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Original article

Effects of coconut oil (*Cocos nucifera*) and sesame oils (*Sesamum indicum* L.) on rapeseed powder induced changes of cardio-hepatic enzymes in Wistar rats

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Summary. *Purpose*: Rapeseed oil contains high percentage of erucic acid which causes cardio-hepatic toxicity. *Methods:* In this study, different doses of sesame oil (SO) and coconut oil (CO) were mixed with constant dose of rapeseed oil and fed to Wistar rats for 6 weeks. After the experimental period, abdomen aortic blood was collected and serum enzymes level such as CK-MB, SGOT and SGPT were measured. *Results:* Rapeseed oil not only increased SGPT enzyme level over control diet but also elevated CK-MB and SGOT significantly. Whereas, sesame oil and coconut oil showed protective effect against rapeseed oil induced cardio-hepatic enzymes. Moreover, higher doses of both oils represented better effect against rapeseed oil toxicity. Although CO and SO significantly decreased serum CK-MB, SGOT and SGPT activities, coconut oil had greater effect on cardiac enzymes like CK-MB while sesame oil were more significant for SGPT and SGOT. *Conclusion:* Therefore, the ameliorating effects of sesame oil and coconut oil trimmed down the toxic effects of rapeseed oil in rats.

Key words: rapeseed oil, sesame oil, coconut oil, CK-MB, SGOT and SGPT

Introduction

Vegetable oils like soybean oil, sunflower oil, rapeseed oil, palm oil etc were commonly used as dietary source for essential fatty acids (EFAs) in South-Asian countries like Bangladesh (1). Among the popularity of edible oils in the world, rapeseed oil was second in position (2) but it contains prevalent levels of erucic acid (51.56-67.98%), which patently produce toxic effects on multiple organs especially heart and liver (1,3,4). According to Downey (1983), erucic acid was poorly metabolized and consequently fats could be accumulated in heart muscle, adrenal gland and ovarian tissues leading to some serious troubles on human (5). In addition, erucic acid developed myocarditis (6), cardiac necrosis and potential cardio-toxicity in rats (7-10). Hafizur *et. al.* (2014) revealed that sesame oil (*Sesamum indicum L.*) and coconut oil (CO) had ameliorated effects on rapeseed oil through lowering lipid levels in serum and also protected from toxicity effect of rapeseed (1,11). Coconut oil increased HDL-Cholesterol (12) and also reduced heart enzymes level in serum like CK-MB which releases during heart injury (13). Although there was a misconception about coconut oil because of its high level of saturated fat (14), recent studies demonstrated that lauric acid present in coconut oil had antiviral, antiprotozoal, antibacterial properties and also increased body metabolism (15,16). CO also acts as an antioxidant of serum enzymes (17). On the other hand, sesame oil (SO) contains natural antioxidant and plays antihypertensive effects of experimental animal (18,19) and used as cooking medium in many countries of subcontinents. This oil also ameliorated the endothelial dysfunction

Md. Hafizur Rahman and Shaikh Shahinur Rahman are equal contribution to prepare this manuscript.

through enhancement of vascular antioxidant defense. Its antioxidant effect was very consistent to super-oxide dismutase (SOD) mimetic (18). It could be postulated that it might have some protective effects against erucic acid toxicity. Thus, the aim of this study was to investigate the acute efficacy and protective effect of saturated (coconut oil) and unsaturated oil (sesame oil) supplemented with high erucic acid containing diet on serum cardio hepatic enzymes in Wistar rats.

Materials and methods

Experimental animals and diets

A total number of 56 Wister male rats were used in this two steps experiment (average body weight 140-160 g and 100-110 gm; aged 5 weeks). Rats were obtained from the Department of Biochemistry and Molecular Biology, Jahangirnagar University, Savar Dhaka, Bangladesh. Animals were maintained under standard and ambient temperature under lights for twelve hours followed by 12 h of darkness environmental conditions having proper ventilation in the room and were fed with a standard diet: mixture of wheat flour (which contributes 30% of diet), molasses (which is rich source of sugar mainly sucrose, glucose and fructose), rice polish, wheat bran and distilled water. 10% of the diet contributes fish-meal that is an excellent source of protein.

