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Consumption of Soy Improves Blood Lipid and Calcium Profile of Post-menopausal Women

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ABSTRACT This was a purposive randomized intervention trial carried out to examine the effect of soy protein isolate and calcium supplementation on blood profiles of post-menopausal women. A total of 100 post-menopausal women were selected and randomly divided in to two groups. Group I was given intervention of 40 gm soy protein isolate and Group II was given 500mg of calcium per day for 100 days. Results of soy protein intervention showed a significant decrease in total cholesterol (15.65%), triglyceride (13.33%), low density lipoprotein (19.90%), and very low density lipoprotein (13.09%). There was a significant decline in the high density lipoprotein level too (5.40%). A significant improvement was also observed in blood calcium (9.90%) and alkaline phosphatase level (11.50%). Calcium supplementation showed significant improvement in blood calcium (12.20%) and alkaline phosphatase (8.37%) level. The study reveals that soy protein isolate and calcium supplementation is beneficial for improving lipid profiles and bone health of post-menopausal women.

INTRODUCTION

Plant derived substances, particularly soy foods and their isoflavones have received much attention as potential beneficial factors in the diet in Asian countries. Asian populations are known to have a lower incidence of cancers, cardiovascular morbidity and mortality and other chronic diseases, which epidemiologists hypothesize, may be attributable to their average daily intake of one serving of soy (equal to approximately 40 mg of isoflavones) (Frankhanel 1999; Radhakrishnan et al. 2009; Liu et al. 2010). Soy isoflavones which are structurally similar to steroidal estrogen have the ability to mimic endogenous estrogen (Burk et al. 2003; Alekel et al. 2010; Li et al. 2010). Genistein, daidzein and glycitein are the major isoflavones in soy and consumption of this class of phytoestrogens has documented health benefits, including reduction of hypercholesterolemia, maintenance of prostrate health, and possibly increased bone density and reduction of the risk of hormone-dependent cancers (Adlercreutz et al.1995; Messina and Erdman 1998; Albertazzi et al.1999; Alekel et al. 2010; Liu et al. 2010).

Studies have shown that intake of natural soy foods, isolated soy protein, and isoflavones are associated with lower risks of a range of chronic diseases. Research findings indicate the dual effect of soy phytoestrogens - the antiestrogenic effect lowers breast cancer risk while the estrogenic effects benefit the cardiovascular, bone and vasomotor systems in peri and post-menopausal women (Cassidy et al. 1995; Potter 1995; Nagata 2000; Persky et al. 2002; Gallagher 2004).

The risks of cardiovascular diseases increase with decline in estrogen production after menopause in women. Dietary intake of compounds with estrogenic properties reduces the incidence of cardiovascular events (Nagata 2000; Cassidy et al. 2006; He et al. 2006). Favourable effects of soy protein on lipid profiles have been studied by various researchers (Potter et al. 1998; Washburn et al. 1999; Dalais et al. 2003; Ye et al. 2006). As regards to bone health, some studies have shown favourable effects of soy protein, while others have reported minimal or no effects (Potter et al. 1998; Ye et al. 2006; Allen et al. 2007). Not many studies have been carried out on Indian post-menopausal women to assess the effect of soy protein isolate supplementation on blood lipid and calcium profile.

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Objective

To assess the effect of soy protein isolate and calcium supplementation on lipid profile, calcium and alkaline phosphatase level in post-menopausal women.

METHODS

Locale, Subjects and Sample Size

Locale was selected on the basis of convenience in terms of easy access for dietary intervention as well as for monitoring the interventions. A total of 100 post-menopausal subjects from North West Delhi were selected on the basis of the inclusion criteria and the willingness to cooperate. Inclusion criteria were (i) menstrual cycle had ceased for at least one year prior to the time of study (ii) on regular diet (iii) not taking any cholesterol lowering drug (iv) not on any type of supplementation (v) not on ERT and (vi) not suffering from any metabolic disorders. Of the 100 post-menopausal women selected, only 72 subjects were finally screened for continuation of dietary interventions due to various unavoidable reasons. These 72 subjects were randomly divided into two groups (36 each). Some of the subjects withdrew themselves in the middle of the intervention because of reasons like i) Dislike for taste of soy isolate ii) Irregularity in taking soy isolate. iii) Migration to other place without giving any information. Thus, finally 30 subjects in Group I (Soy supplementation) and 29 subjects in Group II (calcium supplementation) could be covered for the purpose of determining the effect of dietary interventions.

