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EFFECT OF DIETARY PROTEIN SOURCE ON LIPID METABOLISM IN CHICKS

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The effect of dietary protein source (soybean, egg-yolk, whole egg and casien) on the lipid profile of plasma and liver and excretion of fecal sterols in female Fayumi chicks was studied. Soy-protein had a general hypo effect on blood and liver lipids and significantly increased fecal sterol excretion. Egg-yolk and whole-egg proteins were found generally associated with high blood and liver lipids and low fecal sterols. The mechanism of lipid lowering effect of plant proteins is discussed.

Key words: Cholesterol, triglycerides, phospholipids.

INTRODUCTION

Diet is considered to play major role in hyperlipemia and atherosclerosis. The role of nutritional factors such as the type and concentration of dietary fat [1-4], the type of carbohydrate, and dietary fibre [5-9] in changing plasma lipid concentrations has been widely emphasized. However, there have been indications that atherosclerosis might be influenced by the kind of protein in diet [10]. Furthermore, epide-mological data derived from human populations indicate that positive correlation between animal protein in the diet and mortality from coronary heart disease is as strong as that between dietary fat and heart disease [1,11,12]. Vegetarians are reported to have lower plasma lipids [13-15] and dietary trials [10, 15] provide evidence that level of plasma cholesterol can be reduced in humans by substituting plant protein for animal protein in the diet. The present investigations, therefore, were effected to study the effect of different protein sources (plant and animal origin) on serum and liver lipids and excretion of sterols in female Fayumi chicks.

MATERIALS AND METHODS

The experiment was conducted with female Fayumi chicks in the animal house of Department of Agricultural Chemistry and Human Nutrition, NWFP Agricultural University, Peshawar. Day old chicks were obtained from Veternary Research Institute Poultry Farm, Peshawar, and were fed for one month a commercial poultry diet purchased from Messrs ANI-Feeds Co., Peshawar. The birds were then divided into four groups, each consisting of four chicks and transferred to separate cages. Defatted soybean flour and defatted powders of boiled whole-egg and egg-yolk were used as protein source in the test diets, whereas casein was fed to the control group of birds. Protein and fat levels in the diets were 20 % and 15 % respectively. All the birds were fed a hypercholesterolemia inducing diet containing 0.5 % cholesterol [17] (Table 1). Water and feed were fed adli-bitum throughout the feeding trial.

Table 1. Percent composition of 20 % protein diets.

	Casein group (control)	Soybean group	Egg-yolk group	Whole-egg group
Protein source	21.70	45.50	21.14	25.10
Fat (Hydrogenated oil)	15.00	15.00	15.00	15.00
Mineral mixture*	4.00	4.00	4.00	4.00
Vitamin mixture*	1.00	1.00	1.00	1.00
Cholesterol	0.50	0.50	0.50	0.50
Choline chloride	0.50	0.50	0.50	0.50
Starch	57.30	33.50	57.86	53.90
Total	100.00	100.00	100.00	100.00

*The composition of vitamin and mineral mixture was according to Peterson *et al* [16].

At the end of one month feeding period the chicks were starved overnight, blood was drawn through cardiac puncture and the sera separated by the method of Oser [18]. The chicks were then slaughtered and the livers removed. Liver lipids were extracted by the method of Folch *et al.* [19]. Cholesterol, triglycerides and phospholipids in the sera and liver extract were determined by the methods of Kim and Goldberg [20], Carlson and Wadstrom [21] and Fiske and Subbarow as described by Var-

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ley [22], respectively. Fecal matter of the last 48 hr was collected, air dried and ground. It was then extracted with a 1:1 chloroform: methanol mixture and sterols in the extract were determined by the method of Kim and Goldberg [20]. The results were statistically analysed using T-test for paired data.

RESULTS AND DISCUSSION

Results on the effect of different protein sources on the serum and liver lipid levels and fecal sterol excretion of female chicks fed on hypercholesterolemia-inducing diet are given in Table 2. Soybean fed birds had lower serum and liver lipids compared to casein fed (control) birds. However the effect was statistically insignificant except in liver phospholipids in which case it was highly significant ($P < .01$). Egg-yolk as well as the whole egg has opposite effect on all body lipids as the birds fed on these protein sources had higher lipid contents than casein fed birds. However, the increase by egg-yolk and whole egg feeding was insignificant on serum phospholipids. Feeding of soybean significantly ($P < .01$) increased sterols excretion over that of casein fed birds. Feeding of egg yolk and whole egg had no significant effect and the sterols excretion was comparable with that of control birds fed casein as protein source.

