Nutritional Quality of Sesame Seed Protein Fraction Extracted with Isopropanol

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The nutritional effect of diet containing decorticated sesame seed extracted with isopropanol (DSS-Iso) was evaluated on growth performance, food efficiency ratio, plasma and tissue lipid profile, plasma protein content, and erythrocyte membrane lipid profile of rats on a comparative basis with diets containing casein (control), soybean meal, and decorticated sesame seed extracted with hexane (DSS-Hex). Rats fed a DSS-Iso-based diet showed body weight gain and food efficiency ratio similar to those of the control groups fed diets prepared with casein, soybean meal, and DSS-Hex. However, dietary proteins exerted a separate effect on plasma lipid concentrations of the rats. Rats fed a DSS-Iso-based diet showed significant decreases in plasma total cholesterol ($p < 0.01$), triglyceride ($p < 0.01$), and VLDL+LDL cholesterol ($p < 0.01$) concentrations in comparison to the rats fed diet containing casein. No significant differences in plasma lipid concentrations were observed for the rats fed diets prepared with soybean meal, DSS-Hex, and DSS-Iso. Rats fed the different dietary proteins did not show much variation in plasma proteins, liver lipids, and erythrocyte membrane lipid concentrations, which suggests that DSS-Iso could be a suitable edible protein like casein or soybean meal.

Keywords: *Cholesterol; decorticated sesame meal; isopropanol*

INTRODUCTION

Oilseeds are second only to grain crops in the supply of plant proteins for human and animal consumption (*1*). Sesame seed (*Sesamum indicum*), an oilseed plant of the Pedaliaceae family, is cultivated on a worldwide basis for both oil and protein. The seed contains nearly 25% protein, and the defatted meal contains nearly 50% protein. In addition, the seed hull contains large quantities of undesirable oxalic acid (*2*). Hence, dehulling is necessary to reduce the content of oxalic acid. Sesame seeds provide an excellent source of the essential amino acids and are thus considered to be an excellent protein for complementing other plant proteins and providing essential amino acids (*2*).

Efforts are being made to devise efficient methods for the extraction and recovery of oil and protein from sesame seed. The food uses of sesame products are currently limited in the case of commercial flours because of the very dark brown color due to thermal processing (*2*). However, it has not been possible to develop a method for preparing protein fractions acceptable for human consumption. With the recognition of the value of the protein, milder methods could be developed for preparation of acceptable sesame products for human use.

Also, there are several publications claiming that animal protein is more atherogenic than vegetable protein. The atherogenic potential of casein over soybean protein is well established (*3*−*5*). Various researchers have reported that the amino acid ratio of a protein might play a role in determining the atherogenicity of a protein. Some have suggested that the lysine/arginine ratio of a protein determines its atherogenic potential (*6*, *7*). However, not much work has been done in determining the cholesterolemic potential of sesame seed protein. In this study, an attempt was made to extract oil and protein fraction from sesame seed with isopropanol and to determine the nutritional quality of a diet containing decorticated sesame seed extracted with isopropanol (DSS-Iso) on some physiological parameters of rats.

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MATERIALS AND METHODS

Materials. Sesame seeds (*S. indicum*), ∼6.0 kg, were obtained from Sreekalyan Nursery (Regd), a dealer in plant seed and manure (Baithak khana market, Calcutta, India) and were kept in an airtight desiccator containing $CaCl_2$ before use. Casein, cellulose, and starch were supplied by S. D. Fine Chem, Calcutta, India. Hubble, Mendel, and Wakeman salt mixture was composed of $CaCO_3$ (543 g), $MgCO_3$ (25 g), $MgSO_4$ (16 g), NaCl (69 g), KCl (112 g), KH_2PO_4 (212 g), $FePO_4{\cdot}4H_2O$ (20.5 g), KI (0.048 g), $MnSO_4$ (0.35 g), NaF (1.0 g), $Al_2(SO_4)_3{\cdot}K_2SO_4$ (0.17 g), and $CuSO_4$ (0.9 g). Multivitamin capsules from Pfizer India Ltd. were composed of vitamins A (10000 IU), B_1 (5 mg), B_2 (5 mg), B_6 (1.5 mg), and B_{12} (5 mg), niacinamide (50 mg), calcium pantothenate (5 mg), vitamin C (75 mg), cholecalciferol USP (15 IU), vitamin K (0.1 mg), folic acid (1 mg), and vitamin E USP (0.1 mg).