Study Design

The study was a purposive randomized intervention trial conducted in three phases:

In Phase I (Pre- intervention), data was collected from all the subjects on sociodemographic profile (age, marital status, type of family, educational qualification and occupation) through questionnaire cum interview schedule. The blood samples of the post-menopausal subjects were analyzed for lipid profiles - Total Cholesterol (TC), Triglycerides (TG), Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), Very Low Density Lipoprotein (VLDL), and calcium and alkaline phosphatase levels. These parameters were analyzed using standard techniques.

Phase II (Intervention): Dietary interventions of soy protein isolate and calcium were given to the post-menopausal subjects. Subjects in Group I were given 40 gm of soy protein isolate (containing approximately 35g of soy protein) per day for 100 days and those in Group II were given 500 mg of elemental calcium per day for 100 days. The soy protein isolate (Supro 670) was partially donated by Solae LLC.

Phase III (Post- intervention): After completion of 100 days of interventions, blood samples of subjects were again analyzed for lipid profiles (Total Cholesterol, Triglycerides, Low Density Lipoprotein, High Density Lipoprotein, and Very Low Density Lipoprotein) as well as for calcium and alkaline phosphatase levels. The data for lipid profiles and calcium and alkaline phosphatase level of the post-menopausal women in Phase I (before intervention) and Phase III (after intervention) were used to assess the effect of interventions.

RESULTS

Sociodemographic data showed that the average age of the subjects was 50.2±4.42 years and the mean age of menopause was 46.71±3.74 years, ranging from 38 to 54yrs. Majority of the subjects were married and living in a nuclear family set up. A fairly large number were educated, being graduates and postgraduates. While 42.7% were housewives, others were employed in government or private jobs (Table 1).

Soy Protein Isolate and Calcium Supplementation

A comparison of the blood lipid profile of the subjects before and after the soy isolate intervention is shown in Table 2. The mean blood Total Cholesterol (TC) showed a decrease from 222.73±30.02 mg% to 187.86±23.78mg%. Thus, the percentage decrease was 15.65%, which was found to be significant as tested by paired t test ($p<0.001$). In case of triglyceride and Low Density Lipoprotein (LDL) cholesterol, there was a mean decrease of 13.33% and 19.90% respectively in the blood levels. The percentage decrease in the triglyceride and LDL cholesterol was significant ($p<0.05$). The VLDL

Table 1: Socio- demographic profile of the subjects

Groups/profile		*Post-menopausal N=89*
Age(yrs)	Mean Age ± SD	50.2±4.42
	Age range	39-60
Age of	Mean Age ± SD	46.71± 3.74
Menopause(yrs)	Range	38 to 54
Marital Status	Married	74(83.1)
	Divorced	4 (4.5)
	Widow	8 (8.98)
	Unmarried	3 (3.4)
	Total	**89(100)**
Type of Family	Nuclear	79 (88.8)
	Joint	10 (11.23)
	Extended	-
	Total	**89(100)**
Educational	Under graduate	33 (37.2)
Qualification	Graduate	23 (25.8)
	Post graduate and Higher Studies	33 (37)
	Total	**89(100)**
Occupation	Government	20(22.4)
	Private	31 (34.8)
	House wife	38(42.7)
	Total	**89(100)**

levels decreased from a mean of 33±8.41mg% to 28.68±7.01mg% with a percentage decrease of 13.09, which was also significant as tested by paired t test ($p<0.01$). Like in case of other blood lipids, the mean HDL levels also declined from 58.33 ± 9.01 mg% to 55.13 ± 10.37mg%. The percentage decrease was only 5.4%. The fall in HDL levels may be attributed to a fall in total cholesterol. Although there was a significant decline in the HDL levels, it was still in the desirable level of a mean of 55mg%. The LDL/HDL ratio was 1.86 before the intervention and 1.94 after the intervention. Although there was an increase of 4.30 percent, the ratio was within the prescribed level of less than 2.

The effect of soy supplementation was also determined on blood calcium and alkaline phosphatase levels. Comparison of the values before and after intervention (Table 3) showed that there was a mean increase of 0.89 mg in calcium levels, the percentage increase being 9.9% which was found to be significant on applying paired t test ($p<0.001$). Regarding alkaline phosphatase, the mean levels showed a decline from 81.13U/L to 71.79U/L with a significant ($p<0.001$) decrease of 11.5%.

