Journal of Human Ecology and Sustainability

Citation
Juanico, C. B. & Hernandez, J. A. (2025). Effect of 12-week Single Meal with White Corn Grits on the Lipid Profile of Individuals with Type 2 Diabetes Mellitus: A Randomized Controlled Feeding Trial. *Journal of Human Ecology and Sustainability, 3*(1), 4.
doi: 10.56237/jhes-24-011

Corresponding Author
Clarissa B,. Juanico
Email
cbjuanico@up.edu.ph

Academic Editor
Leila S. Africa

Received: 30 April 2024
Revised: 20 September 2025
Accepted: 30 September 2025
Published: 22 October 2025

Original Research Article

Effect of 12-week Single Meal with White Corn Grits on the Lipid Profile of Individuals with Type 2 Diabetes Mellitus: A Randomized Controlled Feeding Trial

Clarissa B. Juanico [1] **and Jessica A. Hernandez** [1,2]

[1] *Institute of Human Nutrition and Food, College of Human Ecology, University of the Philippines Los Baños, College, Los Baños, Laguna, 4031, Philippines*
[2] *Department of Science and Technology – Science Education Institute, Taguig City, 1673, Philippines*

Abstract

The prevalence of diabetes is increasing worldwide. Dietary recommendations for diabetes focus on lowering blood glucose, regulating blood pressure, and improving lipid profiles. IPB Var 6 Corn, which contains more fiber than well-milled rice, can offer a promising alternative staple for individuals with type 2 diabetes. This study determined how consuming white corn grits as a staple replacement for 12 weeks affects the lipid profile of individuals with type 2 diabetes. Fifty-one eligible participants were randomly assigned to three groups and were given test meals as packed lunches with rice, corn grits, and a mixture of rice-corn grits for 12 weeks. Baseline and endline data were collected to provide information on the effect of the intervention on total cholesterol, triglycerides, LDL-cholesterol, and HDL-cholesterol. The participants' socio-demographic, dietary, anthropometric, and clinical characteristics were determined and found to be homogeneous at the baseline. After 12 weeks of lunch feeding, the lipid profile of all three groups of participants improved, with a significant reduction in total cholesterol and LDL-cholesterol levels. The amount of corn grits consumed in one meal for 12 weeks may not have been sufficient to cause a higher reduction in the total cholesterol, triglycerides, and LDL-cholesterol levels compared to the group that consumed rice. The study demonstrated that a meal consisting of moderate calories, sufficient fiber, and lower saturated fats, irrespective of the staple, consumed in 12 weeks, can improve the lipid profile of individuals with type 2 diabetes.

Keywords— IPB Var 6, quality protein maize, type 2 diabetes, corn grits, lipid profile

1 Introduction

The prevalence of diabetes increased from 422 million in 2014 [1] to 540 million in 2021 [2]. By 2030, diabetes will be the seventh leading cause of death worldwide [3], and by 2045, one in 8 adults will be living with diabetes around the world [2]. Researchers estimate that around 90% of these cases are type 2 diabetes mellitus (T2DM), with Asia as the epicenter [4]. According to the 2023 Expanded National Nutrition Survey of the Food and Nutrition Research Institute (FNRI), the prevalence of very high fasting blood sugar among Filipino adults has risen to 7.5%, with nearly 20% classified as prediabetic. These findings highlight the increasing burden of diabetes in the country, consistent with earlier FNRI surveys that already reported a steady upward trend in prevalence. This can be seen in the Philippines, where the prevalence of diabetes has increased significantly from 4.8% in 2008 to 5.4% in 2013 [5, 6]. Long-term complications associated with diabetes include hypertension and dyslipidemia, including an increased prevalence of lipid abnormalities [7]. Recent studies show that in T2DM and related conditions, persistently high blood sugar reduces the body's ability to produce enough nitric oxide, a substance important for healthy blood vessels. This shortage weakens the lining of the blood vessels and makes them more prone to damage, which in turn increases the risk of developing more severe and complicated forms of atherosclerosis [8].

Without timely and effective intervention, T2DM and its associated comorbidities will continue to escalate, making dietary modification a critical strategy in diabetes management. Additionally, low-glycemic index foods have been widely researched for their potential in reducing diabetes risk and improving glycemic control. Researchers have conducted numerous studies to identify foods with a lower glycemic index that may help reduce the risk of developing diabetes [9, 10, 11].

