Processing methods of lepiu (*Archidendron parviflorum*) on nutrition, glycemic index, glycemic load, cholesterol and glucose mice (*Mus musculus*)

Bernatal Saragih*1, Marwati1, Maulida Rahmawati1, Suhardi2, Netty Maria Naibaho3
1Department of Agricultural Product and Technology, Agriculture Faculty Mulawarman University, Indonesia
2Department of Animal Science, Agriculture Faculty Mulawarman University
3Deparment Plantation Processing Technology, State Agricultural of Polytechnic Samarinda
*Email: bernatalsaragih555@gmail.com; bernatal_saragih@faperta.unmul.ac.id

Abstract. Exploration of new food sources is very important to increase the potential and food reserves, one of which is lepiu. Lepiu is used by the people of East Borneo as food by boiling lepiu seeds. This study was conducted recover out the effect of different treatment on nutritional value, glycemic index, glycemic load, and glucose and cholesterol of mice after 21 days intervention. The fried lepiu provides a lower glycemic response than the boiled and steamed lepiu. The method of treatment gives effect to the compositions of lepiu nutrition. Increase in blood glucose 30 minutes after consumption of fried lepiu was lower (25 mg/dL), boiled (34 mg/dL) and steamed (26 mg/dL). The method of processing gives a differential force on the glycemic index and glycemic load. Decreased glucose in mice after 21 days intervention in the lipid cereals treatment of 39 mg/dL, then lepiu 34 mg/DL, 35 mg/dL standard feed and 22 mg/dL commercial cereals. Cholesterol in standard feeding treatment did not decrease, while lepiu seed treatment decreased by 7 mg/dL and in the treatment of lepiu cereals and commercial cereals respectively 13 mg/dL.

Keywords: nutrition, lepiu, glycemic index, cholesterol

1. Introduction
Consumer demand for functional food gets higher along with the increasing public awareness for healthy foods. Higher carbohydrate and sugar consumption problems are also important factors in dealing with health problems [1-2], especially the problem of increasing the prevalence of diabetes [3-5]. Prospective studies show that low-IG diet (glycemic index) may reduce the risk of diabetes, cardiovascular disease, metabolic syndrome, chronic inflammatory and possibly some cancers [6-7]. Clinical trials have shown that low GI diets improves glycemic control in diabetes [8], improves insulin sensitivity, β cell function [9], weight reduction [10], affects memory [11-12] and may reduce serum cholesterol [13]. Therefore, changes in sugar consumption need to be revisited, including information on sugars added to food. The proposed changes to nutrition labels have the potential to reduce added sugar consumption [14].

Diabetes is an increasingly common disease, dramatically associated with an increased risk of death in developing countries. Various problems associated with the occurrence of any nutritional
problems of late have become the focus of attention of health and nutrition experts. Economic improvements are consistent with lifestyle changes, including diet. The tendency to consume unbalanced foods, high fat intake, low in vitamins, minerals and dietary fiber is an important factor contributing to overweight and obesity [15]. Diabetic patients who ate a low glycemic index diet had a 0.43% reduction in HbA1c (0.72 to 0.13 CI) and a reduction in the glycosylated protein content of 7.4% [16]. Today, many non-DM people use the glycemic index as a way to choose foods to be consumed for health, weight loss, and performance [17].

The exploration of useful plants in the development of new products, especially those available in Indonesia in particular East Borneo is very significant. One of the local plants of Borneo is Tiwai onion, tiwai onion herbs with 2 times a day, morning and evening can decrease cholesterol in patients with hypercholesterolemia after 7 days’ consumption of 5.33 mg/dL [18]. The results of another study showed [19] to local foodstuffs in East Borneo, such as banana cassava flour have components of flavonoids, phenols and alkaloids. The other flour (Durio kutaijensis) has saponins, flavonoids, phenols and alkaloids. The yellow sweet potato flour has flavonoids, phenols and alkaloids while the tiwai onions have flavonoids, phenols and alkaloids lacking steroids and saponins, the results of the glycemic response test of cereals obtained from local foodstuffs are lower than in commercial cereals (Energen cereal).