Extraction of oils

Rape seeds, sesame seeds (*Sesamum indicum L.*) and coconuts were collected from cultivars and then cleaned and dried. Finally, the rape seeds were grinded into powder and dehulled sesame seeds and coconuts were passed through the power driven mill to squeeze oil from kernel and stored at 4°C with sealed plastic packed to avoid the microbial contamination.

Sample collection and estimation of biochemical parameter

After 1 week of acclimatization with normal diet prior to experiment, rats were divided into seven groups (n=4) named as A, B, C, D, E, F and G in both experiment of SO and CO. In this experiment, 15 gm standard diet was provided per day per rat. Group A and B were fed control diet and rapeseed powder (0.6 gm/day/rat), respectively in both cases but group C, D, E, F and G were fed supplementary 1 gm, 0.6 gm, 0.8 gm, 1.0 gm and 1.2 gm either SO or CO, respectively mixed with 0.6 gm rapeseed powder per day per rat which equivalent to 50% erucic acid (20). After 6 weeks experimental doses, rats were sacrificed by ether anesthesia and about 3-5 ml of blood sample was collected directly from artery by syringes. Blood was collected in fresh centrifuge tube and centrifuged at 4000 rpm for 10 min and the serum was preserved to examine CK-MB, SGPT/ALT and SGOT/AST level by semi-auto analyzer (Humalyzer 3000, Human, Germany) using wet reagent diagnostic kits purchased from Atlas Medical, Cambridge, CB4 OWX, UK, according to manufacturer's protocol.

Statistical analysis

Data from the experiments were analyzed using SPSS software for windows version 11.5. All results were expressed as the mean ± Standard Deviation. One-way analysis of variance (ANOVA) used and paired or unpaired t-test was done to see any difference between groups.

Results

In this study, cardio-hepatic enzymes (CK-MB, SGOT/AST and SGPT/ALT) were measured from both sesame and coconut oil feeding experimental rats after 6 weeks. Both table-1 and table-2 showed that rapeseed oil increased enzyme activity significantly ($P<0.05$) where CK-MB were highly significant ($P<0.01$). Table-1 depicted coconut oil containing diet highly reduced CK-MB activity ($P<0.01$) than control and rapeseed oil while other enzymes also reduced considerably.

Table 1 also demonstrated that coconut oil mixed with rapeseed oil in different ratios decreased the activity of cardio-hepatic enzymes in compared with rapeseed oil but in case of CK-MB, this changes was highly significant than normal and rapeseed diet ($P<0.01$). Whereas, SGOP and SGPT were almost same as control diet when 1.2 gm coconut oil mixed with 0.6 gm rapeseed oil. On the other hand, the activity level of CK-MB was drastically reduced. This table

also indicated that higher doses of coconut oil were more protective effect than lower ones (table 1).

Table 1 also showed SGOT level significantly (P<0.05) elevated after feeding rapeseed oil but coconut oil and rapeseed oil mixed diet decreased gradually except group D (coconut oil 0.6 gm) as compared to control diet and rapeseed oil supplementary diet. Surprisingly, SGPT level was significantly reduced in group F (coconut oil 1 gm+ rapeseed 0.6 gm) in contrast to only rapeseed oil containing diet (0.6 gm).

On the other hand, table 2 indicated that sesame oil (Group C) also had protective effect against the elevated level of serum CK-MB enzyme activity caused by rapeseed powder. This table also showed that reduced activity of CK-MB was dose dependent in response to sesame oil. Group G (sesame oil 1.2 gm+ rapeseed 0.6 gm) were more significant (P<0.01) than group B (rapeseed 0.6 gm).