However, despite the growing body of research on low-GI foods, there remains a noticeable gap in studies exploring culturally appropriate and locally available carbohydrate alternatives in Southeast Asia, particularly in the Philippines, where rice dominates as the staple food. Specifically, there is limited empirical evidence on the effectiveness of white quality protein maize (QPM), such as IPB Var 6 (NSIC 2008 Cn224), when used as a partial rice substitute in improving lipid profiles among individuals with T2DM [12]. IPB Var 6 is a white flint open-pollinated corn variety with higher lysine and tryptophan levels than other white corn. Moreover, it contains more dietary fiber, minerals, and antioxidants, and has a lower glycemic index than rice. Although initial findings suggest that QPM grits may support glycemic control and lipid regulation [13], few studies have directly assessed their impact in a controlled dietary context among Filipino adults with T2DM.

This study addresses this gap by investigating the effects of substituting IPB Var 6 corn grits for the usual lunch staple on the lipid profiles of individuals with T2DM. Specifically, the study aims to: (1) describe the profile of individuals with T2DM who participated in the dietary intervention; (2) describe their baseline dietary, anthropometric and clinical characteristics; (3) assess changes in the lipid profile of participants before and after the intervention; and (4) compare the lipid profile outcomes between those who consumed the corn-substituted diet and those who maintained their usual rice-based diet. The academic contribution lies in providing empirical evidence for using QPM corn grits as a complementary staple with potential metabolic benefits for diabetes management. IPB Var 6 corn grits, when used as a partial substitute for rice, may offer metabolic benefits for individuals with T2DM, particularly by improving blood glucose and lipid profiles. This study, therefore, aimed to evaluate the effects of substituting corn grits for the usual rice-based lunch staple on the lipid profile of individuals with T2DM.

2 Methodology

2.1 Study Design and Participants

This study was part of a feeding intervention that examined how consuming white corn grits affected the blood lipid and glucose levels of individuals with T2DM. The participants in the study were diagnosed with T2DM and worked at or near the University of the Philippines Los Baños in Laguna, Philippines. Recruitment involved disseminating letters of request to heads of units and offices within the university. Additionally, digital social media platforms were used to recruit participants. To qualify, participants had to meet the following criteria: age is between 30 and 65 years old, have been diagnosed with T2DM for at least six months, with controlled blood pressure, taking a stable dose of oral antihyperglycemic agents, have no immediate plans to leave or retire, not be pregnant or lactating, and willing to adhere to the study's dietary and recording protocols. A medical doctor assessed their health and issued medical clearance before they proceeded with the feeding trial. Researchers then randomly assigned the participants into three trial groups: the Rice group, the Corn group, and the Rice-Corn Mix (RCM) group. The study participants were given an orientation on the protocols before signing the informed consent form. The study protocol was given ethics approval by the University of the East Ramon Magsaysay Ethics Review Committee (UERM-ERC) with approval code 0299/E/O/16/41.

2.2 Preparation, composition, and distribution of a single-meal replacement

The study provided lunch to participants with three different staples: boiled rice, boiled corn grits, and a boiled rice-corn grits mix. A Registered Nutritionist-Dietitian (RND) developed a three-month cycle menu for viands, ensuring variety and balance based on nutrition principles. The RND supervised the production, portioning, and assembly of packed lunches in a secure kitchen designated exclusively for the study. Each lunch box displayed the participant's code, calorie content, and macronutrient breakdown. The meals for the three groups have identical viands, side dishes, and desserts, differing only in the staple. Group 1 (rice group) received meals containing 160 g of boiled rice, which, according to the Philippine Food Exchange List (FEL), provides 46 g carbohydrates, 4 g protein, zero fat, and 200 calories [14]. Group 2 (corn group) received meals with 160 g of boiled IPB Var 6 corn grits, containing 39 g carbohydrates, 15 g protein, 2.4 g fat, and 236 calories [15]. Group 3 (rice-corn mix group) received meals consisting of 70% rice and 30% corn grits. According to the FEL and Nagares' report, this staple provides 44 g carbohydrates, 7.3 g protein, 0.7 g fat, and 211 calories. The meals were delivered to offices as packed lunches to each participant for 12 weeks, between 11 am and 12 noon, except on weekends and holidays. Research assistants facilitated the distribution of coded lunch boxes.