One of the plants that grows in East Kalimantan is important to develop is lepiu (Archidendron parviflorum). Lepiu is a plant that propagates and has seeds resembling jengkol (Archidendron pauciflorum) and is often used as food for Dayak people especially for food supplies when hunting forests. The adoption of the use of lepiu as a food for breakfast has become an important part in preserving the breakfast culture to meet the food and nutrition needs of the community. Exploration and formulation of foodstuffs sourced from nature as a very important ingredient are done as part of providing nutrition information of Indonesian germplasm especially to support new functional food.

2. Materials and methods

The materials used in this study consisted of lepiu seeds, obtained from Berau East Borneo, commercial cereals (cereal energents), mice, chemicals for protein analysis; oxide of mercury, potassium sulfate or anhydrous sodium sulfate, sulfuric acid (98%), sodium hydroxide solution 40%, solution of indicator of boric acid, methyl red, green bromocresil, 0.1N hydrochloric acid, Petroleum ether, 0.255N sulfuric acid, sodium hydroxide 0.313N, ethyl alcohol at 95% (Merck).

Phytochemicals analyzes performed such as phenolics, alkaloids, flavonoids, saponins and steroids was determined using AOAC [20]. The lepiu seeds are steamed, boiled and fried for 15 minutes. Then tested levels of nutrition, glycemic index and glycemic load on lepiu.

Analysis of water, protein, fat, ash and crude fiber content was analyzed according to AOAC [20], method, while the carbohydrate percentage was calculated by difference method; Energy (kcal) = The calculation is done by adding a multiplication of 4 x carbohydrate, 4 x protein content, and 9 x fat content. The blood glucose response test was done on 10 subjects who had normal blood glucose levels. Giving lepiu to volunteers who have undergone full fasting except water at night (around 20:00 to 08:00). After 3 days with the same result gives glucose as standard food. Number of volunteers as many as 10 people. Blood sampling was done in minutes to 0, 30, 60, 90 and 120. Blood glucose analysis using glucometer (Accu Check Active) [7,21].

The glycemic index was calculated by comparing the area under the food blood glucose curve tested by the area under the standard blood glucose food curve multiplied by 100%. The glycemic load is obtained by multiplying the glycemic index by total carbohydrate of one serving of food divided by 100.

Making cereals from the lepiu and testing the product on the mice was done. The lepiu seeds have been steamed for 15 minutes to give to mice. For the manufacture of cereal first by making lepiu flour. The procedure of making lepiu flour with drying in the oven for 18 hours at a temperature of 70 to dry. Then do the milling, then sieving with 80 mesh.

Lepiu cereal was produced with whole ingredients (lepiu flour 250 grams, 20 grams of milk
powder, vanilla 1 gram and 2 grams of salt), mixed until blended. Then added 2 chicken eggs and 50 g margarine that has been thawed. Then water is added and made pasta paste. After that, the dough is printed with a size of 0.5 cm and in the oven until cooked with 1-3% water content (cooked cereal) and packing. Lepers and cereals were then intervened in mice with standard feed compounds and commercial (energen) products.

The research sample was obtained by consecutive random sampling with the following criteria; Inclusion criteria; male, white mice, age 2 months, weight 20-25 g and healthy condition (active and not disabled). Exclusion criteria: mice experiencing pain, decreased mice weight (less than 20 g), and mice died during the study period. The sample size used 9 tails according to WHO criteria for experimental study, at least use five mice in each treatment group.

The research design of the test phase of cereal formulation and lepiu products was done with Pre-post test control design. Provision of four treatment factors in 36 white rats with 9 replications namely:
A = Mice feeding, feed in standard feed ad libitum
B = Mice that feed on ad libitum lepiu seeds
C = Mice that feed on ad libitum cereal lepiu
D = Mice that feed on ad libitum commercial cereal

Intervention was performed for 21 days in mice. Measurement of glucose and blood cholesterol of mice was done by using the Accu check (Multi-monitoring system 3 in 1). Physical characteristic of mice, glucose and blood cholesterol were analyzed at the start and conclusion of the subject. The data obtained was analyzed by T-test (T-paired) and variance (ANOVA) followed by the Least Significant Different (LSD) with a 5% level.

