wulansari et al., 2024). Another animal study published in 2025 evaluated red fruit extract and highlighted the relevance of its carotenoid and tocopherol content (Salle et al., 2025). These findings strengthen biological plausibility, but they do not replace carefully controlled dose-response experiments, toxicological evaluation, dietary control, or human clinical trials.

Animal studies remain valuable for establishing preliminary metabolic responses when they are designed and reported transparently. Alloxan produces diabetes through beta-cell injury associated with free-radical generation. It is a rapid model, but responses may vary considerably among animals, and the model represents severe insulin deficiency more closely than the full spectrum of human type 2 diabetes. The ARRIVE 2.0 guidelines emphasize clear reporting of experimental units, randomization, blinding, sample-size determination, exclusion criteria, outcomes, statistical methods, and ethical approval to strengthen the reproducibility of animal research (Percie du Sert et al., 2020a; 2020b).

The thesis on which this article is based was completed in 2014, when evidence on red fruit composition and biological activity was more limited. Updating the literature through 2026 places the original data within current scientific knowledge. The primary observations have not been

altered, but terminology, percentage-change calculations, interpretation, and the boundaries of the conclusions have been clarified. In particular, a decline in HDL is not interpreted as a favorable hypolipidemic outcome, and the nonlinear dose pattern is not simplified into the claim that higher doses are necessarily more effective.

In addition to the animal experiment, the findings were developed into a supplementary book entitled *Overcoming Diabetes and High Cholesterol with Red Fruit*. Popular educational materials can connect research with health literacy, but media feasibility does not establish the clinical validity of every health claim. Educational materials should be accurate, understandable, explicit about uncertainty, and designed not to encourage patients to discontinue prescribed treatment. Expert validation and readability testing are therefore treated in this article as preliminary assessments of product quality rather than evidence of educational effectiveness or behavioral change.

This study aimed to: (1) analyze changes in fasting glucose and lipid profiles in alloxan-induced diabetic Wistar rats after four doses of red fruit extract; (2) identify the dose producing the most favorable metabolic response within the tested range; and (3) evaluate the preliminary feasibility of the supplementary book through expert validation and readability testing. The experimental hypothesis was that final metabolic outcomes would differ among treatment groups.

RESEARCH METHODS

The investigation comprised two stages. The first was a completely randomized laboratory experiment, and the second was the limited development and evaluation of a supplementary book based on the experimental findings. Extract preparation was conducted at the Laboratory of Chemistry and Biochemistry of Agricultural Products and the Laboratory of Agricultural Process Engineering, University of Jember. Tocopherol analysis was performed at the Chemistry Laboratory, University of Muhammadiyah Malang. Animal maintenance and treatment took place at the Biomedical Laboratory, Faculty of Dentistry, University of Jember, and serum analyses were conducted at the Diagnostic Center of the University of Jember Dental Hospital. The experiment was conducted from March to June 2014, followed by book evaluation in September 2014.

The experimental subjects were 24 male Wistar rats aged 3-4 months and weighing 150-200 g. The minimum sample was determined using Federer's experimental approximation, $(t-1)(r-1) \geq 15$. With six groups, the calculation required at least four animals per group. Rats were housed four per cage with regularly replaced bedding and received standard pellets and water *ad libitum*. They underwent a seven-day acclimatization period. The groups consisted of a negative control receiving distilled water, a positive control receiving simvastatin at 0.72 mg/rat/day, and four extract groups receiving 0.12 (P1), 0.24 (P2), 0.36 (P3), or 0.48 mL/rat/day (P4).

Mature red fruits were washed, split, and separated from the central pith. The flesh was cut, washed, and steamed at 70-80 degrees C for 30 minutes. After cooling to approximately 50 degrees C, the material was pressed hydraulically. The oil-water paste was centrifuged at approximately 2,500 rpm for 15 minutes. The oil phase was concentrated in a vacuum evaporator at 50 degrees C for 40 minutes and filtered to obtain the oil fraction used as the extract. Alpha-, beta-, gamma-, and delta-tocopherols were quantified by high-performance liquid chromatography.