Extraction of Decorticated Sesame Seeds with Isopropanol (DSS-Iso). Sesame seeds were pulverized and sieved (20 mesh screen size). A weighed quantity of the crushed seed was extracted with isopropanol in a Soxhlet apparatus. Crude sesame oil was obtained by removing the solvent. DSS-Iso obtained after extraction was dried under vacuum (S-1, Simeco vacuum oven) at 50−55 °C and subsequently analyzed.

Chemical Analyses. Moisture content of decorticated sesame seed, decorticated sesame meal obtained upon extraction with hexane (DSS-Hex), and DSS-Iso was determined by

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heating dry solids in an oven at 110 °C for 1.5 h according to AOCS Method Bc 2-49 (*8*). Ash content was determined by a slow combustion of dry solids in a muffle furnace at 600 °C according to AOCS Method Bc 5-49 (*8*). Oil content was determined upon extraction of the sample using *n*-hexane in a Soxhlet apparatus according to AOCS Method Bc 3-49 (*8*). Fiber content was determined upon burning of the insoluble matter (obtained upon hydrolysis of the sample with HCl and then with NaOH) in a muffle furnace at 600 °C for 2 h according to AOCS Method Bc 6-49 (*8*). Protein content was estimated as 6.25 × nitrogen content determined using the Kjeldahl procedure (*9*). Carbohydrate was quantified by using the method of Debois et al. (*10*). Protein dispersibility index (PDI) was determined upon stirring of an aqueous slurry in a mechanical stirrer (Remi mechanical stirrer 1MLH) at 600 rpm for 2 h according to AOCS Method Ba 10-65 (*8*). Then 15 mL of the supernatant (obtained upon centrifugation of the aqueous slurry) was pipetted into a Kjeldahl flask, and the nitrogen content was determined by using the Kjeldahl procedure (*9*) and multiplied by 6.25. Nitrogen solubility index (NSI) was determined upon stirring of an aqueous slurry in a mechanical stirrer (Remi mechanical stirrer 1MLH) at 120 rpm for 2 h according to AOCS Method Ba 11-65 (*8*). Then 25 mL of the supernatant (obtained upon centrifugation of the aqueous slurry) was pipetted into a Kjeldahl flask and the nitrogen content was determined by using the Kjeldahl procedure (*9*). Amino acid contents were determined according to the method of Alaiz et al. (*11*). The samples were dissolved in 6.0 M HCl, and the solution was gassed with nitrogen and sealed in hydrolysis tubes under nitrogen and then incubated in an oven at 110 °C for 24 h. The protein hydrolysates were then derivatized with diethylethoxymethylenemalonate, and the amino acid compositions were determined in a Waters HPLC system.

Animals and Diets. The animal experiment was designed on the basis of earlier studies published from this laboratory (*12*). Male albino rats (Charles Foster) weighing an average of 60.0 ± 2.0 g were housed individually in stainless steel cages with mesh floors in a room maintained under constant temperature (20−25 °C) and a 10 h light/14 h dark cycle. The rats were then divided into four groups of eight rats per group. The rats were grouped randomly so that the average weights of the rats in each group were the same. Three groups were taken as control and one group was experimental. The groups were fed isonitrogenous diets. Proteins in the different diets were supplied either by casein (control), soybean meal (control), DSS-Hex (control), or DSS-Iso (experimental), which contributed 18% of the diet. Four percent of the diet was supplied by a salt mixture. Another 6% of the diet was supplied by cellulose. Carbohydrate contributed 52% of the diet, and 20% of the diet was supplied by oil. A vitamin capsule (1 g/kg) was also included in the diet. For the next 28 days of the study, fresh food and water were provided ad libitum. Food intake was measured daily, and growth of the animals was monitored once a week. The food efficiency ratio (FER) for each rat was calculated by the following equation:

$$\text{FER} = \text{body weight gain/food consumed}$$

At the end of the 28 day experimental period, 14 h fasted rats were subjected to anesthesia using chloroform. The abdomen was opened, and blood samples were collected from the hepatic vein in the presence of heparin and centrifuged at low speed (3000*g*) to isolate the plasma. The plasma cells were collected for erythrocyte membrane isolation and characterization. The liver and brain were also removed, cleaned by washing with saline (0.9%), and mopped dry with tissue paper. The weights of the tissues were noted, and samples were stored at −30 °C until subsequent extraction of tissue lipids.

