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CHOLESTEROL LOWERING EFFECTS OF TEMPE DIETARY FIBER ON RATS

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Article Info	*Abstract*
Keywords: Dietary fiber , tempe, cholesterol	*Tempe is a popular fermented soy product with a variety of health benefits. It's high in protein, prebiotics and a wide array of vitamin, minerals and fiber. One of the macro componen that is dietary fiber could have beneficial effects in lowering cholesterol levels.* *The main goal of this experiment treated determine the tempe diet on the level of total cholesterol in rats. In this experiment 30 male Sprague Dawley rats split into 6 groups . First group treated by standard diet, second group by tempe diet and the third group by concentrate of soy fiber for four weeks. This experiment conducted using Completely Randomized Design (CRD)* *The result showed tempe diet decrease total cholesterol from 106,4 mg/dl (diet standard) to 92,5 mg/dl (diet tempe 40%) . Tempe diet also decrease LDL cholesterol from 38,7 mg/dl (diet standard) to 19,4 mg/dl (diet tempe 40%). HDL increase from 67,7 mg/dl (diet standard) to 74 mg/dl (diet tempe 40%)*
Info Artikel	Abstrak
Kata Kunci: Serat pangan , tempe, kolesterol	Tempe adalah produk kedelai fermentasi yang popular dengan beragam manfaat kesehatan. Tempe kaya akan protein, prebiotik, serta beragam vitamin, mineral, dan serat. Salah satu komponen makronya yaitu serat pangan, dapat memberikan efek positif dalam menurunkan kadar kolesterol. Maksud percobaan ini adalah untuk mengevaluasi efek penurunan kolesterol dari diet tempe dan ekskresi kolesterol pada tikus. Sebanyak 30 ekor tikus Sprague Dawley jantan dibagi menjadi 6 kelompok @ 5 ekor. Kelompok pertama diet standar, kelompok kedua diet tempe, dan kelompok ketiga diberi konsentrat serat kedelai selama 4 minggu. Percobaan dilakukan dengan metode Rancangan Acak Lengkap (RAL). Hasil percobaan mengungkapkan bahwa diet tempe secara signifikan menurunkan kolesterol total dari 106,4 mg/dl (standar diet) menjadi 92,5 mg/dl (diet tempe 40%). Diet tempe juga menurunkan kolesterol LDL dari 38,7 mg/dl (standar diet) menjadi 19,4 mg/dl (diet tempe 40%). HDL meningkat dari 67,7 mg/dl (standar diet) menjadi 74 mg/dl (diet tempe 40%).

1. INTRODUCTION

Indonesia is a transition country, moving from a developing economy towards a more developed status. While it's not yet fully developed, Indonesia has made significant strides in recent decades, and is poised for continued growth. Moving to modern country , Indonesia

will face the many changes in people's lifestyles including changes in the food consumption. Historically, Indonesian diet has been based largely on plant food (rice, cassava, sweet potato, nuts, vegetable and fruit). Now the condition move to western diet where the high intake of fat and low in complex carbohydrate. The diet high of fat have significant role in increasing prevalence of degenerative diseases.

Hypercholesterolemia is one of the degenerative diseases ,the risk factor that is the main cause of hypercholesterolemia is the lack of control of eating patterns in everyday life. Hypercholesterolemia can cause blockages in blood vessels and heart. Not infrequently people with hypercholesterolemia will experience myocardial infraction in the heart which leads to death (Annies, 2015)

Various effort made to prevent or reduce the risk of the disease, one of them are by addressing the hypercholesterolemia on blood with a modification diet. The nutritionists advocated to improve fibrous food consumption in the diet, it is based on observations epidemiologist indicating that prevalence of several degenerative disease including hypercholesterolemia as the result of low fibrous food consumption (LeWine ., 2019).

Tempe is traditional fermented product that originated in Indonesia. The Indonesian has consumed *tempe* for a long time as an affordable and cheap protein source and nutritious (Winarno et al., 2017). Some researchers had found that component in *tempe* is hypo cholesterolemic.