3. Results and discussion

3.1. Morphology of lepiu seeds

The horizontal diameter of the dry lepiu seed with the skin causes an average diameter of about 2.5-3.5 cm and a vertical diameter of 1.9-3.0 cm. While skinless seeds have a horizontal diameter of 2.4-3.1 cm and a vertical diameter of 1.7-2.6 cm. Seeds that have a horizontal diameter of 3.5 cm after peeling the skin to 3.0 cm and the vertical diameter of 3.0 after peeling the skin to 2.6 cm. This proves the average skin gives an increase in diameter of seeds of approximately 0.45 cm. The number of seeds with the skin in 100 grams ranges from 34-40 seeds, while the skinless seeds in 100 grams between 30-42 seeds. Observing lepiu seeds include dicotyledon and legume species.

![Figure 1. Lepiu seed (photo collection author)](image)

3.2. Phytochemicals lepiu

The effects of phytochemical analysis of lepiu I seeds containing saponins, flavonoids, phenols and alkaloids (Table 1), but no steroids. All steroids are manufactured in cells from the sterols lanosterol (animals and fungi) or cycloartenol (plants) [22].
Table 1. Phytochemicals

| Phytochemicals | Steroids | Saponins | Flavonoids | Phenols | Alkaloids |
|---------------|----------|----------|------------|---------|-----------|
| Lepiu         | -        | +        | +          | +       | +         |

3.3. Effect of lepiu seed cooking method on nutritional composition

The results showed that the method of processing lepiu seeds by frying tends to increase the fat content, will also increase the calorific value and decrease the water content (Table 2). Lepiu contains carbohydrates (65.8%), protein (4.26%), fat (7.05%), water content (19.15%), ash (1.40%) and crude fiber (0.30%).

Table 2. Comparison of lepiu nutrition with cooking method with frying pan, boiling and steaming

| Nutrition               | Cooking Methods |
|-------------------------|-----------------|
|                         | Boiling         | Steaming       | Frying         | Lepiu*          |
| Water content (%)       | 35.77±0.20a     | 20.54±0.20b    | 6.2±0.04c      | 19.15±0.82b     |
| Ash (%)                 | 1.63±0.02a      | 2.38±0.04b     | 2.51±0.10bc    | 1.40±0.13a      |
| Fat (%)                 | 13.81±0.17a     | 15.28±0.07bh   | 19.91±0.10c    | 7.05±0.92d      |
| Protein (%)             | 7.06±0.08b      | 8.2±0.02b      | 9.09±0.08bc    | 4.26±0.67d      |
| Crude fiber (%)         | 5.54±0.11a      | 6.2±0.04b      | 7.79±0.07c     | 0.30±0.12d      |
| Carbohydrates (%)       | 36.18±0.12a     | 47.4±0.20b     | 54.5±0.33c     | 65.8±0.69d      |
| Calories (kcal)         | 297.25±1.66a    | 359.92±0.40b   | 433.55±0.17c   | 343.7±1.12b     |

The same letter on the line shows no significant difference (P>0.05),

* Lepiu seed after two days of harvest and dried two days in the sun

Table 3. Blood glucose levels after lepiu and glucose consumption

| Sample         | Time of taking blood (minutes) | Blood glucose (mg/dL) |
|----------------|-------------------------------|-----------------------|
| Glucose        | 0                             | 85.5±2.3a             | 156.4±4.1a          | 152.5±2.0a        | 122.3±2.4a        | 85.1±2.1a         |
| Fred lepiu     | 30                            | 86±6.14a              | 113±6.12b           | 105±5.90b         | 93±5.9b           | 83±6.07b          |
| Boiled lepiu   | 60                            | 80±3.36a              | 113±2.94b           | 93±3.12c          | 89±2.21c          | 77±2.00c          |
| Steamed lepiu  | 90                            | 83±3.43a              | 111±3.25b           | 96±3.55c          | 89±3.97c          | 78±3.33c          |
|                | 120                           |                       |                      |                    |                      |                     |

The same letter in the column shows no significant difference (P>0.05)

These results indicate that fried lepiu has a lower response to a rise in blood glucose at minute 30 after consumption and slower lepiu also in decreased glucose levels. Based on the method of processing the above results obtained by a slower processing, frying method to increase blood glucose is also in decline compared with the lepiu processing method by boiling and steaming.
The other study also demonstrated a reduction in blood glucose levels in volunteers who consumed reference food (pure glucose) (74.9 mg/dL) higher than commercial cookies (31.9 mg/dL), pumpkin cookies with the addition of coco chips (22.1 mg/dL) and pumpkin cookies without the addition of choco chips (24.7 mg/dL) [24].