Lipid Analyses. The total lipids were extracted from the liver with a chloroform/methanol mixture and estimated gravimetrically (*13*). According to the standard enzymatic methods, the lipid components such as total cholesterol (*14*), high-density lipoprotein (HDL) cholesterol (*15*), low-density lipoprotein (LDL) cholesterol plus very low-density lipoprotein (VLDL) cholesterol (*16*), and triglycerides (*17*) of the plasma were determined. Using the same methodologies, total cholesterol, triglyceride, and phospholipids (*18*) of the liver were determined. Using the standard method, total protein (*19*) and albumin (*20*) of plasma were determined. Globulin content was obtained by difference.

Table 1. Chemical Composition (Grams per Kilogram) and Solubility of Decorticated Sesame Seed, DSS-Hex, DSS-Iso, and Soybean Meal

	sesame seed (decorticated)	DSS-Hex	DSS-Iso	soybean meal
moisture	46	100	73	45
ash	33	74	79	45
fiber	72	158	160	45
oil	555	17	20	20
protein	230	505	515	680
carbohydrate	64	146	153	165
PDI (%)	25.0	20.0	22.0	
NSI (%)	14.0	10.0	11.0	

Extraction of Erythrocyte (RBC) Membrane. After plasma separation, erythrocytes were washed three times with 3 volumes (30 mL each) of a cooled isotonic solution containing 0.15 M NaCl and 10^{-5} M EDTA. At the end of each washing, the solution was centrifuged in a cold centrifuge (Remi cold centrifuge) at 120000 rpm. The buffy coat was removed by aspiration after washing, and the pellet at the bottom was again washed with another volume of the cooled isotonic solution. This was repeated three times. Finally, RBC membranes were isolated.

Extraction of RBC Membrane Lipids. RBC membrane lipids were extracted according to the method described by Rose and Oklander (*21*). Cholesterol and phospholipids were determined by the methods adopted for liver and brain lipids. For the determination of phospholipid class composition (i.e., phosphatidylcholine and phosphatidylethanolamine), the phospholipids in the extract of erythrocyte membrane were separated by TLC on silica gel G plates, using chloroform/methanol/water (75:23:1, v/v/v) as a developing solvent (*22*). Each band of phospholipid class was visualized with iodine vapor against its standards, scraped off the plates, and analyzed directly for inorganic phosphorus (*18*). The contents of phosphatidylcholine and phosphatidylethanolamine were then calculated from the phosphorus value.

Statistical Analyses. Statistical differences were calculated using a one-way analysis of variance (ANOVA). In Table 3, analysis was carried out by keeping in mind the fact that repeated measurements were taken on each of 32 animals, four times over four different weeks. This leads to a two-way ANOVA problem with eight observations per cell, each cell corresponding to a week and a food type. Duncan's multiple-range test was used at the 1% level of probability to separate the means.

RESULTS AND DISCUSSION

Chemical Composition. The chemical composition and solubility of decorticated sesame seed, DSS-Hex, and DSS-Iso are given in Table 1. The results showed that DSS-Iso had an enriched protein content of 515 g/kg in comparison to the decorticated sesame seed and was almost similar to that of the protein content (505 g/kg) of DSS-Hex. The solubility values in terms of PDI and NSI in the case of DSS-Iso and DSS-Hex were similar to those of the decorticated sesame seed. Soybean meal had a protein content of 680 g/kg, an ash content of 45 g/kg, a fiber content of 45 g/kg, and a carbohydrate content of 165 g/kg.

Amino Acid Composition. The amino acid compositions of casein, soybean meal, DSS-Hex, and DSS-Iso are given in Table 2. The essential amino acid compositions of casein, DSS-Hex, and DSS-Iso are similar except for lysine, arginine, and methionine contents. The lysine