2.3 Baseline and endline data collection

Dietary assessment and anthropometric measurements were carried out by the RNDs using standard procedures. To determine the blood lipid profile, blood extraction and testing were conducted by licensed medical technologists stationed at the University Health Service. A medical doctor conducted the screening, as well as the assessment and interpretation of the blood chemistry results.

2.4 Statistical Analyses

Descriptive statistics were used to present the demographic characteristics and health and nutrition status of the respondents. One-way analysis of variance (ANOVA) was done to compare the effect of substituting corn as a staple on the lipid profile, and the likelihood of improvement on the lipid profile was estimated through logistic regression.

3 Results

3.1 Profile of the participants

Out of 103 individuals who expressed interest in the study, 51 met the inclusion criteria. However, only 47 completed the feeding trial (Figure 1). One participant withdrew, another experienced an adverse incident, and two failed to follow the study protocol, leading to their exclusion. The study had more women (68%) than men (32%). Most of the participants were married (74%), had college degrees (70%), and were Roman Catholic (77%). About half of the families (49%) had a monthly income of 50,000 Philippine pesos or less. Most participants were between 50 and 59 years old (47%), with only a few in the younger age group of 30 to 39 years old (11%). In addition, the predominant activity level among the participants is characterized by light physical activity (54%), followed by a sedentary lifestyle (34%).