After acclimatization, rats were fasted for 10-12 hours, and baseline blood was collected from the lateral tail vein. Alloxan at 70 mg/kg body weight, dissolved in 0.9% sodium chloride, was administered intravenously. Three to seven days later, the rats were fasted again, and diabetes was confirmed when fasting blood glucose exceeded 200 mg/dL. Each group then received its assigned oral intervention by gastric gavage once daily for 21 days. The negative control received distilled water, the positive control received simvastatin, and groups P1-P4 received the assigned extract dose.

Final samples were obtained following a 10-12-hour fast on the day after completion of the intervention.

Serum glucose was measured using the GOD-PAP method. Total cholesterol, HDL, and LDL were analyzed using CHOD-PAP procedures, whereas triglycerides were determined using the GPO-PAP method. Outcomes were reported in mg/dL as mean plus or minus standard deviation at three time points: after acclimatization, after alloxan induction, and after the 21-day intervention. Percentage change was recalculated from the post-induction mean to the final mean using $[(\text{post-induction value} - \text{final value}) / \text{post-induction value}] \times 100\%$.

The source thesis reported variance homogeneity testing with Levene's test and normality testing with the Kolmogorov-Smirnov test. Because the assumptions were reported as satisfied, final outcomes were analyzed using one-way ANOVA followed by Duncan's multiple range test at $\alpha=0.05$. Values originally reported as $p=0.000$ are presented as $p<0.001$. The post hoc tables in the thesis appear to contain transformed values, but the transformation was not identified. This article therefore prioritizes means and standard deviations on the original measurement scale and uses the reported post hoc groupings only to describe documented between-group differences.

The research findings were presented in a supplementary knowledge book covering herbal and conventional medicines, introductory concepts of diabetes and dyslipidemia, red fruit botany, a public-oriented summary of the experiment, references, a glossary, and an author profile. Three lecturers evaluated the book: one media expert, one botanist, and one zoologist. Readability was evaluated by six respondents, consisting of three community members and three university students with a personal or family history related to diabetes or high cholesterol. Scores were converted into feasibility percentages.

The source document did not report the ethics committee approval number, operational randomization method, blinding, exclusion criteria, animal mortality, or handling of missing observations. These details should be verified from the original research records before journal submission. Missing information has been treated as a reporting limitation rather than filled with assumptions. The present article follows ARRIVE 2.0 principles to the extent permitted by the archived primary information.

RESULTS AND DISCUSSION

Characteristics of the Red Fruit Extract

Botanical identification confirmed the material as *Pandanus conoideus* Lam. of the family Pandanaceae. HPLC analysis showed a combined concentration of 790.40 mg/100 g for the four measured tocopherol homologues, with alpha-tocopherol as the dominant component (Table 1.).

Table 1. PLC analysis of *Pandanus conoideus* Lam.

Component	Concentration (mg/100 g)	Proportion (%)
Alpha-tocopherol	399.10	50.49
Beta-tocopherol	32.06	4.06
Gamma-tocopherol	108.59	13.74
Delta-tocopherol	250.65	31.71
Total	790.40	100.00

The predominance of alpha-tocopherol is biologically relevant because this homologue has high vitamin E activity, whereas gamma- and delta-tocopherol may display different reactivity toward oxygen- and nitrogen-derived species. Sarungallo et al. (2019) demonstrated that total tocopherol in red fruit oil varies among accessions and ripening stages. HPLC characterization is therefore a strength of the present study. More complete standardization would nevertheless require

total and individual carotenoids, fatty-acid profiles, peroxide values, water content, storage stability, and dosing expressed per kilogram of body weight.

Changes in Fasting Glucose and Lipid Profiles

Alloxan increased fasting glucose in every group from baseline values of 37-64 mg/dL to post-induction values of 272.7-309.0 mg/dL, meeting the operational diabetes criterion. Total cholesterol, triglycerides, and LDL also increased after induction. This pattern is consistent with metabolic disruption associated with insulin deficiency and oxidative stress. Responses after 21 days differed among groups and did not follow a linear dose-response relationship (Table 2).

