ORIGINAL ARTICLE

Effect of Sweet Corn (*Zea Mays L*) on Lipid Profile by Nutritional Status

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ABSTRACT

Background: **The food consumed can be an alternative to controlling lipid levels, one of the ingredients that can use corn.**

Aims: **This study was to find out the effect of corn boiled water on HDL-C, LDL-C, triglycerides, and total cholesterol levels and in the selected area in Indonesia.**

Method: **Research used an experimental with a pretest-posttest control group. Samples were taken using simple random sampling consisting of 2 intervention groups and one control group, with 20 subjects per group. Intervention group 1 consist of normal BMI, intervention group 2 and control with excessive nutritional status. Lipid examination was carried out in the laboratory by taking fasting venous blood. The instruments are standard operating procedures and observation sheets. Bivariate analysis is Wilcoxon and Mann Whitney. Multivariate analysis using the Kruskal Wallis test.**

Result: **There was a decrease in the posttest mean HDL-C of 5.25 gr/dl in a control group, p = 0.019. There was no difference in LDL-C, triglycerides, and total cholesterol in the pretest-posttest control group, p = 0.663, 0.087, and p = 0.284. There was an increase in HDL-C in both intervention groups, 5.35 and 7.55 g/dl. The results of bivariate values of HDL-C, LDL-C, triglycerides, and total cholesterol in group B were p = 0.021, p = 0.455, p < 0.001, and p = 0.048. The pretest-posttest values of HDL-C, LDL-C, triglycerides, and total cholesterol in group C showed p = 0.020, p = 0.086, p = 0.028, and p = 0.003. Multivariate test of HDL-C, LDL-C, Triglycerides, and Total Cholesterol showed p = 0.002, p = 0.584, p = 0.12, and p = 0.005.**

Conclusions: **Whole corn boiled water effectively increases HDL-C levels and lowers LDL-C, triglycerides, and total cholesterol in people with normal nutritional status and over the nutritional status.**

KEY WORDS

cholesterol, HDL, LDL, trigliseride, zea mays

INTRODUCTION

Excessive nutritional status is a serious problem that must be addressed. The incidence of nutritional status is more prevalent in both developed and developing countries. More nutritional status occurs in > 1.9 billion adults globally[1)]. Basic Health Research in Indonesia shows that the proportion of overweight and obesity in the population aged over 18 years is 13.6% and 21.8%[2)]. Nutritional status is more closely related to dyslipidemia. The increase in body mass index is associated with a decrease in High-Density Lipoprotein-Cholesterol (HDL-C) and an increase in Low-Density Lipoprotein-Cholesterol (LDL-C)[3)]. The incidence of dyslipidemia shifted from developed countries to developing countries. The highest prevalence of hyperlipidemia moved from America and Europe to Asia and the Pacific[4)].

Hyperlipidemia is a severe problem because it is a risk factor for dangerous diseases. Many reports have appeared in the literature showing that abnormal blood lipids such as total cholesterol and other lipids and lipoproteins predispose individuals to atherosclerosis and cardiovascular disease[5)]. Low HDL-C ratio and high LDL-C, total cholesterol and triglycerides are associated with a higher risk for cardiovascular disease than other common biomarkers[6)]. Elevated serum levels of total cholesterol, triglycerides, LDL, and low HDL are associated with an increased risk of ischemic stroke and a poorer prognosis[7)]. Control of hyperlipidemia can reduce the risk of kidney disease due to SLE[8)].

Lipid profile is closely related to diet and lifestyle. Lack of physical activity and excessive consumption of foods containing calories, saturated fat, cholesterol, and trans fats are the causes of dyslipidemia[9)]. Lipid profile levels should be controlled. Lifestyle and unhealthy food intake must be stopped. Handling and preventing non-drug hyperlipidemia is an easy, inexpensive, and safe option. Consumption of herbs with natural ingredients containing tannins and flavonoids is an option. One of the plants that contain tannins and flavonoids is sweet corn. Tannins help lower lipid profiles but increase suitable lipids, namely HDL[10)]. Various studies have proven the effect of flavonoids to prevent hyperlipidemia. Ingredients containing flavonoids are effective in lowering plasma total cholesterol, LDL-C, triglycerides and increasing HDL-C[11,12)].