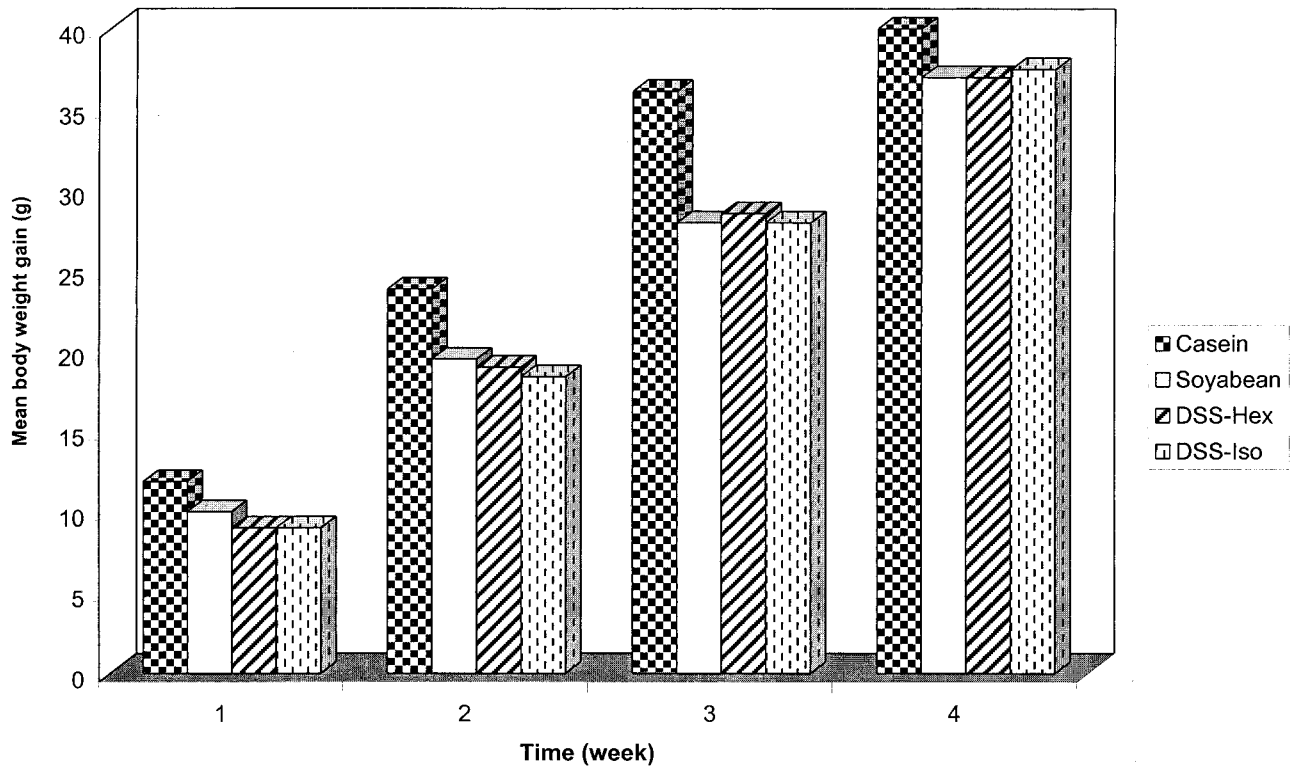

Figure 1. Mean body weight gain of rats fed casein, soybean meal, DSS-Hex, and DSS-Iso at the end of different weeks.

Table 2. Amino Acid Composition (Grams of AA/16 g of N) and Lysine/Arginine Ratio of Casein, Soybean Meal, DSS-Hex, and DSS-Iso and FAO Standard Recommendations

AA	casein	soybean meal	DSS-Hex	DSS-Iso	FAO[a]
Ile	4.7	4.8	3.4	3.3	2.8
Leu	9.5	7.6	7.6	7.2	6.6
Lys	7.8	6.1	2.2	2.1	5.8
Met	2.5	1.5	3.3	3.1	2.5[b]
Phe + Tyr	10.2	8.3	9.5	9.3	6.3[c]
Thr	4.4	4.0	3.5	3.8	3.4
Trp	1.4	1.0	1.0	1.1	1.1
Val	6.4	4.4	5.1	5.0	3.5
Asp[d]		11.9	7.7	7.5	
Glu[e]		20.6	19.8	19.3	
Ser		5.2	6.4	6.2	
Arg	3.8	6.9	9.7	10.0	
Ala		6.5	2.3	2.5	
His		2.7	2.3	2.3	
Gly		6.4	8.9	8.8	
Cys	0.8				
Lys/Arg	2.0	0.9	0.2	0.2	

[a] Reference *23*. [b] Phenylalanine and tyrosine [c] Cystine and methionine. [d] Aspartic acid and asparagine. [e] Glutamic acid and glutamine.

contents in DSS-Hex and DSS-Iso were lower than that in casein as well as the FAO recommended value. On the contrary, methionine and arginine contents in DSS-Hex and DSS-Iso were higher than that in casein. The amino acid composition of soybean meal and DSS-Iso showed higher methionine content in DSS-Iso than in soybean meal. The lysine content was lower in DSS-Iso than in soybean meal. The arginine content of soybean meal was slightly higher than that of DSS-Iso. The other amino acids are in accordance with the FAO recommended values (*23*). DSS-Hex and DSS-Iso showed similar amino acid compositions.