Table 2. Changes in Fasting Glucose and Lipid Profiles

Outcome	Group	Baseline	Post-alloxan	Final	Change*
Glucose	C-	61+/-21.21	280+/-21.93	225.7+/-9.61	-19.4%
	C+	48+/-7.07	309+/-1.00	149.7+/-3.05	-51.6%
	P1	44+/-4.24	277.7+/-18.50	130.3+/-5.51	-53.1%
	P2	64+/-4.24	272.7+/-17.78	163.3+/-1.53	-40.1%
	P3	64+/-16.97	277.3+/-17.39	167.3+/-3.21	-39.7%
	P4	37+/-10.61	287.3+/-16.01	352+/-20.29	+22.5%
Total cholesterol	C-	77+/-1.41	99.3+/-1.53	90.3+/-1.53	-9.1%
	C+	78+/-1.41	105+/-3.00	85.7+/-2.08	-18.4%
	P1	81+/-2.83	92.3+/-1.53	55.3+/-3.05	-40.1%
	P2	73+/-1.41	94.7+/-5.03	56.3+/-1.53	-40.5%
	P3	68+/-4.24	89.7+/-4.93	61+/-1.00	-32.0%
	P4	71+/-2.12	90+/-1.73	58.3+/-3.78	-35.2%
Triglycerides	C-	100.5+/-9.19	114.3+/-2.52	101.7+/-5.13	-11.0%
	C+	110.5+/-0.71	121.7+/-11.15	63.7+/-1.53	-47.7%
	P1	106+/-1.41	119+/-16.82	50.7+/-3.21	-57.4%
	P2	104+/-3.53	113+/-13.89	54.7+/-10.02	-51.6%
	P3	102+/-5.66	118.3+/-15.31	86+/-3.00	-27.3%
	P4	105+/-5.66	121+/-14.93	79.3+/-5.03	-34.5%
HDL	C-	30.5+/-3.53	30.3+/-1.15	25.3+/-0.58	-16.5%
	C+	29.5+/-0.71	32.7+/-2.52	25.7+/-0.58	-21.4%
	P1	30+/-1.41	33+/-1.00	27+/-1.00	-18.2%
	P2	30+/-2.83	30+/-1.00	29.3+/-1.15	-2.3%
	P3	26.5+/-0.71	32+/-1.00	26+/-1.00	-18.8%
	P4	29+/-1.41	31+/-1.00	28+/-1.00	-9.7%
LDL	C-	43+/-4.24	94.3+/-2.89	69.7+/-0.58	-26.1%
	C+	43.5+/-2.12	103+/-12.77	57.7+/-0.58	-44.0%
	P1	45.5+/-2.12	102+/-3.00	44+/-1.00	-56.9%
	P2	46+/-4.24	101+/-9.84	50+/-1.00	-50.5%
	P3	53+/-4.24	108.7+/-1.15	59+/-1.00	-45.7%
	P4	47.5+/-0.71	108+/-11.13	54.7+/-1.53	-49.4%

Values are mg/dL and presented as mean +/- SD. C- received distilled water; C+ received simvastatin; P1-P4 received 0.12, 0.24, 0.36, and 0.48 mL/rat/day, respectively. Change was calculated from post-alloxan to final values; negative values indicate reductions.

Fasting Blood Glucose

P1 produced the lowest final fasting glucose concentration, 130.3+/-5.51 mg/dL, and the greatest reduction from post-induction values, 53.1%. P2 and P3 reduced glucose by approximately 40%, whereas P4 increased glucose to 352+/-20.29 mg/dL. ANOVA indicated a between-group difference ($p < 0.001$), and Duncan's test placed P1 in the group with the lowest mean and P4 in the group with the highest mean. The results suggest a possible effective-dose window rather than a monotonic relationship. This interpretation is biologically reasonable because alloxan-mediated beta-cell injury, reduced insulin availability, and oxidative stress jointly influence glucose homeostasis;

however, the model does not reproduce the entire multifactorial pathogenesis of human type 2 diabetes (Galicia-Garcia et al., 2020; Poznyak et al., 2020).