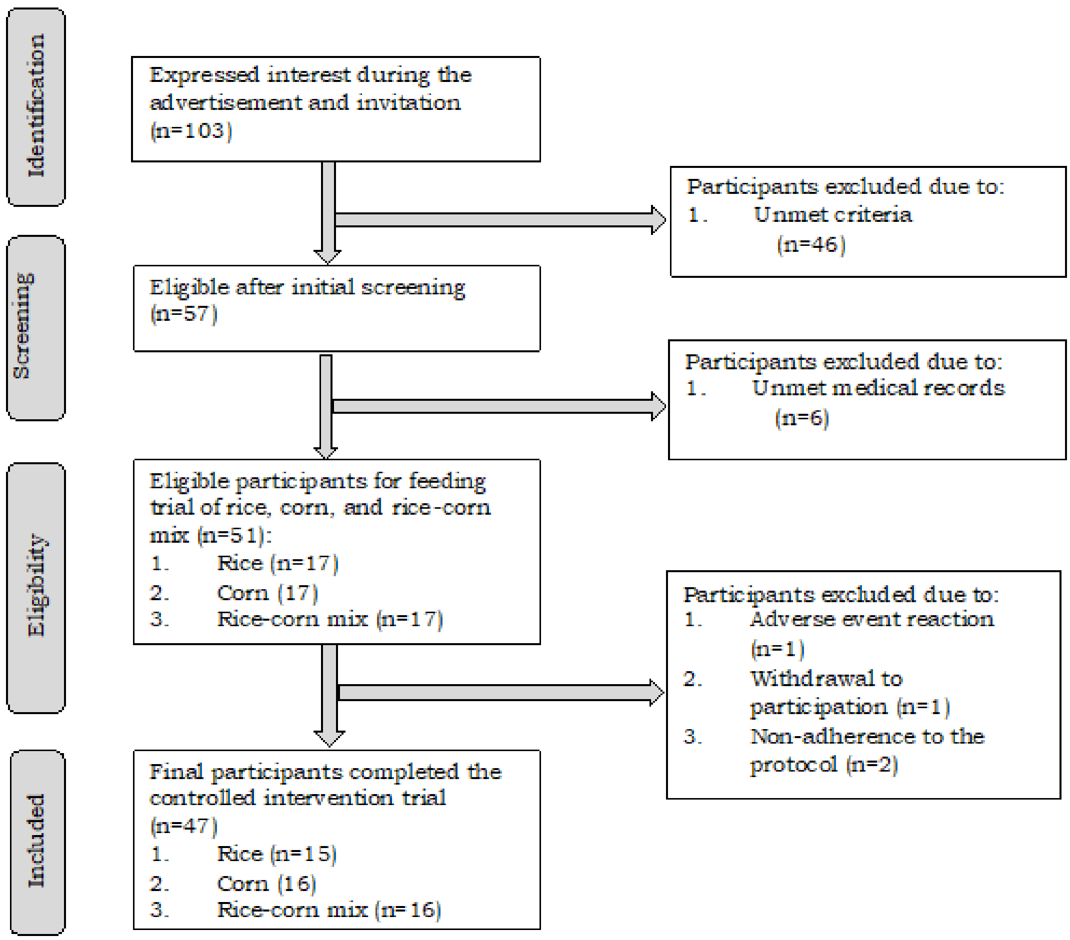

Figure 1.
Flow diagram on the recruitment of the participant

3.2 Dietary Pattern

The usual meal pattern of the participants consisted of breakfast, lunch, supper, and two snacks (43%). Breakfast (70%) and supper (83%) were typically consumed at home, with lunch (79%) generally consumed away from home. The usual lunch time was around noon (72%), as many of them (96%) are employed in the government (68%) or private firms (28%). For carbohydrate-rich foods, most participants consumed brown rice (55%), root vegetables (70%), and saba banana. The most preferred rice variety at home was Sinandomeng (64%). This preference was considered in determining the rice variety to be used in the test meals during the feeding trial.

3.3 Baseline characteristics of individuals with type 2 diabetes mellitus

Table 1 compares the participants' baseline dietary, anthropometric, and clinical characteristics. After randomization, the mean age of the rice and the corn groups was very close at 49.8 years and 49.7 years, respectively. Those randomized to the RCM group were older participants with a mean age of 54.6 years. All individuals had a body mass index (BMI) within the overweight range based on the World Health Organization (WHO) cut-off points. Additionally, their average body fat percentage exceeded 33%, and their HbA1c levels ranged from 8.3% to 9.1%.

Table 1. Baseline dietary, anthropometric, and clinical characteristics

VARIABLES	RICE (n=15)		CORN (n=16)		RCM (n=16)		P value
	Mean	± SD	Mean	SD	Mean	SD	
Age (years)	49.8	± 9.3	49.7	± 9.2	54.6	± 6.3	0.177
Weight (kg)	70.2	±12.2	68.4	±14.3	65.7	±13.5	0.644
BMI (kg/m^2)	27.5	± 3.9	27.4	± 5.2	27.7	6.3	0.991
Energy intake (cal.)	1740	± 515	1440	± 360	1530	446	0.168
Physical activity, n (%)							0.039*
Sedentary	3	(20%)	7	(44%)	6	(38%)	
Light	8	(53%)	9	(56%)	10	(63%)	
Moderate	4	(27%)	0		0		
Waist circumference (cm)	95.8	± 8.1	95.2	± 11.0	93.2	10.5	0.741
Body fat (%)	33.4	± 6.9	36.8	± 7.2	35.9	8.2	0.420
Systolic BP (mmHg)	153	± 23.4	142	± 28.5	145	16.2	0.435
Diastolic BP (mmHg)	85.7	± 9.8	79.1	± 12.2	82.1	9.1	0.225
HbA1c (%)	8.3	± 1.7	9.1	± 2.0	8.5	2.1	0.490
FBS (mg/dL)	157	± 59.5	166	± 45.3	154	46.5	0.796
Total cholesterol (mg/dL)	190	± 62.7	199	± 22.4	208	44.8	0.542
Triglyceride (mg/dL)	237	± 146	181	± 71.9	184	129	0.352
LDL cholesterol (mg/dL)	99	± 44.7	116	± 23.2	119	39.4	0.289
HDL cholesterol (mg/dL)	43	± 11.3	47	± 9.9	52	11.2	0.072

*Significant at 5% level; **significant at 1% level

Furthermore, ANOVA results showed no difference in the baseline weight, BMI, energy intake, waist circumference, percentage body fat, systolic and diastolic blood pressure, glycated hemoglobin, fasting blood sugar (FBS), and blood cholesterol profiles. Since the baseline characteristics of the three groups showed no significant differences, providing the groups with varying staples in their diet for 12 weeks, it can be assumed that the resulting differences in the lipid profile at endline can be attributed to the effect of the staple.

