Kasetsart J. (Nat. Sci.) 43 : 703 - 708 (2009)

Effects of Organic Rice Compared with Conventional Rice on Serum Lipids in Rats

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ABSTRACT

The comparative effects of organic rice and conventional rice on serum lipids in rats were investigated by feeding male Sprague-Dawley rats for 4 weeks with three diets containing: polished conventional rice; unpolished conventional rice; and unpolished organic rice compared with a casein diet. Three experimental diets and a control diet (casein) were prepared by the AOAC method from polished conventional rice, from unpolished conventional rice, from unpolished, organic rice and from casein. Each diet contained 10 ± 0.3% test protein, 8% oil, 5% water, 5% mineral, 1% vitamin, 1% cellulose, 35% sucrose and 35% corn starch. The results of the study showed no statistical significant difference ($P < 0.05$) in the levels of serum cholesterol (110.25 ± 7.91 to 117.75 ± 12.00 mg/dl) and triglyceride (99.50 ± 55.72 to 114.88 ± 41.77 mg/dl) in rats fed with polished conventional rice, with unpolished rice, with conventional rice and with unpolished organic rice. No statistically significant difference ($P < 0.05$) in the levels of serum HDL-C and LDL-C was found in rats fed with organic rice and conventional rice. The findings indicate that organic rice and conventional rice had no effect on the levels of serum lipids in rats.

Key words: organic rice, conventional rice, cholesterol, triglyceride, experimental rats

INTRODUCTION

Rice (*Oryza sativa*) is the main carbohydrate source in the food of Asian and Thai people. The majority of Thailand's rice is harvested during the normal rice-growing period, which begins in July and ends in September. This normal, cultivation season for rice may vary from place to place, depending on the land and climatic conditions (Biz Dimension, 2003). Organic farming is a form of agriculture that relies on crop rotation, green manure, compost, biological pest control and mechanical cultivation to maintain soil productivity and control pests, and excluding or strictly limiting the use of synthetic fertilizers, synthetic pesticides, plant growth regulators, livestock feed additives, and genetically modified organisms. Since 1990, the market for organic products has grown at a rapid pace, averaging 20–25% per year, reaching $33 billion in 2005. This demand has driven a similar increase in organically managed farmland. Approximately 306,000 square km (30.6 million hectares) worldwide are now farmed organically, representing approximately 2% of the world's farmland. In addition, as of 2005, organic, wild

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Received date : 24/04/09 Accepted date : 20/07/09

products are farmed on approximately 62 million hectares (Wikipedia, 2009).

Organic agriculture involves a production system that sustains the health of soils, ecosystems and people. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Currently, only specially selected high-quality jasmine rice is planted organically in a very limited area, although this type of agricultural practice is becoming more widespread as the number of health-conscious consumers is growing rapidly (STC group, 2001).

The higher content of vitamin C in organic crops is beneficial to health, because vitamin C inhibits the *in situ* formation of the carcinogen, nitrosamine, thus diminishing the negative impact of nitrates on the human organism (Mirvish, 1993). Therefore, organic vegetables can play an important anticarcinogenic role.

Organic rice is grown and processed without the use of any synthetic chemicals, while in contrast, conventional rice is grown with synthetic chemicals, such as fertilizer, insecticides, pesticides and herbicides. Thus, organic rice should be safer and more nutritious than conventional rice (Rembialkowska, 2007). However, there is no evidence in the literature of any reports dealing with the levels of serum lipids in rats fed with organic rice and conventional rice.

The objective of this study was to obtain data on the levels of serum lipids in rats fed with organic rice and conventional rice.

MATERIALS AND METHODS

Preparation of powder steamed rice

One type of organic rice and two types of conventional rice (jasmine polished rice and unpolished rice) were weighed, washed, steamed for 30 min, dried in an oven at 70°C for 7 h and then powdered using a pin mill.

Preparation of experimental diets

Three kinds of rice (unpolished organic rice; jasmine conventional rice and unpolished conventional rice) and casein were prepared by the AOAC method (2000) for the experimental diets, which were composed of 10 ± 0.3% protein, 8% soy oil, 5% mineral mixture (Table 1), 1% vitamin mixture (Table 2), 1% cellulose, 5% water, 35% sucrose and 35% corn starch.

Table 1 Composition of salt mixture USP.

Mineral	g/kg
NaCl	139.3
KI	0.79
KH_2PO_4	389.0
Mg SO_4 anhydrous	57.3
$CaCO_3$	381.4
$FeSO_4 .7H_2O$	27.0
$MnSO_4 .H_2O$	4.01
$ZnSO_4 .7H_2O$	0.548
$CuSO_4 .7H_2O$	0.477
$COCl_2 .6H_2O$	0.023

Table 2 Composition of vitamin mixture.