The increase at the highest dose may reflect biological variability, the energy density of the oil, exposure that was not standardized per kilogram of body weight, or an event affecting the small group. Complex phytochemical mixtures may also show threshold, biphasic, or hormetic responses rather than a simple linear dose-response pattern (Calabrese and Mattson, 2017). Without serial food intake, body weight, insulin, or pancreatic histology, the mechanism cannot be established. With only four animals per group, one unusual response could substantially alter the mean. Future studies should show individual data points and prespecify criteria for identifying or retaining outliers, consistent with ARRIVE 2.0 reporting recommendations (Percie du Sert et al., 2020a; 2020b).

Total Cholesterol

All extract doses produced greater numerical reductions in total cholesterol than either control. P2 yielded the largest reduction, 40.5%, closely followed by P1 at 40.1%. According to Duncan's test, final P1 and P2 values were not significantly different. Final total cholesterol in P1-P4 was also lower than the corresponding baseline value, whereas neither control returned to baseline. These findings support a hypocholesterolemic effect within this model. The direction of change is consistent with the broader biology of diabetic dyslipidemia, in which insulin deficiency or resistance alters hepatic lipoprotein production and peripheral lipoprotein clearance (Hirano, 2018; Feingold, 2023). However, rat cholesterol metabolism differs from human metabolism, and simvastatin was examined at only one dose. Numerical superiority to the positive control must not be presented as evidence of therapeutic superiority.

The reduction in total cholesterol may represent combined changes in LDL and other lipoprotein fractions. The available data did not distinguish very-low-density lipoprotein, intermediate-density lipoprotein, or non-HDL cholesterol. Contemporary diabetes guidance places particular emphasis on LDL cholesterol and overall atherosclerotic cardiovascular risk rather than total cholesterol alone (American Diabetes Association Professional Practice Committee, 2026). Future experiments could therefore measure non-HDL cholesterol, apolipoprotein B, particle number, and lipid ratios to characterize the burden of atherogenic particles more fully.

Triglycerides

The greatest triglyceride reduction occurred in P1, 57.4%, followed by P2, 51.6%, and simvastatin, 47.7%. Duncan's test placed P1 and P2 in the same homogeneous subset, with lower means than P3 and P4. This pattern is compatible with improved fatty-acid flux or hepatic lipoprotein production as metabolic stress decreases. In diabetes, increased adipose lipolysis, hepatic fatty-acid delivery, and VLDL secretion are major contributors to hypertriglyceridemia, while reduced lipoprotein-lipase activity can delay particle clearance (Hirano, 2018; Feingold, 2023). Oleic acid and antioxidant components of red fruit oil may contribute to the response, but the experiment did not measure lipoprotein-lipase activity, lipogenic gene expression, fatty-acid oxidation, or VLDL production. These pathways are therefore biological interpretations rather than directly observed outcomes. Dietary control is especially important because energy and fat intake can rapidly influence serum triglycerides.

High Density Lipoprotein

HDL decreased in every group following the intervention. The smallest decline occurred in P2, at 2.3%, which also had the highest final HDL concentration of 29.3+/-1.15 mg/dL. Unlike reductions in total cholesterol, triglycerides, and LDL, a reduction in HDL cannot be interpreted as

beneficial. The original thesis included lower HDL among its cholesterol-lowering effects; the present article corrects that interpretation. P2 is more accurately described as best preserving HDL, not as producing the greatest favorable reduction. HDL concentration does not fully capture HDL function. Cholesterol-efflux capacity, particle size, apolipoprotein composition, inflammatory remodeling, and turnover were not assessed. Contemporary evidence distinguishes HDL cholesterol concentration from HDL functionality and cautions against assuming that every increase or decrease in HDL-C directly predicts protection or harm (Rosenson et al., 2016; Ouimet et al., 2019). The observed concentration therefore represents only one aspect of HDL metabolism. Further studies should prespecify HDL as a distinct outcome and clearly define the expected direction of a favorable response.