Growth and FER. Figures 1 and 2 represent growth patterns and FER values of the rats fed diets prepared with casein, soybean meal, DSS-Hex, and DSS-Iso. No significant differences in body weight gain were observed among the groups fed the different dietary proteins. Also, the FER values of the rats fed diets prepared with casein, soybean meal, DSS-Hex, and DSS-Iso were similar.

Table 3. Food Intake (Grams per Rat) and Actual Protein (Grams per Rat) and Energy Intakes (Kilocalories) per Week (on a Cumulative Basis) of Rats Fed Casein, Soybean Meal, DSS-Hex, and DSS-Iso[a]

week	casein	soybean meal	DSS-Hex	DSS-Iso
		Food Intake		
I	59.7 ± 5.3	65.5 ± 5.3	58.9 ± 6.3	60.0 ± 7.5
II	121.0 ± 3.3	130.0 ± 4.0	127.4 ± 5.8	125.3 ± 7.0
III	186.0 ± 5.9	189.0 ± 6.3	192.0 ± 11.2	192.0 ± 10.1
IV	236.4 ± 7.9	250.0 ± 8.3	253.1 ± 13.3	258.0 ± 11.3
F	1.5 ns	1.2 ns	1.7 ns	1.6 ns
		Protein Intake		
I	10.75 ± 0.95	11.79 ± 0.95	10.59 ± 1.14	10.80 ± 1.34
II	21.78 ± 0.60	23.40 ± 0.72	22.92 ± 1.04	22.55 ± 1.25
III	33.48 ± 1.07	34.02 ± 1.14	34.56 ± 2.02	34.56 ± 1.82
IV	42.50 ± 1.42	45.0 ± 1.50	45.57 ± 2.39	46.44 ± 2.03
F	1.5 ns	1.0 ns	1.9 ns	1.6 ns
		Energy Intake		
I	270	297	267	273
II	550	592	581	569
III	846	861	873	873
IV	1074	1142	1150	1176
F	0.9 ns	1.0 ns	0.8 ns	0.7 ns

[a] Values are mean ± SEM, $n = 8$. ns, not significant at $p < 0.05$ and $p < 0.01$.

Feed, Actual Protein, and Energy Intakes. Food intakes of the rats fed casein-, soybean meal-, DSS-Hex-, and DSS-Iso-based diets are given in Table 3. No significant differences in food intake were observed