Vitamin	mg/100 g
Vitamin A (dry, stabilized)	2000 (IU)
Vitamin D (dry, stabilized)	200 (IU)
Vitamin E (dry, stabilized)	10 (IU)
Menadione	0.5
Choline	200
p-Aminobenzoic acid	10
Inositol	10
Niacin	4
Ca D-pantothenate	4
Riboflavin	0.8
Thiamine. HCl	0.5
Pyridoxine. HCl	0.5
Folic acid	0.2
Biotin	0.04
Vitamin B_{12}	0.003
Glucose, to make	1000

Animals

Three-week-old weanlinged male Sprague-Dawley rats were used. These were divided into four groups, consisting of one control group and three test groups. The rats were obtained from the National Laboratory Animal Centre, Mahidol University, Thailand and had a mean initial weight of 50-60 g, with the mean body weight range within a group of not more than 10 g and between groups of not more than 5 g.

All rats were housed in individual, stainless steel, metabolic cages in an experimentally controlled environment at 20-22° C, 60% relative humidity and with a 12-hour, light-dark cycle. Rats were assigned randomly to four groups, with 10 rats per group. Rats were given free access to their diet and water throughout the 28-day feeding period. Daily food intake and weekly body weight were recorded. The experimental protocol was developed according to the guidelines of the Committee on Care and Use of Experimental Animal Resources, Institute of Food Research and Product Development, Kasetsart University, Bangkok, Thailand.

Sample collection

After 28 days, the experimental rats were anaesthetized with zoletil. Blood was drawn into a test tube using cardiac puncture and allowed to clot at room temperature for 30 min. The clotted blood was centrifuged at 3000 rpm for 10 min to obtain serum.

Experimental chemical laboratory

Raw and cooked organic and conventional rice were analyzed for proximate and total dietary fiber using the AOAC (2000) method. Serum samples were analyzed using enzymatic colorimetric procedures to determine the lipid profile, such as cholesterol (TC) (NCEP, 2001), triglyceride (TG) (Bucolo and David, 1973; Fossali and Prencipe, 1982), low density lipoprotein-cholesterol (LDL-C) (Nauck *et al.*, 2002) and high density lipoprotein-cholesterol (HDL-C).

Statistical analysis

Data were statistically analyzed using analysis of variance (ANOVA) and Duncan's new multiple range test. A value of $p < 0.05$ was considered significant.

Table 3 Composition of four experimental diets (10 kg).

	Cooked conventional rice	Cooked unpolished conventional rice	Cooked unpolished organic rice	Casein
	g	G	g	g
Rice	7002.80	6337.14	6693.44	
Casein	614.63	614.63	614.63	122.92
Cellulose	95.08	88.48	91.44	97.98
Vit. mixture	100.00	100.00	100.00	100.00
Min. mixture	495.70	488.65	489.42	495.14
Soy oil	728.00	771.58	771.02	798.77
Water	443.08	460.03	459.68	487.14
Corn starch	260.355	569.745	390.185	3949.025
Sugar	260.355	569.745	390.185	3949.025

Vit. = Vitamin
Min. = Mineral

RESULTS

Proximate analysis of conventional rice and organic rice

Raw conventional rice and organic rice were steamed and dried to produce cooked conventional rice and organic rice. Tables 4 and 5 show that protein, fat, ash and crude fiber content of cooked rice were higher than those of raw rice except for the fat content of cooked conventional rice, which was lower than in raw conventional rice, possibly due to the moisture content of the raw rice being higher than in the cooked rice (Tables 4 and 5). The rice samples were steamed and dried before use. The cooked powdered rice then was prepared into three experimental diets and one control (casein) diet using the AOAC (2000) method, which contained 10 ± 0.3% protein. The composition of the experimental diets is shown in Table 3.

The protein content of the experimental diets made from the cooked polished conventional rice, the unpolished conventional rice, the unpolished organic rice and casein was 9.05-9.45% wet weight or equal to 9.59-10.14% on a dry basis at 5% moisture (10 ± 0.3%). The total dietary fiber in experimental Diet 4 was the lowest at 1.89% (Table 6).

Table 4 Proximate analysis of raw conventional and organic rice.

Rice	Protein	Moisture	Fat	Ash	Crude Fiber
	g/100 g wet wt.				
Polished conventional rice	6.33	11.54	1.16	0.23	0.31
Unpolished conventional rice	7.08	11.13	3.20	1.11	1.11
Unpolished organic rice	6.79	11.97	3.37	1.00	1.09

Table 5 Proximate analysis of dried cooked conventional and organic rice powder.

Cooked rice	Protein	Moisture	Fat	Ash	Crude Fiber
	g/100 g wet wt.				
Polished conventional rice	7.14	7.22	1.02	0.27	0.56
Unpolished conventional rice	7.89	5.30	4.39	1.41	1.66
Unpolished organic rice	7.47	5.07	4.24	1.22	1.13

Table 6 Proximate analysis of the experimental diets containing cooked conventional rice and organic rice.