Table 2 also depicted that sesame oil had significant (P<0.05) lowering effect of serum SGOT and SGPT activity in compare to rapeseed oil. When sesame oil mixed with 0.6 gm rapeseed containing diet, serum cardio-hepatic enzymes (CK-MB, SGOT/AST and SGPT/ALT) were reduced but not drastically except group G (0.6gm rapeseed mixed with 1.2 gm sesame oil) where CK-MB were highly momen-

Table 1. Effects of blended oils (rapeseed with coconut oil to a varying ratio) on serum enzymes CK-MB, AST and ALT in rats.

Experimental Groups	Blood Serum analysis (u/L), Mean ±SD		
	CK-MB	SGOT(AST)	SGPT(ALT)
Group A: Control diet	65.33±2.08	110.67±7.07	51.96±3.56
Group B: RSP 0.6gm	74**a ±1.73	126.33*a ±7.78	62*a ±4.58
Group C: Coconut oil 1gm	43.67**ab±5.86	106.3*b±6.36	52.37±0.54
Group D: RSP 0.6gm+CO 0.6gm	63.67**b ±2.89	128.33±9.60	58.33*b±7.23
Group E: RSP 0.6gm+CO 0.8gm	57.67**ab ±1.16	117.3±8.386	58.22±4.66
Group F: RSP 0.6gm+CO 1.0gm	57**ab ±2	117.3±8.32	53* b±1.73
Group G: RSP 0.6gm+CO 1.2gm	51.3**ab±3.21	113.33±6.66	51.66*b±3.22

Values are mean ± SD; n=4 a values significant differ from control
**Significant values p<0.05 b values significant differ from mustard*
***High significant values p<0.01*

Table 2. Effects of blended oils (rapeseed with sesame to a varying ratio) on cardio-hepatic enzymes.

Experimental Groups	Blood Serum analysis (u/L), Mean ±SD		
	CK-MB	SGOT(AST)	SGPT(ALT)
Group A: Control diet	23.25±1.15	106.75±7.50	58.24±3.01
Group B: Rapeseed oil 0.6gm	30.66*a±3.21	126.33*a±7.77	62±4.58
Group C: Sesame oil 1gm	17.67*a **b±2.52	108*b±4.58	55.66±1.15
Group D: RSP 0.6gm+SO 0.6gm	21.68±2.08	122±7.54	56.67±5.68
Group E: RSP 0.6gm+SO 0.8gm	23.67±3.05	117±13.0	54.33±6.80
Group F: RSP 0.6gm+SO 1.0gm	22.65±2.02	115.33±6.42	52.67±9.86
Group G: RSP 0.6gm+SO 1.2gm	18.66**b±1.15	113.66±2.08	52.67*b±3.05

Values are mean ± SD; n=4 a values significant differ from control
**Significant values p<0.05 b values significant differ from mustard*
***High significant values p<0.01*

tous (P<0.01) and SGPT were considerable (P<0.05) in contrast to group B (0.6 gm rapeseed oil).

Figure 1 also clearly showed the effect of consumable oils on cardio-hepatic enzymes and a choice of better ones to prevent heart and liver injury. This figure exclusively demonstrated that both CO and SO were beneficial for serum enzyme activity but sesame oil was more favorable for CK-MB while coconut oil was better for SGPT and SGOT.

Discussion

Rapeseed oil contains 40-55% erucic acid (21) that causes myocardial lesion as well as necrosis and also affects peroxisomal β-oxidation enzyme system which is responsible for fatty acid breakdown and inhibits mitochondrial oxidation (22,23), as a consequence, these injuries tend to consume lower amount of foods and leading to weight loss. Interestingly, when sesame oil or coconut oil mixed with rapeseed oil and fed to rats, the effect of erucic acid in rapeseed oil was decreased and also the weight was increased due to its anti-inflammatory effect over rapeseed oil toxicity (24). Elevation of serum CK-MB enzyme activity level was considered as a significant marker of cardiac inflammation (25,6). This study found that erucic acid (rapeseed) elevated CK-MB level in rat which indicated the disease or damage to the rat which indicated the disease or damage to the heart muscle. But the mixture of coconut oil or sesame oil with rapeseed oil were potentially inhibited the elevation of serum CK-MB. It was already established