A comparison of blood calcium and alkaline phosphatase levels before and after calcium intervention (Table 4) showed a mean increase of 1.07 mg in the calcium levels. The percentage increase was 12.2% and was found to be highly significant as tested by paired t test ($p<0.001$). At the same time, there was a mean decrease of 6.25U/L of alkaline phosphatase levels, percentage change being 8.37%. The change was significant when paired t test was applied ($p<0.05$).

Table 2: Mean blood lipid levels before and after soy intervention

Lipid profile	*Normal value**	*Preintervention Mean ± SD*	*Postintervention Mean ± SD*	*Change(%)*	*t-value*
Total Cholesterol(mg %)	<200	222.73 ± 30.02	187.86 ± 23.78	-34.87(15.65)	4.60***
Triglyceride (mg %)	<150	165.00 ± 42.06	143 ± 35.03	-22.00(13.33)	2.24*
LDL Cholesterol (mg %)	<100	129.57 ± 31.89	103.78 ± 20.40	- 25.79(19.90)	3.34**
VLDL(mg %)	<30	33 ± 8.41	28.68 ± 7.01	-4.32(13.09)	2.23 **
HDL(mg %)	40-60	58.33 ± 9.01	55.13 ± 10.37	-3.20 (5.40)	4.06**
LDL/HDL	<2	1.86 ± 0.78	1.94 ± 0.53	0.08 (4.30)	2.90*

**Source:* National Cholesterol Education Program ATP III report 2005. t value significant at *** $p<0.001$, ** $p<0.01$, * $p<0.01$.

Table 3: Mean blood calcium and alkaline phosphatase levels before and after soy supplementation

	Normal value	*Before intervention Mean ± SD*	*After intervention Mean ± SD*	*Change(%)*	*t value*
Blood calcium (mg%)	8.5-10.5	8.99 ± 0.60	9.88 ± 0.57	+ 0.89 (9.90)	4.119***
AlkalinePhosphatase(U/L)	50-160	81.13 ± 13.00	71.79 ± 15.15	- 9.34 (11.50)	4.28***

t value significant at *** $p<0.001$.

Table 4: Blood calcium and alkaline phosphatase level of the subjects before and after calcium supplementation

	Normal value	*Before intervention Mean ± SD*	*After intervention Mean ± SD*	*Change(%)*	*paired t-value*
Calcium mg%	8.5- 10.5	8.77 ± 0.60	9.84 ± 0.57	+1.07 (12.20)	5.15***
Alkaline PhosphataseU/L	50 -160	74.69 ± 20.59	68.44 ± 14.12	- 6.25 (8.37)	2.86*

t value significant at *** $p<0.001$, * $p<0.01$.

Calcium supplementation was carried out to assess and compare the effectiveness of soy and calcium in improving calcium and decreasing alkaline phosphatase level in blood. Figure 1 depict the results.

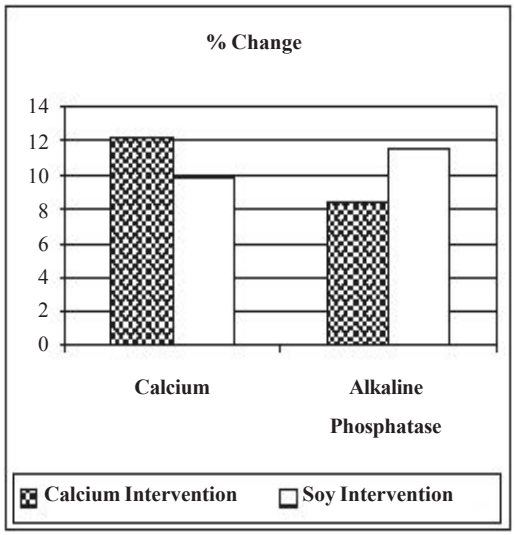

Fig. 1. Comparison of effect of soy isolate and calcium supplementation on blood calcium and alkaline phosphatase level

DISCUSSION

This study attempts to assess the effect of soy protein isolate intervention on lipid profiles, calcium and alkaline phosphatase level of post-menopausal women in Indian population. Soy protein isolate supplementation showed a marked effect in improving the blood lipid profile of the subjects. The findings of this study were in line with several studies that show the association of soy protein isolate and lipid profile. Various studies done on soy supplementation have shown a decrease in TC, LDL, TG and VLDL levels. The effect on HDL cholesterol is not consistent. While some studies show an increase, others have not.

Washburn et al. (1999) in their study showed that dietary supplementation with soy derived phytoestrogens improved lipid profiles in perimenopausal women. A study by Clarkson and Anthony (1998) found that soy phytoestrogens appear to lower low density lipoprotein concentrations, while increasing plasma concentrations of high density lipoproteins. Similar results were obtained by Ashton and Ball (2000) while experimenting with tofu diet.