3.4 Comparison of the baseline and endline blood lipid profiles

Following a 12-week period where three groups of individuals with T2DM substituted one meal with a test meal provided by the study containing either rice, corn, or a rice-corn mixture, all groups showed an improvement in their lipid profiles (Table 2). At baseline, the mean total cholesterol is 190 mg/dL, 199 mg/dL, and 208 mg/dL for rice, corn, and rice-corn mixture groups, respectively. Afterward, it was reduced to 173 mg/dL, 186 mg/dL, and 193 mg/dL, respectively. For the triglycerides (TAG), from the mean baseline values of 237mg/dL, 181 mg/dL, and 184 mg/dL for rice, corn, and rice-corn mixture, respectively, these levels dropped to 216 mg/dL, 172 mg/dL, and 164 mg/dL, respectively, after 12 weeks. A consistent decline in the LDL-cholesterol was also observed after 12 weeks, from 100 mg/dL, 116 mg/dL, and 119 mg/dL to a decline in 86 mg/dL, 104 mg/dL, and 109 mg/dL, in rice, corn, and rice-corn mixture, respectively. Meanwhile, HDL cholesterol levels in the rice and corn groups remained unchanged and stayed within the ideal range, except for the RCM group, which showed a slight decrease (1.9%).

Overall, a significant decrease was observed in the total cholesterol ($p = 0.002$) and LDL-cholesterol ($p = 0.002$) at 5% significance level. The group that consumed rice had the most substantial reduction in LDL-cholesterol (14%) and total cholesterol (8.9%). On the other hand, participants in the rice-corn mixture (RCM) group had the highest reduction in triglycerides (10.9%), but this reduction was not statistically significant ($p = 0.170$).

Table 2. Changes in the lipid profile

	RICE (n=15)			CORN (n=16)			RCM (n=16)			P value	
BLOOD LIPID (mg/dL)	Week 0	Week 12	% change	Week 0	Week 12	% Change	Week 0	Week 12	% Change	Time effect	Staple effect
Total cholesterol											
Mean	190	173	(8.9)	199	186	(6.5)	208	193	(7.2)	0.002**	0.373
SD	±62.7	±47.3		±22.4	±22.9		±44.8	±33.5			
Triglyceride											
Mean	237	216	(8.9)	181	172	(5.0)	184	164	(10.9)	0.170	0.230
SD	±146	±73.5		±71.9	±94.0		±129	±78.7			
LDL-cholesterol											
Mean	100	86	(14)	116	104	(10.3)	119	109	(8.4)	0.002**	0.194
SD	±44.7	±46.2		±23.2	±24.1		±39.4	±34.7			
HDL-cholesterol											
Mean	43	43	0	47	47	0	52	51	(1.9)	0.992	0.087
SD	±11.3	±11.4		±9.9	±8.9		±11.2	±10.6			

% Change in parenthesis signifies decrease; *p < 0.05; **p < 0.01

The effect of varying the amount of IPB Var 6 corn grits intake on lipid parameters was also examined. At 100% corn, there was a very weak association between corn intake and blood lipid parameters, specifically TC, TAG, and LDL-c. Meanwhile, Table 3 reveals no within-group association between the amount of IPB Var 6 corn grits intake and the change in the blood lipid profile. Moreover, using logistic regression analysis, the likelihood of improvement in the blood lipid profile was determined (Table 4), which showed no significant differences for total cholesterol ($p = 0.993$), triglycerides ($p = 0.999$), LDL-cholesterol ($p = 1.01$), and HDL-cholesterol ($p = 1.01$).

Table 3. Relationship of varying IPB Var 6 corn grits intake with changes in blood lipid parameters

BLOOD LIPID PARAMETERS[1]	CORN PROPORTION IN THE MEAL	CORRELATION COEFFICIENT (r)	P VALUE
Total Cholesterol	100%	-0.142	0.599
	30%	0.312	0.240
Triglycerides	100%	-0.222	0.408
	30%	0.416	0.109
LDL-cholesterol	100%	-0.111	0.683
	30%	0.084	0.756
HDL-cholesterol	100%	0.307	0.248
	30%	0.300	0.260

[1] Change is the difference between week 0 and week 12 values

Table 4. Likelihood of improvement in blood lipid profile with the consumption of IPB Var 6 corn grits

BLOOD LIPID PARAMETERS	P VALUE	ODDS RATIO ESTIMATES
Total cholesterol	0.229	0.993
Triglyceride	0.910	0.999
LDL-cholesterol	0.254	1.01
HDL-cholesterol	0.241	1.01