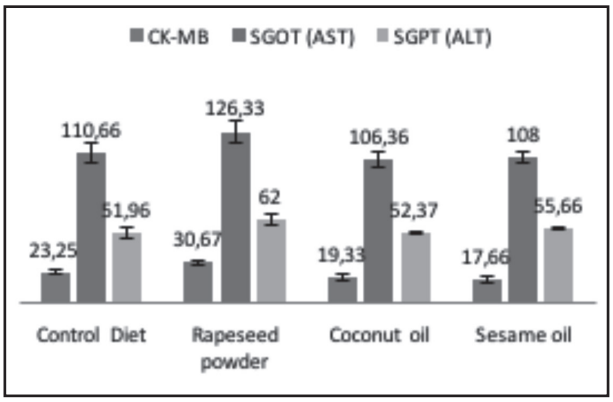

Figure 1. Comparative effect of vegetable oils (rapeseed, coconut and sesame oils) on serum enzymes.

that coconut oil increased HDL-Cholesterol and inhibit endothelial cell apoptosis, decreased complement activation, and reduced inflammation (26,27,11). Thus, the rising of HDL-C by coconut oil may play such role to reduce CK-MB level as well as inflammation to heart. SGOT (AST) also an important inflammatory marker for heart inflammation (28). This study also found non-significant elevation of SGOT (AST) level when rats were fed with supplementary rapeseed oil compared to normal diet. This result also holds up the previous studies (29,30,9). But when rats were treated with coconut oil and sesame oil, SGOT level was significantly (P<0.05) reduced. Thus, this result indicated that coconut oil or sesame oil had anti-inflammatory effect of heart which may be due to its HDL-C that mediates cholesterol efflux from the vasculature by reverse cholesterol transport process and promotes anti-oxidant, anti-inflammatory, and anti-thrombotic effects (26). In addition, SGPT (ALT) was considered as a useful quantitative marker to describe the extent and type of hepatocellular damage (31). Elevated activity of liver enzymes represents the liver dysfunction. When the plasma membrane of liver cell is damaged, the enzyme SGPT (ALT) normally found in the cytosol is released into blood stream. In our study, we also tried to evaluate the effect of coconut oil and sesame oil on the alteration of SGPT (ALT) enzyme activity in the rapeseed oil treated rats.Results showed that significant (P<0.05) elevation of SGPT level when rats were fed with rapeseed oil containing diet. Surprisingly, food supplemented with coconut oil or sesame oil abrogated the elevation of SGPT activity level in erucic acid containing rapeseed oil treated rats. Besides, mixed oil group (D, E, F) showed non-significantly inhibited the elevation of serum enzyme SGPT activity but F group significantly depleted the enzyme activity. So, the authors suggested that elevated level of SGPT is inhibited by coconut oil due to its anti-inflammatory properties (32).. On the other hand, this study didn't clarify how sesame oil protects the elevation of these enzymes. One possibility was that sesame oil contains lignan: sesamin, sesamolin and high percentage of natural antioxidant linolenic acid (33) those were active ingredient of sesame might inhibit the erucic acid induced toxicity by the perturbation of erucic acid rapeseed oil-mediated signal transduction path way because of its antioxidant property. The authors also elucidated

that SO was better than CO in case of CK- MB while CO was more significant for ALT and AST (Figure 1). Although coconut oil was considered as saturated oil, many researchers recommended its antioxidant and anti-inflammatory properties (15-17). In our study, we found that coconut oil could be more effective for myocardial lesion and hepatocellular damage.

Conclusion

This study was tried to evaluate the effect of sesame oil (SO) and coconut oil (CO) on the alteration of CK-MB, SGOT (AST) and SGPT (ALT) enzyme activity induced by rapeseed oil in rats. SO and CO were found a trimmed down tendency on blood serum cardio-hepatic enzymes in Wister rats. In conclusion, the authors suggested that coconut oil and sesame oil could play a great role in future to reduce or to prevent the toxic effect of rapeseed oil in humans.