Research on the effect of foodstuffs containing tannins and flavonoids on lipid profiles has been carried out. The study that uses corn as a source of tannins and flavonoids has not been carried out. An in vitro study on white rats of the Sprague Dawley strain using boiled water of whole corn and the skin effectively reduced blood cholesterol concentrations. Further research on the effect of corn on lipid profiles is still limited. Based on the results of previous studies, researchers are interested in developing research on the impact of whole corn boiled water on levels of HDL-C, LDL-C, triglycerides, and total cholesterol in people with excess nutritional status.

METHODS

Study Design

This research used an experimental design with a randomized pretest-posttest control group design. The provision of whole corn water became the independent variable. The lipid profile as the dependent variable consisted of HDL-C, LDL-C, total cholesterol, and tri-

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Table 1: Subject Characteristics Distribution

Variable	Group A	Group B	Group C	Total	p-value*
	n (%)	n (%)	n (%)	N (%)	
Gender					
Male	12 (60,0)	4 (20,0)	6 (30,0)	22 (36.7)	.735**
Female	8 (40,0)	16 (80,0)	14 (70,0)	38 (63.3)	
Occupation					
Yes	16 (80,0)	14 (70,0)	15 (75,0)	45 (75.0)	.628**
No	4 (10,0)	6 (30,0)	5 (25,0)	15 (25.0)	
Age					
Early adulthood	9 (45.0)	3 (15.0)	5 (25.0)	17 (28.3)	.591**
Late adulthood	4 (20.0)	11 (55.0)	5 (25.0)	20 (33.3)	
Early elderly	7 (35.0)	6 (30.0)	10 (50.0)	23 (38.4)	

*Homogenity test **Chi-square test

glycerides through fasting venous blood examination in the laboratory.

Samples

The research population is people with nutritional status in the categories of overweight and obesity. The research sample consisted of 3 groups with details of 1 control group (group A) and two intervention groups (group B and C). Group A are people with excess nutritional status and do not get any therapy. Group B were people with normal nutritional status who received the intervention. Group C is people with more nutritional status who get the intervention. The number of respondents in each group is calculated based on the Federer formula, n = number of samples for each group, and t = number of groups. To anticipate dropout, Researcher added 20% of the respondents in each group. The number of each group is 20 respondents. The inclusion criteria were 25-55 years old, did not smoke, did not consume anti hyperlipidemia, and were willing to be research subjects by signing informed consent. Alcohol consumption, diabetes mellitus, and hypertension were exclusion criteria in the study. Respondents are required to follow all treatments during the research process. Sampling technique to get samples with consecutive sampling, to determine group members using simple random sampling.

Intervention Program

Corn boiled water is made by boiling two whole corns (each corn ± 200 grams) after being washed in 300 ml of water. The water is boiled until it boils and shrinks to 200 ml. Corn boiled water is given warm and served in a thermos. The intervention group consumed corn boiled water two times a day, every morning at 08.00-09.00 and in the afternoon from 16.00-17.00 for seven consecutive days. Making corn boiled water is always fresh every day. Making is done 1 hour before giving to each respondent. Respondents drank corn boiled water in front of the researcher/research assistant. The control group did not get treatment; the researchers gave 200 ml of mineral water consumed simultaneously as the intervention group.

Instruments

Lipid profile using fasting venous blood of respondents. The process of taking venous blood and analyzing HDL-C, LDL-C, total cholesterol, and triglycerides uses standard operating procedures that apply in the laboratory. Digital scales and Microtoise to measure the respondent's weight and height. BMI calculation uses the formula for body weight (kg) divided by height^2 (m^2). The process of making corn boiled water, measuring body weight, and weighing body weight using standard operating procedures. All standard operating procedures have passed the validity test of three medical-surgical nursing experts with an average score of 92.0. The weight and height measurements were retested for reliability with reliable results. Documentation of giving corn boiled water using observation sheets.

Data Collection

Research conducted August-September 2021 in Central Java, Indonesia. Researchers conducted health education to all respondents about activities and foods allowed and not allowed during the research process. The measured lipid levels were the values of HDL-C, LDL-C, total cholesterol, and triglycerides using fasting venous blood. Respondents did fasting before at least 8 hours before their blood was taken. Measurement pretest lipid levels were one day before the first day of the intervention. Posttest lipid levels measurements were 24 hours after the last intervention. Lipid levels measurement was conducted in the laboratory. Data collection for group A from 2nd to 10th August 2021. Group B data collection from 19th to 27th August 2021. Group C data is collected from 6th to 14th September 2021.