Low Density Lipoprotein

P1 produced the lowest final LDL concentration, 44 ± 1.00 mg/dL, and the greatest reduction, 56.9%. This value was slightly lower than the P1 baseline. Other extract doses reduced LDL by 45.7-50.5%, compared with 44.0% in the simvastatin group. Duncan's test indicated that P1 differed from the other groups. Lower LDL may relate to altered hepatic cholesterol synthesis, particle clearance, or protection from lipid oxidation. LDL is a causal component of atherosclerotic cardiovascular disease, making its reduction biologically important, but the magnitude of clinical benefit depends on sustained exposure and validated human interventions (Ference et al., 2017). The experiment measured LDL concentration only and did not assess oxidized LDL, LDL receptors, HMG-CoA reductase, particle number, or atherosclerotic lesions.

Biological Interpretation and Relationship to Recent Evidence

Taken together, doses of 0.12 and 0.24 mL/rat/day produced the most consistent profiles. P1 performed best for glucose, triglycerides, and LDL, whereas P2 was marginally best for total cholesterol and preservation of HDL. Higher doses did not increase the benefit, and P4 worsened hyperglycemia. U-shaped or threshold responses are possible with complex phytochemical mixtures because individual constituents have different pharmacokinetics and molecular targets. In addition, dosing by volume per animal rather than by current body weight may have created different exposures per kilogram during the experiment.

The alpha-tocopherol concentration of 399.10 mg/100 g provides a chemical basis for an antioxidant hypothesis. Tocopherols can protect membrane lipids from peroxidation, whereas carotenoids may interact with radicals and redox pathways. Oxidative stress is closely linked to beta-cell dysfunction, insulin resistance, vascular injury, and diabetic complications, yet antioxidant supplementation studies have produced heterogeneous results because effects vary by compound, dose, baseline nutritional status, and disease stage (Poznyak et al., 2020). Lestari et al. (2024) reported changes in oxidative and inflammatory markers after red fruit oil in a diabetic neuropathy model. Although the model and outcomes were different, their findings are compatible with the possibility that red fruit modifies the oxidative environment of diabetes. Consistency across studies strengthens plausibility but does not establish tocopherol as the sole cause of the lipid changes observed here.

Oil composition must also be considered. Red fruit oil contains unsaturated fatty acids, particularly oleic acid, together with palmitic and linoleic acids in proportions that vary among plant materials and extraction procedures (Sarungallo et al., 2019). Replacing dietary saturated fat with unsaturated fat can lower LDL cholesterol and cardiovascular risk, although the effect depends on the replacement nutrient and overall dietary pattern (Sacks et al., 2017). This experiment did not implement a dietary substitution design and did not quantify total fat or energy intake. The response

may therefore arise from a combination of bioactive compounds, the oil matrix, altered energy intake, and interaction with the diabetic state.

Current evidence also emphasizes the need for product standardization and safety assessment before clinical translation. An extract should be defined according to authenticated species, accession, ripening stage, processing method, tocopherol and carotenoid concentrations, oxidation status, contaminants, and stability. Doses should be expressed per kilogram of body weight and accompanied by toxicology, liver and kidney function, histopathology, and drug-interaction data. Guidance on complementary products consistently warns that natural origin does not guarantee safety and that supplements may interact with established diabetes treatments (National Center for Complementary and Integrative Health, 2025). Only after adequate preclinical characterization would a controlled clinical trial be justified. Until human evidence is available, red fruit should be regarded as an indigenous food and a candidate functional ingredient, not as a substitute for statins, insulin, or prescribed glucose-lowering medicines.

The local relevance of the study is substantial. Red fruit is both a biological resource and a culturally important Papuan food. Research on it can connect biodiversity, indigenous knowledge, food technology, health education, and local economic development. Such research should respect benefit sharing, material traceability, sustainable cultivation, and responsible risk communication. Cultural and economic value should not be used to exaggerate health claims; rather, these values increase the obligation to produce rigorous evidence so that future use is safe and sustainable.

Feasibility of the Supplementary Book

The media expert awarded 88.75%, the botany expert 86.67%, and the zoology expert 71.67%, resulting in a mean expert-validation score of 82.36%. The six readability respondents produced a mean score of 87.50%, with individual scores ranging from 78.13% to 93.75% (Table 3). The experts recommended reducing decorative elements, adding a brief botanical introduction, and simplifying the presentation of the experimental findings. Readers suggested improving physical presentation, chapter introductions, content sequence, and alignment between illustrations and text.