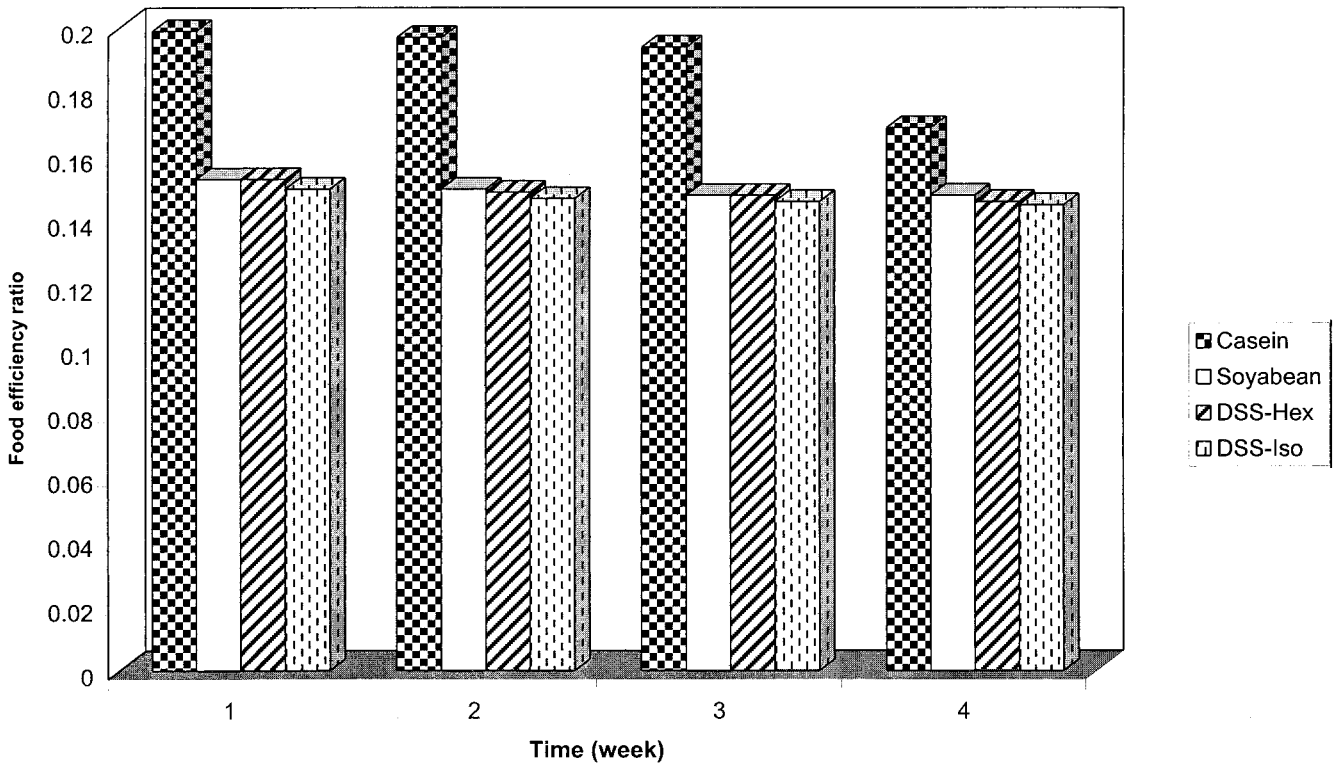

Figure 2. FER values of rats fed casein, soybean meal, DSS-Hex, and DSS-Iso at the end of different weeks.

Table 4. Lipid Concentrations of Plasma of Rats Fed Casein, Soybean Meal, DSS-Hex, and DSS-Iso[a]

protein source	total cholesterol (mg/dL)	triglyceride (mg/dL)	HDL cholesterol (mg/dL)	LDL+VLDL cholesterol (mg/dL)	total cholesterol/HDL cholesterol
casein	44.6 ± 5.2	55.6 ± 4.9	10.1 ± 3.0	34.5 ± 3.6	4.4 ± 1.0
soybean meal	31.5 ± 4.9	36.8 ± 4.9	9.5 ± 3.0	22.0 ± 2.5	3.3 ± 1.1
DSS-Hex	33.8 ± 3.9	38.6 ± 4.4	10.3 ± 3.8	23.5 ± 2.0	3.2 ± 1.0
DSS-Iso	32.0 ± 4.4	35.6 ± 4.9	9.5 ± 3.0	22.5 ± 2.1	3.4 ± 0.9
F	74[a]	69[b]	0.06 ns	42.8[c]	4.8 ns

[a] Values are mean ± SEM, $n = 8$. Different superscript letters represent significant ratios at $p < 0.01$. ns, not significant at $p < 0.05$ and $p < 0.01$. Duncan's multiple-range test was used at 1% level of probability to determine the significance of difference between food types. Significant difference was observed betweeen the groups fed casein and DSS-Iso ($p < 0.01$).

among the different dietary groups at the end of the fourth week. Not much variation in protein and energy intake (Table 3) was observed among the different dietary groups of rats.

Lipid Analyses. Mean plasma total cholesterol, triglyceride, HDL cholesterol, LDL cholesterol plus VLDL cholesterol, and total cholesterol/HDL cholesterol ratio of the rats fed casein-, soybean meal-, DSS-Hex-, and DSS-Iso-based diets and the *F* values found by analysis of variance are listed in Table 4. Plasma cholesterol concentration was significantly lower ($p < 0.01$) between rats fed diet prepared with DSS-Iso and those fed diet containing casein. Furthermore, Duncan's multiple-range test was used at the 1% level of probability to determine the significance of difference among food types. Significant difference was observed between the groups fed casein and DSS-Iso. Significant differences were observed in triglyceride ($p < 0.01$) and LDL+VLDL cholesterol ($p < 0.01$) concentrations of the rats fed DSS-Iso-based diet in comparison to the rats fed diet containing casein. HDL cholesterol and total cholesterol/HDL cholesterol ratio between the two groups did not show any significant difference. Plasma lipid concentrations of the rats fed diets prepared with soybean meal, DSS-Hex, and DSS-Iso were comparable and did not show any difference.