Glycemic index and glycemic load also differ with different processing methods. However, the glycemic index and the glycemic load in the three treatment methods were not significantly different (Table 4).

Table 4. The glycemic index, glycemic load lepiu seed

| Cooking Methods | Boiled | Steamed | Fried |
|-----------------|--------|---------|-------|
| Glycemic Index  | 37     | 38      | 39    |
| Glycemic Load   | 13     | 17      | 19    |

IG and Glycemic loads occur even higher in fried lepiu. This can happen because the rise in blood glucose is not only determined by glucose or carbohydrates, but also the energy content in the diet however. Cooking methods that affect the nutritional composition, water and fat content as occurs in this study. IG foods were influenced by various elements, including the type of materials, processing methods and characteristics (composition and biochemical properties) [25]. The same type of food stuff with different processing gave different IG values [26]. The addition of chocolate to the yellow pumpkin cookies causes the difference in IG. Pumpkin cookies with the addition of chocochips as topping have IGs of 62, without chocochips 64, whereas commercial cookies IG = 73 [19].

3.5. Weight loss and feed consumption of mice

Mice weight increased 3.6-10 grams after feeding. The highest increase in mice weight occurred at treatment A 10 g, whereas treatment B 3.6 g, treatment C 7.3 g and treatment D was 6.7 g (Table 5).

Table 5. Weight (g) mice pre and post treatment 21 days

| Feed Treatment | A     | B       | C       | D     |
|----------------|-------|---------|---------|-------|
| Pre            | 20±6  | 22±5    | 21±5    | 20±6  |
| Post           | 30±5  | 25.6±5  | 28.3±5  | 26.7±5|

Remarks:
A = Mice feeding feed in standard feed ad libitum
B = Mice that feed on ad libitum lepiu seeds
C = Mice that feed on ad libitum cereal lepiu
D = Mice that feed on ad libitum commercial cereal
The average consumption of feed by mice in one day between 2-3.3 g per day. Mean feed intake of mice from day 1 to day 21 on treatment A 3.3 + 0.97 g, treatment B 2.0 + 0.78g, treatment C 2.1 + 0.74 g and treatment D 3.1 + 0.70 g.

3.6. Glucose

The results showed a decrease in glucose compared with the average of initial glucose mice 219 mg/dL all treatment decreased, with the highest decrease in treatment C (39 mg/dL), then B (34 mg/dL), A (35 mg/dL) and the last D (22 mg/dL) (Table 6).

| Treatment | Glucose (mg/dL) |
|-----------|----------------|
| A         | 184±17         |
| B         | 185±12         |
| C         | 180±20         |
| D         | 197±23         |

Table 6. Mice glucose after feeding 21 days

Anova test results in the four treatments showed has no significant effect (p = 0.26) mice glucose levels. Glucose mice were determined by biological variation and metabolism of experimental mice, when observed also from weight gain with feed consumption of mice also showed few differences from the four experimental groups. The protein extract from the nuts koma (Lablab purpureus) after a 42 day intervention can decrease the blood glucose concentration from 455.75 mg/dl to 104.50 mg/dl, while the control decreases from 458 mg/dl to 455.33 mg/dl [27].

Other studies have shown that no significant difference in glucose decrease occurs due to regeneration of pancreatic beta cells [28,29]. This is consistent with the study of the that pancreatic regeneration and neogenesis can occur at 12 days with the use of alloxan doses of 120 mg/kg [30].

3.7. Cholesterol

The results showed no cholesterol reduction in standard feeding treatment (A) after 21 days of consumption, compared with the initial cholesterol of 171 mg / dL mice. While the treatment of lepiu (B) diet was decreased by 7 mg/dL, treatment of lepiu (C) cereal drop 13 mg/dL and decreasing 13 mg/dL decrease in cereals (D). The results of Anova test on all four treatments showed no significant difference (p = 0.30) of mice cholesterol level.

| Treatment | Cholesterol (mg/dL) |
|-----------|---------------------|
| A         | 172±20              |
| B         | 164±13              |
| C         | 158±12              |
| D         | 158±25              |

Table 7. Mice cholesterol after feeding 21 days

The results of this study differ with the protein extract from the kacang koma after the 42 day intervention significantly affect the decrease of total cholesterol, LDL cholesterol and triglyceride [23]. Similar results also obtained that consumption of isoflavones from soya beans may lower LDL in people with hypercholesterolemia [31,32]. The consumption of fiber from rice and rice bran can also lower cholesterol [33].