Table 3. Feasibility of the Supplementary Book

Evaluator	n	Score or range	Interpretation
Media expert	1	88.75%	Highly feasible
Botany expert	1	86.67%	Good
Zoology expert	1	71.67%	Moderately good
Mean expert validation	3	82.36%	Feasible
Community readers	3	87.50-93.75%	Good
University students	3	78.13-90.63%	Moderately good to good
Mean readability	6	87.50%	Good

These results indicate that the prototype was readable and preliminarily feasible, but the evaluation sample was very small. Each expert field was represented by only one person, preventing assessment of inter-rater reliability. Six readers cannot represent the variation in age, education, first language, health literacy, or health-care access among the intended audience. Health literacy involves the ability to access, understand, appraise, and use health information, so readability alone captures only part of the construct (Santana et al., 2021). The evaluation also did not measure pre-post factual understanding, retention, decision-making, or behavioral outcomes.

The supplementary book should be updated to avoid a curative title. The phrase *overcoming diabetes and high cholesterol* may be interpreted as a treatment claim. A more appropriate title would be *Understanding Red Fruit, Diabetes, and Lipid Profiles: Preclinical Evidence and Informed Use*. The content should clearly distinguish evidence from rats and humans, state that prescribed medicines should not be discontinued without professional advice, identify warning signs, and provide information on

accessing health services. Simple infographics may assist interpretation, but each visual should include units, comparators, and limitations.

After these revisions, the educational product could function as a science-literacy resource. Readers would not merely receive claims of benefit but would learn how evidence is generated, why animal results do not equal clinical effectiveness, and how to assess information about herbal products. This approach is consistent with health communication that prioritizes transparent risk information and evidence-informed decision-making.

Strengths and Limitations

The strengths of this study include negative and pharmacological controls, four extract doses, measurements before and after diabetes induction, multiple lipid outcomes, botanical authentication, and characterization of four tocopherol homologues. Combining an animal experiment with an educational product also broadened the pathway for communicating the findings. The main limitations were the small group size, absence of reported randomization and blinding procedures, and the lack of a documented ethics approval number in the source thesis. Extract doses were expressed per rat rather than per kilogram of body weight. Food intake, serial body weight, insulin, glycated hemoglobin, liver and kidney function, oxidative-stress biomarkers, pancreatic histology, and toxicity were not measured. Statistical reporting lacked F statistics, degrees of freedom, effect sizes, and confidence intervals. The Duncan tables also appeared to use transformed data without identifying the transformation. One-way ANOVA of final values did not fully account for the repeated-measures structure. A future study should use a mixed-effects model or repeated-measures ANOVA with a group-by-time interaction, multiplicity control, effect sizes, and confidence intervals. A primary outcome should be specified before the experiment to reduce the risk of positive findings arising from multiple tests. Because the experiment was conducted in 2014, its reporting is being evaluated against standards issued later, without changing the historical data. This article is a scientific repackaging and contextual reinterpretation, not a replication or a new experiment. Generalization is limited to male Wistar rats under the specific conditions, extract preparation, doses, and duration used in the study.

CONCLUSION

Red fruit (*Pandanus conoideus* Lam.) extract demonstrated hypolipidemic activity in alloxan-induced diabetic male Wistar rats. After 21 days, 0.12 mL/rat/day produced the greatest reductions in fasting glucose, triglycerides, and LDL, whereas 0.24 mL/rat/day produced the greatest reduction in total cholesterol and best preserved HDL. The response was nonlinear, and 0.48 mL/rat/day increased fasting glucose. These findings support the preclinical potential of red fruit but do not establish effectiveness or safety in humans. Future work requires standardized extracts, body-weight-adjusted doses, toxicological assessment, repeated-measures statistical analysis, ARRIVE 2.0 reporting, and controlled clinical investigation. The supplementary book achieved an expert-validation score of 82.36% and a readability score of 87.50%, supporting its use as an initial prototype after revision of health claims, simplification of content, and evaluation in a larger and more diverse readership.

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