Data Analysis and Ethical Consideration

Researchers explain information about the process, objectives, and benefits of research to all subjects. All data, including possible side effects and management, is written in the informed consent. Group A received additional information about the purpose of not getting treatment like the intervention group. Consent to participate in the research by signing the informed consent. The study obtained ethical clearance from the Health Research Ethics Committee Poltekkes Kemenkes Semarang, Description of "Ethical Exemption" No. 458/EA/KEPK/2021. Normality test using Komlogorov-Smirnov. The pretest-posttest bivariate analysis used the Paired T-test in the group with normal distribution and the Wilcoxon test in the non-normally distributed group. The difference test between the two groups used the Independent T-Test in the normally distributed group, and the Mann-Whitney Test in the non-normally distributed group. The difference test between the three groups using the Kruskal Wallis test in the group that is not normally distributed.

RESULTS

Subject Characteristics Distribution

Table 1 informs that most respondents are women (36.7%) and work (75.0%). Age in this study was categorized according to WHO (2015) into early adulthood (26-35 years), late adulthood (36-45 years), and early elderly (46-65 years). Most respondents were in the early elderly age category (38.4%). The homogeneity test of the gender, occupation and age aspects showed $p > 0.05$, indicating that the sample of this study was homogeneous.

Lipid Profile Examination among Groups

Table 2 shows that group A has a difference in HDL-C pretest and posttest ($p = 0.019$). The difference is evidenced by an increase in the mean HDL-C of 5.25 gr/dl. Groups B and C showed that corn-boiled water effectively increased HDL-C levels ($p = 0.021$ and $p = 0.020$), groups B and C increased HDL-C (5.35 gr/dl and 7.55 gr/dl). There was a difference between groups A with B and C ($p = 0.010$ and $p = 0.030$), while groups B and C showed no difference in HDL-C ($p = 0.967$). The decrease in mean LDL-C occurred in all groups; the most was in group C (34.9 g/dl). Bivariate pretest-posttest LDL-C group A, B, and C obtained $p = 0.663$, $p = 0.455$, and $p = 0.086$; the results showed no effect of corn boiled water on LDL-C levels. The LDL-C difference test showed a difference between groups A with B and C ($p = 0.018$ and $p = 0.002$); there was no difference in the two intervention groups ($p = 0.304$). The comparison of posttest LDL-C values in the three groups showed no significant difference ($p = 0.584$).

Table 2 also presents data for all groups showing a decrease in the mean triglycerides, the most in group B (101.60 g/dl). Group A showed no difference in the mean pretest-posttest triglycerides ($p = 0.087$). At the same time, groups B and C indicated an effect of corn boiled water on decreasing triglyceride levels ($p < 0.001$ and $p = 0.028$). The triglyceride value difference test showed a difference between group A with group B and C ($p = 0.041$ and $p = 0.024$), but there was no difference between the two intervention groups ($p = 0.238$). Group A experienced an increase in the mean total cholesterol at posttest (18.39 gr/dl), while groups B and C decreased the mean total cholesterol (28.64 gr/dl and 63.95 gr/dl). Groups B and C proved an effect of corn boiled water on total cholesterol levels ($p = 0.048$ and $p = 0.003$); on the other hand, group A had no difference between pretest and posttest ($p = 0.284$). The effect of consuming corn boiled water on reducing total cholesterol was evidenced by the difference between groups A with B and C ($p = 0.004$ and $p = 0.002$). There was a difference in effect between the intervention groups ($p = 0.043$); the highest distinction in the posttest mean in group C was 17.6 g/dl. Multivariate test using Kruskal Wallis showed significant differences in HDL-C, triglycerides, and total cholesterol between the three groups ($p = 0.002$, $p = 0.012$, and $p = 0.005$). The