*p < 0.05; **p < 0.01

4 Discussion

The study observed that replacing the staple of one out of the usual three meals a day with either rice, corn, or a rice-corn mix for twelve weeks improved the lipid profile of all three groups of individuals with T2DM. However, this improvement did not appear to result from the staple type, as initially assumed. The test meals contained nearly identical amounts of calories, carbohydrates, protein, and fats, differing only in the staple used. The test meals were designed to include a good amount of fiber and lower saturated fat content. The total dietary fiber from fruits, vegetables, and other sources likely contributed to the improvement in lipid profiles. Recent research indicates that higher dietary fiber intake is linked to lower levels of total and LDL cholesterol, improved blood pressure, and other cardiometabolic risk factors, thereby reducing the risk of cardiovascular disease [16]. A high-fiber diet rich in the insoluble type is indicated to treat irritable bowel syndrome, diverticulosis, and atonic constipation. On the other hand, soluble fiber helps manage diabetes and helps decrease total cholesterol [7]. Soluble dietary fibers interact with bile acids, enhancing their fecal excretion. The consequent depletion of the hepatic bile acid pool stimulates cholesterol catabolism for bile acid synthesis, leading to a compensatory upregulation of hepatic LDL receptors. This receptor-mediated pathway facilitates increased clearance of circulating LDL cholesterol, thereby reducing serum LDL concentrations [17]. Similarly, additional mechanisms contribute to the reduction of cholesterol: first, the fermentation of dietary fiber produces short-chain fatty acids (SCFA), which could hinder the synthesis of fatty acids; second, the high viscosity of fiber promotes slow absorption of macronutrients, which enhances insulin sensitivity; and third, fiber induces satiety, which may aid in weight management. These mechanisms are all desirable in the management of T2DM; thus, increasing dietary fiber is among the recommendations given to patients with diabetes.

A study showed improved plasma lipid concentrations and glycemic control after a diet composed of 50 g dietary fiber (25 g insoluble fiber and 25 g soluble fiber) was reported in another study [18]. This fiber intake exceeded the ADA recommendation of 24 g (16 g insoluble and 8 g soluble). The Philippine Diet Manual [19] classifies a high-fiber diet as one that includes two to three servings of fiber-rich foods, such as fruits and vegetables. According to the Food and Agriculture Organization (FAO) [20], the dietary fiber (DF) content of QPM corn is mainly insoluble. Although QPM corn is lower in soluble fiber, its consumption could still contribute to dietary fiber intake, especially when combined with other fiber-rich foods. Meanwhile, the soluble fiber of IPB Var 6, in flour form, is only 2.17% [21]. Dietary fiber from locally available foods such as corn, beans, fruits, and vegetables has been shown to help improve blood sugar control and lower total and LDL cholesterol levels among individuals with type 2 diabetes [22].

The trial group, who were given a corn diet, had a mean corn intake of 122 g, while the RCM group consumed 39 g. Following the percent soluble DF of IPB Var 6 [22] translates to only around 2.65 g and 0.85 g soluble DF for the corn and the RCM groups, respectively. This amount is quite low compared with the moderate fiber diet with 8 g soluble DF recommended by the ADA. Chandalia et al. [18], in their study about the beneficial effects of DF among T2DM, concluded that lowering cholesterol can be attributed primarily to an average increase of 17 g of soluble fiber.

For 12 weeks, the test meals included lean meats with minimal fat and oil, contributing to improved cholesterol levels among participants. Meal planning prioritized reducing pork and beef without eliminating them, instead specifying lean cuts from the food concessionaire. Lean chicken cuts, such as breast meat, and fish were included more frequently. To further reduce fat intake, frying and other cooking methods requiring fats and oils were minimized.

Although the lipid profile improved after the 12-week feeding trial, the difference between groups remained insignificant, regardless of the staple consumed ($p > 0.05$). The initially elevated triglyceride levels may have resulted from unrestricted rice intake, which was controlled during the 12-week intervention. All groups received a computed diet with a good amount of dietary fiber.

The initially higher carbohydrate intake of the participants resulted in their elevated triglyceride levels. High carbohydrate intake has been associated with elevated triglyceride concentrations, a response attributed to impaired clearance of triglyceride-rich lipoproteins and enhanced hepatic VLDL synthesis, which together increase circulating triglyceride levels [23].