Anderson et al. (1995) performed a meta analysis of 38 clinical studies reported in 29 scientific articles that provided quantitative data showing that consumption of soy protein, rather than animal protein, significantly decreased concentrations of total cholesterol, LDL cholesterol and triglyceride in humans. While this meta analysis reported a decrease of 9.3% for TC, the decrease was as high as 15.65% in the present study. The decrease in LDL and TG were also higher (19.90% and 13.33% respectively) than that reported in the meta analysis (12.9% and 10.5% respectively). An Indian study on post-menopausal women by Radhakrishnan et al. (2009) showed reduction in TC and LDL by 7.7% and 14% respectively which is lesser than the value reported in the present study (15.65% and 19.90%). The study reported no change in HDL, while significant decrease in HDL has been observed in the present study. Several other studies have also reported a statistically significant decrease in total and LDL cholesterol after the intervention of soy protein isolate on post-menopausal women (Allen et al. 2007; Jaku et al. 2007; Huanz et al. 2011).

Results of this study indicate a favorable effect of soy protein isolate supplementation on bone mass by increasing calcium and decreasing alkaline phosphatase level in blood which is desirable for bone remodeling. Other studies have also shown a positive effect of soy supplementation on increasing blood calcium level and decreasing alkaline phosphatase levels and hence protection against osteoporosis. Potter et al. (1998) found a significant increase in Bone Mineral Density (BMD) with 40 gm/day of soy protein. Arjmandi et al. (2005) in their study showed that one year of supplementation of 25 gm protein positively modulated markers of bone formation. Evan et al. (2007) in a study on 61 post-menopausal women showed the effectiveness of soy protein isolate supplementation in reducing bone specific alkaline phosphatase- marker of bone resorption. Alekel et al. (2010) showed a modest effect of soy isoflavone on bone particularly at femoral neck. Other studies have also shown the bone sparing effect of soy isoflavones (Dalais et al. 2003; Newton et al. 2006; Huanz et al. 2011). This indicates that consumption of soy offers protection against osteoporosis.

Calcium supplementation brought about a favorable change in the blood profile of the subjects in terms of calcium as well as alkaline phosphatase level. This indicates an improvement in prevention of loss of bone mass and osteoporosis with calcium supplementation. The findings of the present study are in line with other studies in this area. Fardellone et al. (1998) studied the biochemical effects of supplementation with 1200 mg elemental calcium during a 2 month course in post-menopausal women. Calcium supplementation resulted in a significant increase in 24 hour urinary calcium and a significant reduction of bone alkaline phosphatase at 2 months. Thus, two months of calcium supplementation in post-menopausal women was efficient in reducing markers of bone turnover, with a greater effect in women with a low dietary calcium intake. Shea et al. (2006) reviewed 15 trials representing 1806 participants concluded that calcium was more effective than placebo in reducing rates of bone loss after two or more years of treatment. Nordin (2009) reviewed 32 trials of calcium supplementation in 3,169 post-menopausal women and concluded that calcium supplementation of about 1,000 mg daily has a significant preventive effect on bone loss in post-menopausal women for at least 4 years.

Comparison of effects of supplementations on calcium and alkaline phosphatase level: A comparison of the effects of soy protein isolate and calcium supplementations on blood calcium and alkaline phosphatase levels is depicted in Figure 1. The effect of calcium supplementation was better than that of soy protein isolate in improving blood calcium level (12.2% as compared to 9.9%). However, when viewed in relation to decrease in alkaline phosphatase as a marker of decrease in bone turnover, the effect of soy isolate supplementation was better (11.5%) as compared to that of calcium supplementation (8.37%).

CONCLUSION

Dietary intervention in the form of soy protein isolate has a marked influence on improving the blood lipid profile, increasing blood calcium level and decreasing blood alkaline phosphatase levels and thus decreases the chances of chronic disease relating to cardiovascular system and bone in post-menopausal subjects. Calcium supplementation also increases blood calcium levels and reduces alkaline phosphatase levels which help to check bone resorption during menopause. Thus, suitable dietary modifications can help improve the quality of life after menopause.

RECOMMENDATIONS

1. Results of the present study suggest that soy should be included in the diet of post-menopausal women to improve the blood lipid profiles and thus reduce the risk of cardiovascular disease.
2. Soy and calcium should be supplemented in the diet of post-menopausal women for reducing the chances of osteoporosis.

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