In the form of *tempe* flour it's could be good source of protein in infant food formula. Tempe a fermented soybeans product is rich in protein, and its flour form can easily be incorporated into various dishes for infants. This makes it an affordable and accessible protein source for children, especially in regions where soybeans are readily available. Tempe flour can be used to fortify infant food such as porridges, biscuits or other weaning foods to increase their protein content.

Dietary fibre is one of the macro components that is hypocholesterolemic effect, but so far there is no research express the issue. According to Palupi and Puspitasari (1995) composition fiber in soy flour consists of cellulose (8,92%), hemicellulose (6,09%), pectate substances (2,66%), lignin (4,07%) and the total fiber of 21,75 %. Seen from composition and there are huge, seems tempe potential as a source of fiber food.

Considering physiological effects of fibers food positive in a reduction of cholesterol and relevant to health problem in Indonesia pertaining to cholesterol levels, it is important to study the potency of fiber in diet tempe relation to lipid profile in blood serum (total cholesterol levels, triglyceride, cholesterol excretion on feces).

2. PURPOSE

This study attempts to: (1) to examine the effect of tempe diet to lipid profile in rats, (2) to examine lipid profile (Total cholesterol , HDL, LDL and Triglycerides), relation to excretion of sterol feces and proportions VFA (volatile fatty acids) on digesta caecum.

The results of the study is expected to provide information the potency of tempe as a source of dietary fiber which have important physiological role in a reduction of cholesterol.

3. MATERIALS AND METHODS

Male Sprague Dawley rats strains as many as 30 tail age adapted with feed standard for a week. High lipids and cholesterol diet were treated for two weeks .Then rats divided into six groups each 5 tail and given feed treatment diet standard, flour tempe 10%, 20%, 30%, 40% and soybean concentrates fiber by following standard (iso protein and isocaloric) for four weeks. Composition of tempe flour as follows:

Tabel 1. *The components of tempe flour*

Component	Percentage
Protein	42,2
Fat	18,6
Carbohydrate	28,7
Water	7,8
Ash	2,6
Starch	7,8
NSP* (by different)	20,9

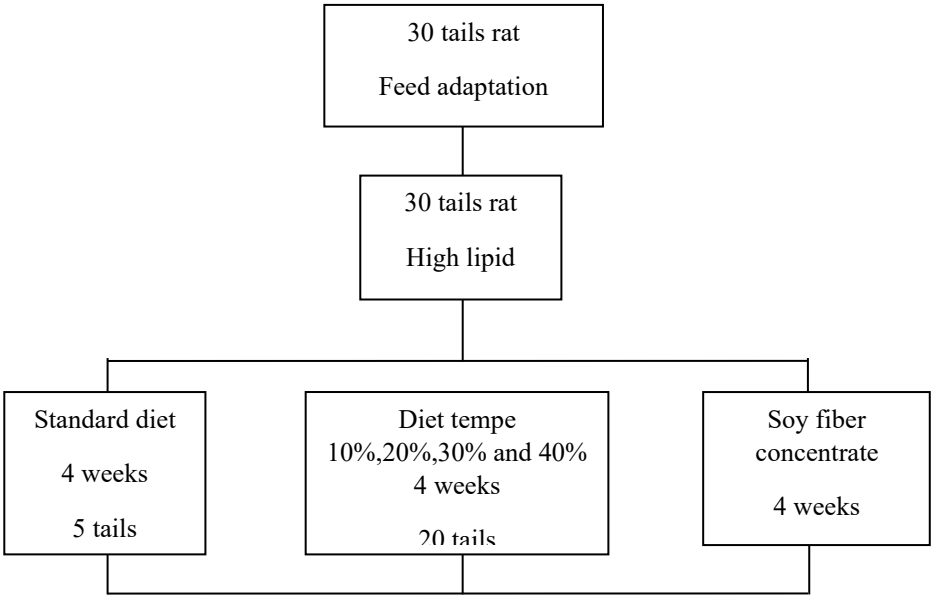
**) NSP = Total carbo – Strach*

Composition diet as stated in the Table 2:

Tabel 2. *The composition of the diet (g/kg)*

Composition	Standard Diet g/kg	Diet Tempe	Diet Soy Fiber
Corn starch 86%	596,2	544,6	586,6
Sucrose	100,0	100,0	100,0
CMC	50,0	0	0
Soya oils	70,0	0	54,3
Casein 85%	200,0	0	179,6
A mixture of mineral	35,0	35,0	35,0
A mixture of vitamins	10,0	10,0	10,0
Flour Tempe	0,0	405	0
Concentrates soybean fiber	-	-	156,9
NSP	50	84,6	94,3
Protein : Casein	170	170	153
: Cons			18,3
NSP.Soybean			
Energy (Calorie)	3760,0	3756,6	3761,0

By arranging feed as on a table 2 so on a diet tempe a source of fiber only come from tempe flour.



Analysis
1. Total Cholesterol (CHOD-PAP)
2. LDL Cholesterol (CHOD-PAP)
3. HDL Cholesterol (CHOD-PAP)
4. Triglycerides (GPO-PAP)
5. Cholesterol feces (Liberman-Burchard)
6. VFA digesta caecum (GC)

Figure 1. *Flow Diagram of research*

4. RESULT AND DISCUSSION

Cholesterol levels

The results of lipid profile on rats treatment by tempe diet showed that a fermented soybean product can have a positive effect on total cholesterol level, generally leading to reduction in both total cholesterol and LDL cholesterol and Triglyceride(diagram 1 ,diagram 2 and diagram 3). In this diagram can be seen that the level of flour tempe given to feed impact on the Total cholesterol, LDL and Triglycerides significantly ($p < 0,05$) and increased HDL cholesterol levels of flour tempe 30 % and 40 %) significantly ($p < 0,05$) this shown in diagram 4. Incorporating tempe into diet can potentially increase HDL cholesterol levels. Studies have shown that tempe can positively impact cholesterol profiles, including increasing HDL. Tempe might help increase HDL cholesterol levels maybe tempe contains many substances, tempe is good source of soy protein which has been linked to improved cholesterol profiles. Tempe contain isoflavones, antioxidant which may help protect against free radicals by improving HDL's ability to remove cholesterol from artery walls.