Experimental Diet	Protein	Moisture	Fat	Ash	Total Dietary Fiber
	g/100 g wet wt.				
Diet 1	9.42	7.17	7.87	4.49	5.32
Diet 2	9.44	6.56	9.22	4.94	4.17
Diet 3	9.45	6.38	9.94	5.08	4.20
Diet 4	9.05	5.71	5.71	4.16	1.89

Diet 1 = experimental diet from cooked polished conventional rice
Diet 2 = experimental diet from cooked unpolished conventional rice
Diet 3 = experimental diet from cooked unpolished organic rice
Diet 4 = control (casein) diet

The serum cholesterol and triglyceride levels of rats fed on the experimental diets containing polished conventional rice and organic rice were not significantly different (Table 7). The serum HDL-C level of rats fed with the experimental diet containing polished conventional rice (Diet 1) was the highest, whereas the serum LDL-C level was the lowest (Table 7).

DISCUSSION

Table 3 and 4 show that the protein, fat, ash and crude fiber contents of cooked rice were higher than for raw rice, except for the fat content of cooked conventional rice, which was lower than the fat content of raw conventional rice. In addition, the moisture content of the raw rice was higher than for the cooked rice because the cooked rice was dried in a hot air oven before use. The fat content of polished conventional rice was the lowest, which may have been due to the oxidation of fat in the polished conventional rice because one experimental diet in the full report of Mesomya *et al*. (2007) was rancid, so in the current study that experimental diet (Diet 3 = polished, organic rice in the full report) was excluded. The protein content of the experimental diets was 10 ± 0.3% because the minimum requirement for the rats in the current in the experiment was 10% protein. Total dietary fiber in the control diet was the lowest at 1.89% because this diet contained only casein, without any rice.

The serum cholesterol and triglyceride levels of rats fed with the experimental diets made from conventional rice and organic rice were not significantly different. This result showed that neither organic rice nor conventional rice affected the serum cholesterol and triglyceride level in rats. The serum HDL-C level in the fat of rats fed on Diet 1 made from conventional rice was the highest, with the serum LDL-C level in rats fed with Diet 1 being the lowest. This result may have been due to the fact that Diet 1 had the highest total dietary fiber. However, the HDL-C and LDL-C levels of organic rice and conventional rice in the same column were not significantly different (Table 7), which indicated that using either organic or conventional rice did not affect the level of serum lipids in rats. This could have been due to many reasons, with one possibility that the differences between the nutrient levels of components such as dietary fiber in organic rice and conventional rice are not enough to affect the level of serum lipids in rats. Previous findings with organic and conventional wheat also indicated that the nutritional value (protein content, serum lipid level) was not affected by the farming system (Mader *et al*., 2007).

Table 7 Mean ± standard deviation (SD) of serum cholesterol, triglyceride, HDL-C and LDL-C concentration of experimental rats fed with the four experimental diets.

Diet	Cholesterol	Triglyceride	HDL-C	LDL-C
	mg/dl			
1	117.75 ± 12.00[a]	99.50 ± 55.72[a]	81.88 ± 7.06[b]	21.50 ± 8.21[a]
2	111.25 ± 7.63[a]	110.00 ± 26.07[a]	59.75 ± 19.88[a]	35.63 ± 18.66[b]
3	110.25 ± 7.91[a]	114.88 ± 41.77[a]	70.25 ± 13.58[ab]	26.13 ± 8.79[ab]
4	113.50 ± 11.49[a]	112.00 ± 49.69[a]	59.38 ± 6.84[a]	31.75 ± 8.19[ab]

Values are means ± SD, N = 8.
Values in a column with different superscripts are significantly different at $P < 0.05$.
Diet 1 = experimental diet from cooked polished conventional rice
Diet 2 = experimental diet from cooked unpolished conventional rice
Diet 3 = experimental diet from cooked unpolished organic rice
Diet 4 = control (casein) diet

ACKNOWLEDGEMENTS

The authors would like to express their sincere thanks to the Kasetsart University Research and Development Institute (KURDI), Thailand for financial support for the research. The authors are grateful to Dr Laddawan Kunnoot, Director of the Bureau of Rice Products Development, Mr. Montri Gosalawat, Secretary-General of the Progressive Farmer Association and Mr. Ueychai Viravan for kindly helping to provide conventional rice and organic rice from Ubon Ratchathani province. The authors respectfully express their gratitude for the guidance, supervision, discussion and suggestions made throughout the research by the expert researcher, Ms. Pongsri Jittanoonta and also by Dr. Warunee Varanyanond, the Director of the Institute of Food Research and Product Development, Kasetsart University, Bangkok, Thailand.

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