Table 2: Lipid Profile Examination Among Groups

Variables	Group A				Group B				Group C				p
	Pretest M ± SD	Posttest M ± SD	Δ Mean	p	Pretest M ± SD	Posttest M ± SD	Δ Mean	p	Pretest M ± SD	Posttest M ± SD	Δ Mean	p	
HDL-C	71.05 ± 6.21	65.80 ± 7.78	-5.25	.0019†	66.30 ± 4.89	71.65 ± 9.38	5.35	.021†	60.40 ± 9.42	67.95 ± 9.30	7.55	.020*	.002‡
LDL-C	129.74 ± 47.85	122.63 ± 50.53	-7.11	.663*	119.63 ± 33.17	105.65 ± 37.38	-13.98	.455†	143.77 ± 59.27	108.87 ± 41.42	-34.90	.086†	.584‡
Trigliserid	244.46 ± 81.45	232.94 ± 68.21	-11.52	.087†	299.52 ± 91.03	197.92 ± 35.47	-101.60	.000*	248.90 ± 85.24	218.82 ± 57.57	-30.08	.028*	.012‡
Kolesterol Total	232.18 ± 50.89	250.57 ± 49.20	18.39	.284†	234.58-36.61	205.94 ± 36.57	-28.64	.048*	252.29 ± 56.33	188.34-32.58	-63.95	.003*	.005‡
The mean difference posttest HDL-C between Group A and Group B (5.85, $p = 0.010^{\dagger}$)													
The mean difference posttest HDL-C between Group A and Group C (2.15, $p = 0.030^{\dagger}$)													
The mean difference posttest HDL-C between Group B and Group C (-3.70, $p = 0.967^{\dagger}$)													
The mean difference posttest LDL-C between Group A and Group B (-16.98, $p = 0.018^{\dagger}$)													
The mean difference posttest LDL-C between Group A and Group C (-13.76, $p = 0.002^{\dagger}$)													
The mean difference posttest LDL-C between Group B and Group C (3.22, $p = 0.304^{\dagger}$)													
The mean difference posttest Trigliseride between Group A and Group B (-35.02, $p = 0.041^{\#}$)													
The mean difference posttest Trigliseride between Group A and Group C (-14.12, $p = 0.024^{\#}$)													
The mean difference posttest Trigliseride between Group B and Group C (20.9, $p = 0.238^{\dagger\dagger}$)													
The mean difference posttest Total Cholesterol between Group A and Group B (-44.63, $p = 0.004^{\dagger\dagger}$)													
The mean difference posttest Total Cholesterol between Group A and Group C (-62.23, $p = 0.002^{\#}$)													
The mean difference posttest Total Cholesterol between Group B and Group C (-17.6, $p = 0.043^{\dagger\dagger}$)													

M = Mean; SD = Standard Deviation; p = p-value; *Paired T Test; †Wilcoxon; ‡Uji Kruskal Wallis; #Uji T Test Independent; ††Uji Mann-Whitney Test

LDL-C variable showed no significant difference between groups A, B, and C (p = 0.584).

DISCUSSION

The results showed that the average HDL of respondents in all groups during the pretest and posttest showed normal results. HDL is normal if 60 gr/dl and shows low results if < 40 gr/dl[13]. The average LDL value of respondents in all groups at the pretest showed results > 100 mg/dl. The results show that all groups have an average LDL level above normal. Normal LDL has a value < 100 g/dl[13]. The mean pretest and posttest triglyceride levels in all groups showed abnormal data. Normal triglycerides if the fasting test value shows results < 150 g/dl[14]. The mean total cholesterol pretest and posttest showed abnormal values, except for group C posttest data. Total cholesterol was called normal if < 200 gr/dl[14].

The results showed no significant difference between pretest and posttest lipid profile levels in the control group. This condition is because respondents in the control group did not receive any intervention during the study. HDL-C levels decreased in the mean by 5.25 mg/dl and increased in total cholesterol by 18.39 g/dl at the posttest. Respondents need to be aware of this decrease; HDL is called good fat because it cleans excess cholesterol from the walls of blood vessels by transporting it back to the liver. An increase in total cholesterol also needs to be considered because it can increase the risk of cardiovascular disease. Previous studies have proven the relationship between HDL-C and total cholesterol with the incidence of atherosclerosis[15], myocardial infarctions[16], hypertension[17], strokes and risk of death[18].

The control group showed a decrease in LDL-C and triglycerides. Although the control group did not get the intervention, these data are happy. Low triglyceride levels are associated with good endothelial function[19]. Respondents were not given a specific diet during the intervention, although before the study were given education about food and activities that were not allowed. LDL-C and triglycerides in the control group can be caused by the diet consumed by respondents during the intervention. Characteristics of respondents are rural communities where food ingredients are still natural and far from junk food. Respondents are also mostly workers, so they do physical activity to change the body's cholesterol levels. The results of this study are not in line with previous studies with the results of the control group experiencing an increase in the mean total cholesterol level[20].