4. Conclusion

The cooking method gives effect to the composition of lepiu nutrition, lepiu with the frying method has a moisture content (6.2%) lower than the steaming method (20.54% moisture content) and boiling (moisture content 35.77%). Increased levels of lipid have a decreasing effect on lepiu glycemic response. The glycemic index and the glycemic load on lepiu seeds with different processing will also give different results. The decrease in glucose in mice was highest in treatment lepiu cereal (39 mg/dL), then lepiu seed (34 mg/dL), feed standard (35 mg/dL) and commercial cereal (22 mg/dL) and cholesterol in standard feed treatment there was a decrease, while treatment lepiu seed (7mg/dL) and on treat lepiu cereal and commercial cereal were 13 mg/dL.
5. References

[1] Yvonne R, Gyöngyi B, Jan G, D’Haese, Barbara E, Thurnheer M, Schultes B, and Stephan C. Bischoff. 2014. Effect of High Sugar Intake on Glucose Transporter and Weight Regulating Hormones in Mice and Humans. PLoS One. 9(7): e101702. Doi:10.1371/journal.pone.0101702

[2] Siervo M, Montagnese C, Mathers JC, Soroka KR, Stephan BC. 2013. Sugar consumption and global prevalence of obesity and hypertension: an ecological analysis. Public Health Nutr: 1–10

[3] Macdonald IA, 2016. A review of recent evidence relating to sugars, insulin resistance and diabetes. Eur J Nutr. 55(Suppl 2): 17–23 Doi: 10.1007/s00394-016-1340-8

[4] Pereira MA. 2006. The possible role of sugar-sweetened beverages in obesity etiology: a review of the evidence. Int J Obes. 30: S28–S36

[5] Weed DL, Althuis MD, Mink PJ. 2011. Quality of reviews on sugar-sweetened beverages and health outcomes: a systematic review. Am J Clin Nutr. 94: 1340–1347

[6] Augustin LSA, Gallus S, Negri E, La Vecchia C. 2004. Glycemic index, glycemic load and risk of gastric cancer. Ann Oncol.15:581–584.

[7] Wolever TMS. 2008. Measuring the glycemic index of foods: interlaboratory study. The Am J Clin Nutr. 87(1):247S–257S. doi.org/10.1093/ajcn/87.1.247S.

[8] Brand-Miller J, Hayne S, Petocz P Colagiuri S. 2003. Low-glycemic index diets in the management of diabetes: a meta-analysis of randomized controlled trials. Diabetes Care. 26:2261–2267

[9] Juntunen KS, Laaksonen DE, Poutanen KS, Niskanen LK, Mykkänen HM. 2003. High-fiber rye bread and insulin secretion and sensitivity in healthy postmenopausal women. Am J Clin Nutr.77:385–391

[10] McMillan-Price J, Petocz P, Atkinson F. 2006. Comparison of 4 diets of varying glycemic load on weight loss and cardiovascular risk reduction in overweight and obese young adults. Arch Intern Med 166:1466-1475.

[11] Kaplan RJ, Greenwood CE, Winocur G, Wolever TMS. 2000. Cognitive performance is associated with glucose regulation in healthy elderly persons and can be enhanced with glucose and dietary carbohydrates. Am J Clin Nutr 72:825-835

[12] Benton D, Ruffin MP, Lassel T. 2003. The delivery rate of dietary carbohydrates affects cognitive performance in both rats and humans. Psychopharmacol 166:86-90

[13] Kelly S, Frost G, Whittaker V, Summerbell C. 2004. Low glycemic index diets for coronary heart disease. Cochrane Database Syst Rev 4: CD004467.

[14] Drewnowski A and Rehm CD.2014. Consumption of added sugars among US children and adults by food purchase location and food source. Am J Clin Nutr 100:901-907; doi:10.3945/ajcn.114.089458.