5 Conclusion

Generally, the lipid profile of the participants improved, regardless of the intervention group. At a 5% level, there was a significant reduction in the total cholesterol (p=0.002) and LDL-cholesterol (p=0.002). The improvement in the lipid profile seemed to be comparable among the groups, regardless of the staple consumed. This was validated by the statistical analysis results showing an insignificant treatment effect (p>0.05). The improvement in the lipid profile may have been affected by the reduction in calorie intake, controlled saturated fats in the test meals, and increased total dietary fiber from the fruits and vegetables given to all the groups. Soluble fiber helps lower cholesterol, but corn grits contain very small amounts of this dietary component. The result suggests that the amount of IPB Var 6 corn consumed in one meal for 12 weeks may not have been enough to cause a significant reduction in total cholesterol, triglycerides, and LDL-cholesterol.

Future studies should provide more than one corn-based meal per day and extend beyond 12 weeks in duration to better evaluate the long-term effects of corn grits consumption on blood lipid levels, blood glucose, body mass index, and other relevant metabolic parameters.

Statements and Declarations

Acknowledgment

The authors acknowledge the support provided by the Neys-van Hoogstraten Foundation, the UP-Emerging Interdisciplinary Research (UP-EIDR), DOST-ASTHRDP-NSC, and the Sight and Life Foundation. Dr. Wilma A. Hurtada, Ms. Jailah Bamba, and Ms. Valerie Acayen are also acknowledged.

Competing Interest

The authors declare no conflicts of interest, whether financial, personal, or professional, that could compromise the results of the study.

Ethical Considerations

The study applied for its ethical clearance in the University of the East Ramon Magsaysay Ethics Review Committee (UERM-ERC), with approval code: 0299/E/O/16/41.

Data Availability

The data in this study is available upon request from the authors.

Author Contributions

C.B.J.: Conceptualization, Project administration, Funding acquisition, Validation, Formal analysis, Writing – Review and Editing. **J.A.H.**: Writing – Review and Editing. All authors have read and agreed to the published version of the manuscript.

References

[1] World Health Organization (WHO). (2024). *Diabetes: Key facts* [Accessed: Jan. 20, 2024]. https://www.who.int/news-room/fact-sheets/detail/diabetes

[2] Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N., Colagiuri, S., Guariguata, L., Motala, A. A., Ogurtsova, K., et al. (2019). Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice*, *157*, 107843. https://doi.org/10.1016/J.DIABRES.2019.107843

[3] World Health Organization (WHO). (2016). *Global report on diabetes* [Accessed: Jan. 20, 2023]. https://apps.who.int/iris/bitstream/handle/10665/204874/WHO_NMH_NVI_16.3_eng.pdf

[4] 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. https://doi.org/10.1038/nrendo.2017.151

[5] Department of Science and Technology - Department of Science and Technology (DOST-FNRI). (2022a). *Philippine Nutrition Facts and Figures: 2018-2019 Expanded National Nutrition Survey (ENNS)* [Accessed: Jun. 23, 2022]. https://enutrition.fnri.dost.gov.ph/uploads/2018-2019%20ENNS%20FACTS%20AND%20FIGURES_JULY182023.pdf

[6] Department of Science and Technology - Department of Science and Technology (DOST-FNRI). (2015). *8th national nutrition survey overview* [Accessed: Jan. 20, 2023]. http://enutrition.fnri.dost.gov.ph/assets/uploads/publications/Overview_8thNNS_050416.pdf

[7] Raymond, J. L., & Morrow, K. (2020). *Krause and mahan's food and the nutrition care process elsevier ebook on vitalsource, 15th edition*. Elsevier Health Sciences.