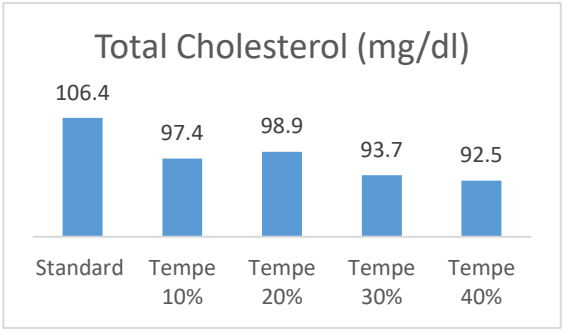


***Figure 2**. Effect of Diet Tempe on Cholesterol Total*

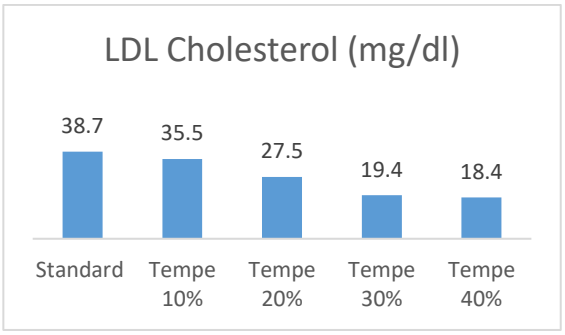


***Figure 3**. Effect of Diet Tempe on Cholesterol LDL*

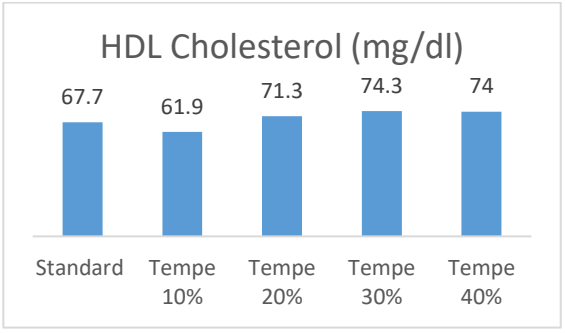


***Figure 4.** Effect of Diet Tempe on Cholesterol HDL*

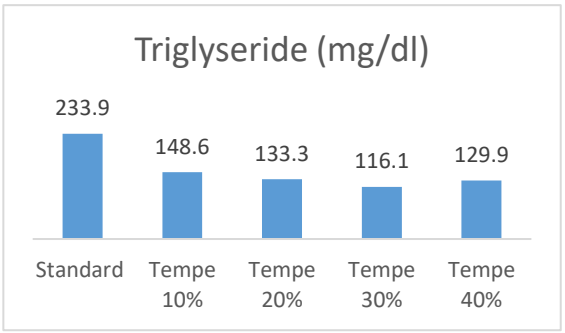


***Figure 5.** Effect of Diet Tempe on Trigliserida*

Tempe's fermentation process, utilizing Rhizopus oligosporus, may lead to the production of substances that help lower cholesterol levels, Additionally the high fiber content in tempe can contribute to the reduction of cholesterol.

Compared with component of standard fiber diet, diet tempe10%, and diet tempe 20%, it is evident that the fiber relatively similar 50 g/kg. But diet tempe 10% and 20% give cholesterol levels the total lower and markedly dissimilar compared to a diet standard. Apparently a source of fiber impact on the nature of the hypocholesterolemic. On a diet standard, CMC (carboxymethyl cellulose) as a source of fiber. According to Anderson (1986) CMC have no influence against cholesterol levels. While on a tempe diet 10% with CMC 21,1 g/kg and fibers (29,1 g/kg), tempe diet 20% with CMC 8,1 g/kg and fibers tempe 42,2 g/kg and appeared to have the effect of to a decrease in cholesterol. In treatment by tempe diet 30% and 40% a source of fiber food only come from the tempe flour. It appears that fiber small proportion of food to high cholesterol levels give the total the worse.

The results of the analysis fiber food in tempe flour shown as NSP (non starch polysaccharide) of 20,9% data is not much different from other researcher namely (Palupi, and Puspitasari, 1995). The fibers total in tempe flour 21,75% with the following: cellulose 8,92%, hemicellulose 6,09%, substance pectate 2,66% and lignin 4,07%. It is evident that tempe contains soluble fiber substance hemicellulose and pectate substances.

In relation to cholesterol metabolism, fibers food soluble reported have leverage real in a reduction of cholesterol compared with fibers food insoluble (LeWine., 2019). Soluble fiber can help lower cholesterol by trapping fats in the digestive system dan preventing their absorption into the bloodstream. This process involving binding to bile salts, reduce the amount of cholesterol that enters the body, leading to lower overall and LDL cholesterol level.

Excretion of sterol feces

The results of the analysis cholesterol feces outlined in diagram 5 and 6 as follows:

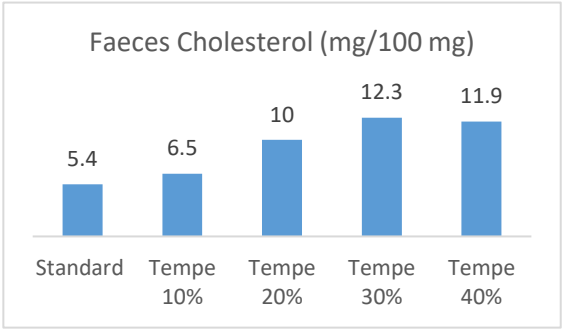


Figure 6. *Effect of various diet tempe on Cholesterol feces*

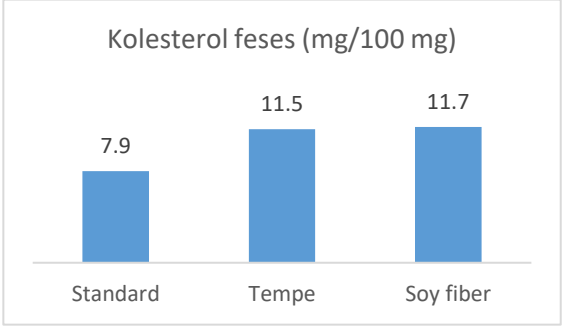


Figure 7. *Effect of diet standard, tempe, and soyfiber on Cholesterol feces*

Tempe a fermented soybean product, is a good source of dietary fiber, which plays a crucial role in cholesterol management. Soluble fiber in tempe binds to bile acids in the digestive system, preventing their absorption and promoting their excretion through feces. This in turn forces the liver to use more cholesterol to synthesize new bile acids, thus lowering overall blood cholesterol levels. In diagram 5 and 6 seen that the tempe diet or fiber soy can lead exretion of cholesterol feces significantly ($p < 0,05$) compared with diet standard.

Research presented in diagram 5 show has caused the increase cholesterol feces the fed with (10%, 20%, 30% and 40%) compared with diet standard. The diet tempe 30% and 40% have the capacity larger and markedly dissimilar ($p < 0,05$) to increase cholesterol feces than 10% and 20%. While the diet 20% larger and markedly dissimilar to raise cholesterol feces than 10%. Increased excretion cholesterol feces possible allegedly was caused by a bond in the intestine between fibers with cholesterol and bile acid that will eventually expelled through feces. This situation will reduce circulation enterohepatic bile acid and improve cholesterol change into a bile cholesterol decline and plasma (Dziedzic.,2016). This strengthens the fact that the mechanism caused by increasing excretion sterol bile into feces.

Volatile Fatty Acids (VFA)

Research presented in diagram 7 and 8 shows that the tempe flour and soybean concentrate fiber influence on the proportion volatile fatty acids In diagram 7 and 8 seen that the tempe flour on a diet give the proportion of propionic acid higher than the standard, similarly in diagram 7 seen that tempe flour and soybean fiber give the proportion of propionic acid higher than the standard diet.