Researchers divided the intervention group into two groups, namely groups with normal nutritional status and groups with excess dietary levels. The researcher aimed to compare the effects of corn boiled water in the two groups. The results showed that the overweight group's average LDL-C and total cholesterol were higher than the regular nutrition group. The average HDL-C of normal nutritional status was better than the heavy group. The study results align with previous studies that stated that nutritional status was positively related to cholesterol levels[21]. The results showed an effect of corn boiled water on HDL-C, triglycerides and total cholesterol. Statistically, it shows that there is no effect on LDL-C, but in terms of the pretest and posttest values, it can be seen that there is a decrease in the average value at the posttest. The results align with previous research that giving boiled water from two corns can significantly reduce cholesterol levels in white rats (Rattus norvegicus)[22]. Whole corn boiled water effectively increases HDL-C and lowers LDL-C, triglycerides, and total cholesterol. The increase in HDL-C of the excess nutritional status group was more than that of the regular group (7.55 > 5.35 g/dl). The excess nutritional status group also showed a more significant reduction in LDL-C than the normal nutritional status (34.90 > 13.98 g/dl). Previous studies have also shown that corn oil lowers LDL cholesterol levels in rats induced by high-fat diets[23]. The decrease in mean total cholesterol in the excess nutritional status group was more than the normal (63.95 > 28.64 g/dl). Triglyceride levels showed different results; the decrease in the normal dietary status group was higher than the more nutritional status (101.61 > 30.08 g/dl).

Corn contains phytochemical compounds, including flavonoids, tannins, and phytosterols which help lower cholesterol levels. All parts of corn contain these compounds; based on that; researchers used whole corn for intervention to respondents. Flavonoids lower cholesterol levels by acting on human liver cells (HepG2), reducing levels of apolipoprotein B as the main protein of LDLc[24]. Tannins prevent adipogenesis and absorption in the intestine, inhibit LDL oxidation, reduce body fat[25], stimulate bile salt secretion and remove cholesterol through faeces. Phytosterols can reduce total and LDL cholesterol levels in the blood[26]. Beta-sitosterol inhibits the process of cholesterol production in the liver by destroying the enzymes needed for cholesterol formation[27].

Researchers did not find similar studies on the effect of corn boiled water on lipid profiles in humans. Previous researchers investigated in vivo the benefits of corn to reduce cholesterol levels in experimental rats[22,23,26]. Another difference to prior studies is that Yanuarti examined total cholesterol levels. At the same time, Haslina and Wahyuningsih used corn in corn silk powder extracts and added variable liver weight and adipose fat. only examined LDL-C levels and used corn oil. Research on the effect of corn milk on cholesterol levels has been carried out, the difference with this study is from the sample of the number of respondent groups, the corn product used, and the lipid profile studied. Several studies to control lipid profiles in humans using herbal

plants have been carried out. This research is different from Fadlilah, who uses dragon fruit to lower cholesterol levels[28], Winarso researched the benefits of red onions on cholesterol and triglyceride levels[29].

This study has several limitations; researchers find it challenging to quarantine research subjects so that their diet and activities are not closely monitored. Researchers overcome this limitation by providing health education about what is allowed and not allowed during the study. Another limitation is that the researcher did not determine the inclusion criteria for a family history of disease related to dyslipidemia. Another limitation is the varied educational background; researchers overcome this problem by repeatedly providing health education about this research. Corn boiled water that was given was pure without any additives, had a taste that not everyone liked, so that some respondents withdrew at the beginning of the study. Researchers overcome this problem by looking for replacement respondents so that the number of samples remains by the calculation.

The administration of the intervention for seven days was following the previous study; the study results showed a decrease in the lipid profile after seven days of intervention.26 Corn boiled water given to respondents effectively increased HDL-C levels and reduced respondents' LDL-C, triglycerides, and total cholesterol levels. Corn is a widely grown plant in Indonesia, so it is easy to find and consume. So far, the part that is often used is the fruit seeds. Utilisation is limited to corn seeds for consumption or animal feed. After the seeds are taken, the rest of the corn will be discarded or become animal feed. The utilisation of corn as herbal medicine is still rarely used. This research hopes that it can become the basis for utilising all parts of corn for handling specific problems, especially dyslipidemia. The delicious taste of corn that is familiar to the community and the low price benefits the community. No side effects of corn consumption were found, so it is safe for consumption.

CONCLUSION

The study showed a significant effect of corn boiled water on increasing HDL-C levels and decreasing respondents' LDL-C, triglycerides, and total cholesterol levels. The respondents with excess nutritional status showed an increase in HDL-C and decreased LDL-C and total cholesterol more than the respondents with normal nutritional status. There was no difference in LDL-C, triglycerides, and total cholesterol in the control group. The decrease in HDL levels in the control group needs to be watched out for and need treatment. Further research is suggested to increase the intervention time so that the metabolic effect of corn on lipid profile is more visible.

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CONFLICT OF INTEREST

There was no conflict of interest in this study.

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