[8] Ikonomidis, I., Pavlidis, G., Tsoumani, M., Kousathana, F., Katogiannis, K., Tsilivarakis, D., Thymis, J., Kountouri, A., Korakas, E., Pliouta, L., et al. (2022). Endothelial dysfunction is associated with decreased nitric oxide bioavailability in dysglycaemic subjects and first-degree relatives of type 2 diabetic patients. *Journal of Clinical Medicine*, *11*(12), 3299. https://doi.org/10.3390/jcm11123299

[9] Jenkins, D. J., Kendall, C. W., Augustin, L. S., Franceschi, S., Hamidi, M., Marchie, A., Jenkins, A. L., & Axelsen, M. (2002). Glycemic index: Overview of implications in health and disease. *The American journal of clinical nutrition*, *76*(1), 266S–273S. https://doi.org/10.1093/AJCN/76/1.266S

[10] Luscombe, N., Noakes, M., & Clifton, P. (1999). Diets high and low in glycemic index versus high monounsaturated fat diets: Effects on glucose and lipid metabolism in niddm. *European journal of clinical nutrition*, *53*(6), 473–478. https://doi.org/10.1038/SJ.EJCN.1600779

[11] Siyuan, S., Tong, L., & Liu, R. (2018). Corn phytochemicals and their health benefits. *Food Science and Human Wellness*, *7*(3), 185–195. https://doi.org/10.1016/J.FSHW.2018.09.003

[12] (n.d.).

[13] Panlasigui, L. N., Bayaga, C. L., Barrios, E. B., & Cochon, K. L. (2010). Glycaemic response to quality protein maize grits. *Journal of nutrition and metabolism*, *2010*(1), 697842. https://doi.org/10.1155/2010/697842

[14] Department of Science and Technology - Department of Science and Technology (DOST-FNRI). (2022b). *Food Exchange List 4th Edition* [Accessed: Nov. 24, 2023]. https://www.fnri.dost.gov.ph/index.php/publications/fnri-seminars-series/24-publications/nutritional-handbooks/68-nutritional-handbooks

[15] Nagares, N. d., Hurtada, W., Rodriguez, F., & Dizon, E. (2010). Nutritional value, physicochemical properties and acceptability of rice (oryza sativa l.)-corn (zea mays l.) composites. *Asia Life Sciences - The Asian International Journal of Life Sciences*, *20*(1), 199–214.

[16] Fu, L., Zhang, G., Qian, S., Zhang, Q., & Tan, M. (2022). Associations between dietary fiber intake and cardiovascular risk factors: An umbrella review of meta-analyses of randomized controlled trials. *Frontiers in Nutrition*, *9*, 972399. https://doi.org/10.3389/fnut.2022.972399

[17] Bakr, A. F., & Farag, M. A. (2023). Soluble dietary fibers as antihyperlipidemic agents: A comprehensive review to maximize their health benefits. *ACS omega*, *8*(28), 24680–24694. https://doi.org/10.1021/acsomega.3c01121

[18] Chandalia, M., Garg, A., Lutjohann, D., Von Bergmann, K., Grundy, S. M., & Brinkley, L. J. (2000). Beneficial effects of high dietary fiber intake in patients with type 2 diabetes mellitus. *New England Journal of Medicine*, *342*(19), 1392–1398. https://doi.org/10.1056/NEJM200005113421903

[19] NDAP. (2010). *Diet manual. 5th ed.* Nutritionist-Dietitians' Association Of The Philippines, Inc: Metro Manila.

[20] UN-FAO. (2010). Physical and chemical changes in maize during processing. In *Maize in human nutrition*. https://www.fao.org/4/T0395E/T0395E06.htm

[21] Sunico, D. J. A., Rodriguez, F. M., Tuaño, A. P. P., Mopera, L. E., Atienza, L. M., & Juanico, C. B. (2021). Physicochemical and nutritional properties of nixtamalized quality protein maize flour and its potential as a substitute in Philippine salt bread. *Nat. Sci*, *20*(2), e2021035. https://doi.org/10.12982/CMUJNS.2021.035

[22] Lu, K., Yu, T., Cao, X., Xia, H., Wang, S., Sun, G., Chen, L., & Liao, W. (2023). Effect of viscous soluble dietary fiber on glucose and lipid metabolism in patients with type 2 diabetes mellitus: A systematic review and meta-analysis on randomized clinical trials. *Frontiers in Nutrition*, *10*, 1253312. https://doi.org/10.3389/fnut.2023.1253312

[23] Kim, S., Shin, M.-J., & Krauss, R. M. (2025). Dietary management of atherogenic dyslipidemia. *Current Atherosclerosis Reports*, *27*(1), 93. https://doi.org/10.1007/s11883-025-01335-6