Table 5. Protein Concentrations (Grams per Deciliter) of Plasma of Rats Fed Casein, Soybean Meal, DSS-Hex, and DSS-Iso[a]

protein	total protein	albumin	globulin + fibrinogen
casein	6.7 ± 0.3	4.8 ± 0.3	1.9 ± 0.4
soybean meal	6.5 ± 0.4	4.5 ± 0.5	2.0 ± 0.5
DSS-Hex	6.5 ± 0.4	4.6 ± 0.6	1.9 ± 0.4
DSS-Iso	6.9 ± 0.2	4.4 ± 0.6	2.5 ± 0.8
F	2.28 ns	2.35 ns	1.22 ns

[a] Values are mean ± SEM, $n = 8$. ns, not significant at $p < 0.05$ and $p < 0.01$.

Protein Analyses. The plasma protein concentrations of the rats fed diets prepared with casein, soybean meal, DSS-Hex, and DSS-Iso (Table 5) did not show any significant difference.

Liver, Brain, and RBC Membrane Lipid Analyses. No significant differences in liver and brain lipid concentrations (Table 6) were observed among the different dietary groups. Also, RBC membrane total protein and lipid concentrations (Table 7) among the different groups were similar.

The present study demonstrates that sesame seeds extracted with isopropanol not only provide oil but also gave a fraction rich in protein, with a well-balanced

Table 6. Lipid Concentrations (Milligrams per Gram of tissue) of the Liver and Brain of Rats Fed Casein, Soybean Meal, DSS-Hex, and DSS-Iso[a]

	liver			brain	
	total cholesterol	triglyceride	phospholipid	total cholesterol	phospholipid
casein	3.2 ± 0.7	1.5 ± 0.5	15.3 ± 2.0	1.6 ± 0.3	8.9 ± 0.7
soybean meal	2.9 ± 0.5	1.3 ± 0.2	16.1 ± 2.1	1.6 ± 0.4	9.1 ± 0.9
DSS-Hex	3.0 ± 0.2	1.6 ± 0.4	16.2 ± 2.1	1.6 ± 0.4	9.1 ± 0.5
DSS-Iso	2.7 ± 0.3	1.6 ± 0.3	16.5 ± 2.6	1.5 ± 0.3	9.2 ± 0.6
F	2.3 ns	1.36 ns	0.5 ns	0.23 ns	0.48 ns

[a] Values are mean ± SEM, $n = 8$. ns, not significant at $p < 0.05$ and $p < 0.01$.

Table 7. Protein (Milligrams per Milliliter) and Lipid Concentrations (Milligrams per Milligram of Protein) of RBC Membrane of Rats Fed Casein, Soybean Meal, DSS-Hex, and DSS-Iso[a]

	protein	total cholesterol	phospho-lipid	PC/PE
casein	4.9 ± 0.5	0.2 ± 0.02	0.4 ± 0.03	0.5 ± 0.1
soybean meal	4.6 ± 0.5	0.2 ± 0.04	0.4 ± 0.02	0.6 ± 0.2
SEM	4.5 ± 0.2	0.2 ± 0.04	0.4 ± 0.03	0.8 ± 0.2
SEPF	4.8 ± 0.5	0.2 ± 0.04	0.4 ± 0.03	0.7 ± 0.2
F	0.15 ns	1.0 ns	1.0 ns	0.05 ns

[a] Values are mean ± SEM, $n = 8$. ns, not significant at $p < 0.05$ and $p < 0.01$.