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References

1. Md. Hafizur Rahman, Khadija Habib, Shaikh Shahinur Rahman, Lubna Nasreen and Asad Ud-Daula. Ameliorating Effect of Dietary Sesame Oil on High Erucic Acid Rapeseed Powder–Induced Changes of Blood Serum Lipids in Rats. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) e-ISSN: 2319-2402, p- ISSN: 2319-2399. 2016;10 (2): 49-53
2. USDA, Major Vegetable Oils: World Supply and Distribution at Oilseeds: World Markets and Trade Monthly Circular. FOP. 2009; 1-09.
3. R. O'Brien, Fats and Oils Formulating and Processing for Applications, Third Edition: Formulating and Processing for Applications. CRC Press, 2008; 37–40. ISBN 1-4200-6166-6.
4. Murphy CC, Murphy EJ, Golovko MY. Erucic acid is differentially taken up and metabolized in rat liver and heart. In: Proceedings from the Department of Pharmacology, Physiology, and Therapeutics, School of Medicine and Health Sciences, University of North Dakota, 501 N. Columbia Rd, Grand Forks, ; ND 58202-9037, USA. 2001.
5. Downey RK. In High and low erucic acid rapeseed oils. Kramer JKG, Saner FA and Pigden W J, Ed. Academic Press, Canada. 1983; 1–18.
6. Roine T, Uksila E., Teir H. and Rapola H.. Histopathological changes in rats and pigs fed rapeseed oil. Z. Ernaehrungswiss 1960 ;1: 118–124.
7. Evin Bozcali, Öner Süzer, Hatice Nilüfer Gürsoy, Pinar A tukeren, and Koray M Gümüstas. Effects of erucic acid supplemented feeding on chronic doxorubucin toxicity in rats, Int J Clin Exp Med 2009; 2(4): 337–347.
8. Mccutcheon JS, Umemura T, Bhatnagar MK. and Walker, BL. Cardiopathogenicity of rapeseed oils and oil blends differing in erucic, Iinoleic, and linolenic acid content. Lipids 1976;11:545-552.
9. Badawy IH. Atta B. Ahmed WM.. Biochemical and toxicological studies on the effect of high and low erucic acid rapeseed oil on rats. Die Nahrung 1994; 38 (4): 402-411.
10. Kaunitz H. 1986. Medium chain triglycerides (MCT) in aging and arteriosclerosis. J Environ Pathol Toxicol Oncol.6(3-4):115-121.
11. Md. Hafizur Rahman, Lubna nasreen, Khadiza Habib and Md. Nazibur Rahman. Effects of Dietary Coconut Oil on Erucic Acid Rich Rapeseed Oil-induced Changes of Blood Serum Lipids in Rats. Current Nutrition & Food Science 2014; 10: 302-307.
12. Nagaraju A. and Belur LR. Rats fed blended oils containing coconut oil with groundnut oil or olive oil showed an enhanced activity of hepatic antioxidant enzymes and a reduction in LDL oxidation. Food Chemistry 2008; 108: 950-957.
13. Seneviratne KN. Kotuwegedara RT. Ekanayake S. Serum cholesterol and triglyceride levels of rats fed with consumer selected coconut oil blends. International Food Research Journal 2011; 18(4): 1303-1308
14. Conrado SD.. Coconut oil: Atherogenic or not? What therefore causes Atherosclerosis? Journal of cardiology 2003; 31(3): 97-104.
15. Mary Enig G. Health and Nutritional Benefits from Coconut Oil: An Important Functional Food for the 21st Century Presented at the AVOC Lauric Oils Symposium. Ho Chi Min City, Vietnam 25 April 1996.
16. Guillot E, Vaugelade P, Lemarchal P, Rerat A. Intestinal absorption and liver uptake of medium chain fatty acids in non-anaesthetized pigs. Br J Nutr 1993; 69: 431-42.
17. Sabitha P and Vasudevan DM , Lipid profile and antioxidant enzymes in coconut oil consumers , Indian coconut Journal, Department of Biochemistry, Amrita Institute of Medical Sciences, Kochi, April 2010.
18. Nakano D, Itoh C, Ishii F, Kawanishi H, Takaoka M, Kiso Y, Tsuruoka N, Tanaka T. Effects of sesamin on aortic oxidative stress and endothelial dysfunction in deoxycorticosterone acetate-salt hypertensive rats. Biol. Pharm. Bull. 2003; 26:1701–1705.