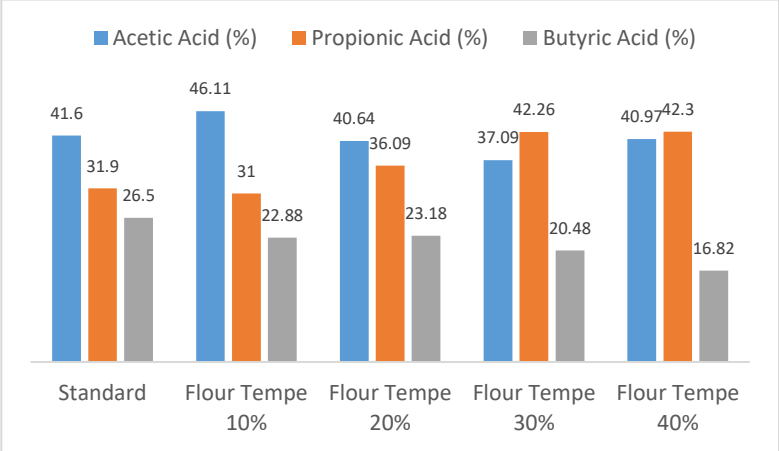


Figure 8. *Effect of various diet tempe on Volatile Fatty Acids (VFA)*

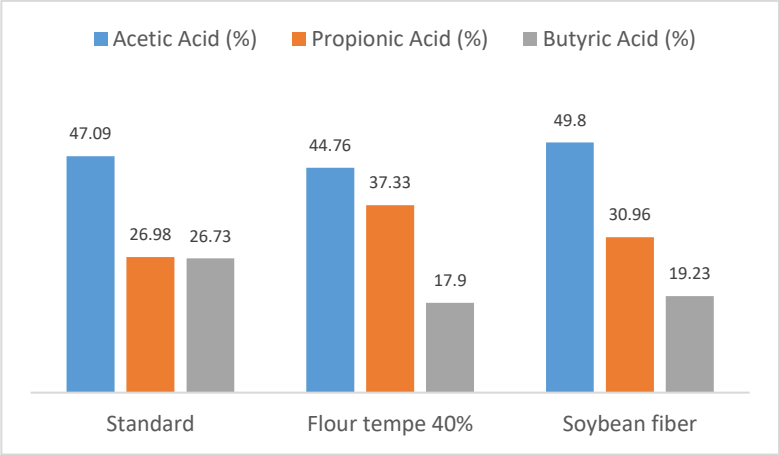


Figure 9. *Effect of diet standard, tempe 40% and soybean fiber on Volatile Fatty Acids*

In a colon, food fiber were fermented by bacteria produce volatile fatty acids as butyric acid, propionate, acetate. Propionic acid transferred to liver and fatty acids is reported can reduce cholesterol synthesis (Anderson et al., 1990). This may one cause of that renders fiber food may lower the concentration of blood cholesterol.

The proportion of individual volatile fatty acids in cecum highly influenced by a source of fiber. Research results in vitro shows that cellulose will produce acetic concentration high, while starch is a substrate to the formation of butyric acid (Goodlad and Mathers, 1990). Hemicellulose will produce the high proportion of propionate acid in the colon (Levrat et al., 1990).

Fermentation food fiber with substrate cellulose give the proportion of 81 acetic: 13 propionate: 6 butyrate. While if the source fiber is the (nuts) give the ratio of 60 acetate: 26 propionate: 6 butyrate. Pectin produce acetate highest (81%) followed by cellulose (75%) while starch produces butyric highest (42%). (Goodlad and Mathers, 1988).

Composition food fiber in diets containing cellulose in the number of the highest (8,92%), followed by hemicellulose (6,09%), while substance pectate was most small being (2,66%). In fermentation process in the colon cellulose and substance pectate will produce the proportion of acetic acid in the number of biggest, while hemicellulose potential produce propionic acid.

From both experiment was demonstrated that treatment by diet tempe and soy fibers give the proportion of propionic acid higher than the treatment use by diet standard. So the supplementation tempe flour in this experiment put a positive value, especially its effect on the lowering of cholesterol.

In this research the proportion of butyric acid provides indications of the starch undigested in colon. In the process of fermentation starch will produce the high proportion of butyric acid. In this research feed given in the form of pellets (mix feed made into dough and printed in the form of pellets then dried in the cabinet blow dryer on the temperature 60-70oC). Through a drying process, starch and water will lead retrogradation process causing the slower digestibility, thus there are many the starch contained in the colon.

While dietary fiber is a key player, other components of tempe, such as protein and unsaturated fatty acids may also contribute to overall cholesterol management and lipid profile improvements.

5. CONCLUSION

Studies in rats has shown that diets supplemented with tempe flour can lead to a reduction total cholesterol and LDL cholesterol level. Diet tempe 10% and 20% could reduced total cholesterol from 106,4 mg/dl to 97,4 mg/dl -98,9 mg/dl and diet tempe 30% and 40% could reduce total cholesterol become 93,7 mg/dl and 92,5 mg/dl. LDL-cholesterol reduced from 38.7 mg/dl become 35,5 mg/dl(diet tempe 10%) 27,7mg/dl (diet tempe 20%) 19,4 mg/dl (diet tempe 30%) and 18,4 mg/dl (diet tempe 40%). HDL increase from 67,7 mg/dl to 71,3 mg/dl (diet tempe 20%) 74,3 mg/dl (diet tempe 30%) and 74 mg/dl (diet tempe 40%).

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