amino acid composition. Nutrition data indicated that consumption of a DSS-Iso-based diet influenced the plasma cholesterol level in rats. This study showed significant reductions in plasma total cholesterol, triglyceride, and lipoprotein cholesterol concentrations in rats fed diet containing DSS-Iso in comparison to rats fed diet prepared with casein. Rats fed the DSS-Iso-based diet had significantly lower total cholesterol concentration than those fed the casein-based diet. This reduction in cholesterol was largely due to a significant reduction in LDL+VLDL cholesterol concentration. LDL+VLDL cholesterol was significantly lower in rats fed the DSS-Iso-based diet than in rats fed the casein-based diet, which can be considered to be an added advantage as high concentrations of LDL+VLDL cholesterol in blood pose a risk to human health, including the risk of coronary heart disease. HDL cholesterol concentrations between the two groups showed no marked variations. Plasma triglyceride concentrations were lower in rats fed the diet containing DSS-Iso than in those fed the diet containing casein. The nutrition data of the rats fed the diet containing DSS-Iso did not show any variation in the plasma lipid concentrations in comparison to the rats fed diets prepared with soybean meal and DSS-Hex.

A steady increase in weight gain was observed in the case of rats fed the DSS-Iso-based diet. No significant differences in body weight gain were observed for the rats fed diets prepared with soybean meal, DSS-Hex, and DSS-Iso. The FER values of the rats fed diets containing casein, soybean meal, DSS-Hex, and DSS-Iso did not show any significant difference. Variation of dietary proteins, however, did not have any effect on the plasma protein concentrations. Lipid concentrations of liver among the dietary groups were more or less similar. Also, RBC membrane protein and lipid concentrations of the different dietary groups were similar.

One possible source of the differences in plasma lipid concentrations upon variation of the dietary protein source might be in the amino acid ratio of the dietary proteins. Kritchevsky (*6*) proposed that the cholesterolemic potential of a dietary protein is determined by its lysine-to-arginine ratio. The ratio is more than twice as high in casein than in soybean protein. Kritchevsky hypothesized that a high ratio of lysine/arginine, which is 2 in the case of casein, increases the atherogenicity of that diet, whereas in the case of soybean protein (the ratio of which is 0.9) only addition of lysine to a soybean protein diet to raise the lysine/arginine ratio to 2 increases the atherogenicity of that diet. The lysine/arginine ratio has been suggested to influence cholesterol metabolism by affecting the synthesis of the apoprotein, which is a constituent of the lipoprotein which causes atherogenecity in the animals. Lysine inhibits liver arginase activity, and it was hypothesized that in the animals fed casein, due to its higher lysine content than soybean, more arginine might be available to be incorporated into the arginine-rich apoprotein, a constituent of the lipoprotein that is atherogenic for the animals (*6*). Rajamohan and Kurup (*7*) studied the effect of the globulin fraction with a lysine/arginine ratio of 0.67, isolated from sesame seeds, on cholesterol metabolism in rats fed cholesterol-free and cholesterol-containing diets compared with casein (lysine/arginine ratio is 2) and observed that rats fed sesame seed globulin showed significantly lower concentrations of cholesterol in the serum. Their studies also suggested that a low lysine/arginine ratio of a protein exerts a hypocholesterolemic effect. In this study, the lysine/arginine ratio of the DSS-Iso was 0.2, which was even lower than that of soybean, and thus, on the basis of the assumption of Kritchevsky and others, it could be presumed that the lysine/arginine ratio of a protein plays a role in controlling the plasma lipid concentrations in animals. The plasma lipid concentrations between the groups fed diets containing DSS-Iso and DSS-Hex did not vary. The possible explanation is that the lysine/arginine ratios of DSS-Iso and DSS-Hex were almost similar. Although the lysine/arginine ratio of soybean meal (0.9) was higher that that of DSS-Iso (0.2), there was no difference in plasma lipid concentrations between the groups fed soybean meal- and DSS-Iso-based diets. To expand upon the hypothesis of Kritchevsky (*6*), a high ratio of lysine/arginine (∼2) causes significant difference only in plasma lipid concentrations, which could be the possible explanation for the lack of any significant variation in plasma lipid profile in rats fed diets prepared with soybean meal and DSS-Iso as the lysine/agrinine ratio in both is <1. Also, it might be suggested that individual amino acids such as lysine or arginine play a role in determining the cholesterolemic effect; the lysine content of sesame seed is 2.1, which is low in comparison to that of casein (7.8), and the arginine content in sesame seed is 10, which is high in comparison to that of casein (3.8). The exact molecular mechanism behind this assumption needs to be established.

This study thus provides evidence for the hypocholesterolemic effect of a sesame protein fraction (DSS-Iso) in rats and also finds DSS-Iso to be a suitable edible protein similar to casein or soybean meal.

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