[15] Cho SS, Lu Qi, G.C.Fahay Jr, and D.M.Klurfeld. 2014. Consumption of cereal fiber, mixtures of whole grains and bran, and whole grains and risk reduction in type 2 diabetes, obesity, and cardiovascular disease, www. ajcn.nutrition.org (access 5th September 2014)

[16] Pateda V, Nofi LS, Nanis SM, Pulungan A, Tridjaja A, Batubara B, dan Jose RL. 2009. Pengaruh Konsumsi Beras Indeks Glikemik Rendah Terhadap Pengendalian Metabolit Diabetes Melitus Tipe-1. Sari Pediatr. 10 (5) : 320-324.

[17] Barclay A, Flood W, Cecile J, Brand-Miller and Mitchell P. 2007. Validity of Carbohydrate Glycaemic Index and Glycaemic Load Data Obtained Using a Semi Quantitative Food Frequency Questionnaire. Public Health Nutrition. 11 (6) : 573-580.

[18] Saragih B, Pasiakan M, Saraheni, and Whyudy D. 2014*: Effect of herbal drink plants tiwai (Eleutherine americana Merr) on lipid Profile of hypercholesterolemia patients. International Food Research Journal 21(3):1163-1167.
[19] Saragih B, Rachmawati M, Marwati dan Suhardi, 2017. Nutrition and Blood Glucose Response of Food Formulated Four Types of Local Flour East Borneo Added Plant Extracts Tiwai (Eleutherina americana Merr). IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 11(2): 37-43. DOI: 10.9790/2402-1102013743.

[20] AOAC, 2006. Association of Official Analytical Chemists. Official method of Analysis (18th edition). Int'l., USA.

[21] Miller, JB, K. Foster-Powel and S Colagiuri, 1996. The GI Factors; The GI Solution Hodder and Stoughton. Hodder Headline Pty. Limited. Australia.

[22] Zorea A 2014. Steroids (Health and Medical Issues Today). Westport, CT: Greenwood Press. pp. 10–12. ISBN 978-1440802997.

[23] Hefnawy TH. 2011. Effect of processing methods on nutritional composition and anti-nutritional factors in lentils (Lens culinaris). Annals of Agricultural Sciences. 65(2):57-61. doi:10.1016/j.aoas.2011.07.001

[24] Saragih B. 2014. Respon Glikemik Cookies Labu Kuning (Cucurbita moschata Duch). Jurnal Boga dan Gizi. 8(1): 11-15

[25] Saragih B, Marwati, Saragih B, Suprapto H, Rachmawati M. 2013. Effect of Various Types of Herbs on Sensory Properties and Blood Glucose Response Adan Instant Black Rice. International Journal of Science and Engineering (IJSE). 5 (1):42-4. Doi:10.12777/ijse.5.142-48.

[26] Astawan M, Widowati S. 2011. Evaluation of Nutrition and Glycemic Index of Sweet Potatoes and Its Appropriate Processing to Hypoglycemic Foods. Ind J Agric. Sci 12(1):40-46.

[27] Hartoyo A, Muchtadi D, Astawan M dan Winarto A. 2011. Pengaruh ekstrak protein kacang komak (Lablab purpureus (L.) Sweet) pada kadar glukosa dan profil lipida serum tikus diabetes. Jurnal Teknologi dan Industri Pangan. XXII(1):58-63

[28] Nugroho AE. 2006 Hewan percobaan diabetes melitus: Patologi dan mekanisme aksi diabetogenik. Biodiversitas. 7(4): 378-382.

[29] Yuriska AF. 2009. Efek Aloksan Terhadap Kadar Gula Darah Tikus Winstar. Fakultas Kedokteran Universitas Diponegoro. Semarang

[30] Chougale AD, Panaskar SN, Gurao PM, Arvindeka AU.2007. Optimization of alloxan dose is essential to induce stable diabetes for prolong period. [cited 2016 August 10]. Available from: http://sciarlet.net/fulltext/?doi=ajb2007.402.408

[31] Earnest PC. 2005. Cholesterol-lowering effects of bovine serum immunoglobulin in participants with mild hypercholesterolemia. Am J Clin Nutr. 81: 792-798

[32] Zhan S and Ho CS 2005. Meta-analysis of the effects of soy protein containing isoflavones on the lipid profile. Am J Clin Nutr. 81(2): 397-408.

[33] Most MM, Tulley R, Morales S and Lefevre M 2005. Rice bran oil, not fiber lower cholesterol in humans. Am J Clin Nutr. 81:64-68.

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