Other investigators have reported substantial reduction in plasma cholesterol associated with soybean protein feeding in chicks [23], rats [24] and pigs [25]. The hypocholesterolemic effect of soybean protein feeding has also been demonstrated in rabbits fed on diets low in fat and devoid of cholesterol, but lactalbumin and egg white were associated with increased plasma cholesterol [10,26]. An enzymatic digest of soy-protein gave a low level of plasma cholesterol similar to that obtained with the intact protein in rabbits, and soy-protein isolates could partially counteract the hypercholesterolemic effect of casein [27]. Our results also agree with those of Hevia and Visek [28] on chicks who reported that soybean protein feeding depressed plasma cholesterol compared to lactalbumin and egg white solids.

A number of dietary trials on human beings indicated cholesterol lowering effect of vegetable proteins [29-35]. Some workers, however, suggested that this effect might have been due to variations in dietary constituents other than protein [35-37]. Nevertheless, Carroll [38] and Sirtori *et al* [29] clearly demonstrated decrease in plasma cholesterol in healthy and hypercholesterolemic human beings respectively with soyprotein diets in comparison to diet containing animal protein.

The mechanism by which dietary protein affect the plasma and tissue lipid levels is yet not fully understood. The observed decrease in lipids with plant proteins could arise from decreased synthesis and absorption of lipids, and/or increased secretion of steroids. Feeding of soy-protein to chicks in the present study, feeding of whole grain and their lipid extracts [17], and administration of unsaturated lipids to rats [40, 41] increased fecal excretion of sterols and bile acids. Therefore, an increased excretion of cholesterol/bile acids in feces might be one of

Table 2. Effect of feeding of soybean,whole-egg and egg-yolk proteins on serum and hepatic lipids and fecal sterols in female Fayumi chicks.

	Serum mg/100 ml			Liver mg/100 g			
	Cholesterol	Triglycerides	Phospholipids	Cholesterol	Triglycerides	Phospholipids	Fecal sterols mg/chick/ 48 hr.
Control	158.41 ± 26.41	151.87 ± 21.43	224.50 ± 0.89	208.00 ± 58	268.00 ± 83	425.00 ± 81.00	100.00 ± 9.80
Soybean	135.82 ± 11.63	146.50 ± 11.07	174.50 ± 0.50	206.00 ± 0.93	247.00 ± 22.00	257.00 ± 14.24	314.00 ± 16.50
	14.26 D	3.35 D	22.27 D	0.96 D	7.80 D	39.52 D	214 I
	(N S)	(N S)	(N S)	(N S)	(N S)	(P < 0.01)	(P < 0.01)
Egg-yolk	415.74 ± 61.12	273.75 ± 33.80	245.75 ± 0.88	526.00 ± 12.00	520.00 ± 19.00	1260.00 ± 5.2	117.0 ± 5.6
	162.44 I	80.25 I	9.46 I	152 I	94.02 D	194.47 I	17 I
	(P < 0.05)	(P < 0.05)	(N S)	(P < 0.01)	(P < 0.01)	(P < 0.01)	(N S)
Whole egg	383.33 ± 52.2	215.62 ± 19.62	166.66 ± 5.9	500 ± 19.00	494.00 ± 19	1250.00 ± 11.72	99.00 ± 8.8
	141.98 I	41.97 I	25.75 D	140 I	84.32 I	194.11 I	1.00 D
	(P < 0.05)	(P < 0.05)	(N S)	(P < 0.01)	(P < 0.01)	(P < 0.01)	(N S)

All values are average of four independent determinations from four chicks (Mean ± Standard Deviation).
D = % Decrease over control, 1 = % Increase over control, NS = Nonsignificant.

the possible mechanisms of lipid lowering action of plant foods. Oxidation and turnover rate of cholesterol were slower in rabbits on casein diet than those on either chow diet [8] or diet with soyprotein isolate [42]. This might be one of the reasons for the hypocholesterolemic response to plant proteins diets. Coenzyme A (CoA) which has a functional sulphydral (-SH) group, plays an important role in acetylation [43], and in the synthesis of cholesterol [44]. Reports of Bagchi *et al.* [45] indicate that serum cholesterol level in rats correlate closely with sulphydral content of liver. It can be, therefore, presumed that the biosynthesis of cholesterol can be inhibited in animals fed plant protein diets.

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