19. Nakano D, Itoh C, Takaoka M, Kiso Y, Tanaka T, Matsumura Y.. Antihypertensive effect of sesamin. IV. Inhibition of vascular superoxide production by sesamin. Biol. Pharm. Bull 2002; 25(9): 1247-1249.
20. De Wildit DJ. Speijers GJ. Influence of dietary rapeseed oil and erucic acid upon myocardial performance and hemodynamics in rats. Toxicol Appl Pharmacol 1984; 74(1):99-108.
21. M.M. Chakrabarty. Chemistry and Technology of Oils & Fats. Allied publishers pvt. Limited. New Delhi. ISBN 81-7764-495-5. 2003;Page-170.
22. Innis SM. Clandinin MT.. Mitochondrial membrane polar-head-group composition is influenced by diet fat. Journal of Biochemistry 1981; 198: 231-4.
23. Hung S, Umemura T, Yamashiro S. et al. The effects of original and randomized rapeseed oils containing high or very low levels of erucic acid on cardiac lipids and myocardial lesions in rats. Lipids 1977; 12(2):215-21.
24. Gordon T. Castelli WP. Hjortland MC. et al. High density lipoprotein as a protective factor against coronary heart disease. The Framingham study. Am J Med. 1977; 62:707-14.
25. Mauro P. Diagnostic application of CK-MB mass determination. Clinica Chimica Acta. 1998; 272(1): 23–31.
26. Jeffrey T. Kuvin MD. Alawi A. Alsheikh-Ali MD. Et al. High-Density Lipoprotein Cholesterol-Raising Strategies. J Cardiovasc Pharmacol TM 2006; 47:196–204.
27. Xia P, Vadas MA, Rye KA, et al.. High density lipoproteins (HDL) interrupt the sphingosine kinase signaling pathway, a possible mechanism for protection against atherosclerosis by HDL. J Biol Chem 1999; 274:33143–33147.
28. Aherne FX, Bowland JP, Christian RG. Hardin RT. Performance of myocardial and blood seral changes in pigs fed diets containing high or low erucic acid rapeseed oils. Can. J. Anim. Sci. 1976; 56: 275–284.
29. Lowe, Schieferv FM, Laxdalk B. Prasadg. Korsythr W, Ackmane G, Olfert D, Bell JM.. Nutr. Metabol 1978; 22 201.
30. Mohamede M. Chemical and biological evaluation of rapeseed oil. Ph. D. Thesis. Food Tech. Depart m., Faculty of Agric., Cairo University 1989.
31. Ghouri, N, Preiss, David, Sattar, Naveed. Liver enzymes, nonalcoholic fatty liver disease, and incident cardiovascular disease: a narrative review and clinical perspective of prospective data. Hepatology 2010; 52(3): 1156–61. doi:10.1002/hep.23789. PMID 20658466.
32. Zakaria ZA, Rofiee MS, Somchit MN. et al. Hepatoprotective Activity of Dried- and Fermented-Processed Virgin Coconut Oil. Evid Based Complement Alternat Med. 2011; 142739.
33. Philip John Kanu, Joseph Zed Bahsoon, Jestina Baby Kanu and Joseph BA Kandeh. Nutraceutical Importance of Sesame Seed and Oil: A Review of the Contribution of their Lignans. Sierra Leone Journal of Biomedical Research 2010; 2(1): 4 -16.

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