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Efficacy of Flaxseed Supplementation on Nutrient Intake and Other Lifestyle Pattern in Menopausal Diabetic Females

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ABSTRACT Ninety non-insulin dependent menopausal diabetic female subjects free from serious complications were selected and equally divided into three groups, viz. E_1, E_2 and C. Subjects of group E_1 and E_2 were provided 15g and 20 g of flaxseed powder for a period of two months respectively, while group C was not given any supplementation. Nutrient intake and menopausal symptoms of all the subjects were recorded before and after the supplementation period. Results indicate that blood glucose level decreased significantly in the both the experimental groups after the supplementation. It could be due to the presence of fibre in flaxseed which delays blood glucose absorption. After the supplementation period, significant ($p \leq 0.01$) decrease in the energy intake was observed in both the experimental groups and it could be due to the presence of fibre in the flaxseed which gives a high satiety value and results in decreased consumption of energy rich foods. It was observed that majority of the subjects were physically inactive and watching TV was most popular way of relaxation among all the subjects. Further, it was observed that menopausal symptoms were relieved after supplementation, this decrease could be due to the presence of phytoestrogens in the flaxseed. It can be inferred from the results that improvement in the blood glucose levels and menopausal symptoms of diabetic subjects was observed among the subjects of E_2 group as compared to E_1 group. Hence, this can can be a panacea in counteracting the problems of menopausal diabetic patients.

INTRODUCTION

Diabetes is a chronic disease marked by higher level of blood glucose from defects in insulin production, insulin action or both. India has the maximum number of diabetic patients in the world and this had given the country the dubious distinction of being the "Diabetic Capital" of the world. According to International Diabetes Federation, it currently affects 246 million people worldwide and India has the largest number of diabetics, that is, 40.9 million (IDF 2007). It has been estimated that by 2030 there would be 366 million diabetics throughout the world and 79.44 million in India alone. Diabetes deaths are likely to increase by more than 50% in the next 10 years (WHO 2007). In India, incidence of diabetes is quite high and Punjab being a prosperous state with high per capita income and lifestyles similar to industrialized western countries is no exception.

Flaxseeds *(Linum usitatissimum)* are flat seeds which are slightly larger than sesame seeds and has been used for its health benefits by people for thousands of years. Flaxseeds contain lignan, which is a good source of soluble fiber which is responsible for the improvement in glycemic control by delaying postprandial glucose absorption, decrease some markers of inflammation, and raise serum levels of the omega-3 fatty acids, ALA and eicosapentaenoic acid (Bleodon et al. 2004). Further, soluble fiber forms a gel-like matrix with water that adds bulk to stools and promotes more regular bowel movements, while the insoluble fiber found in flaxseed helps to slow the release of sugar into the bloodstream following a meal, preventing spikes in blood glucose levels (Dahl et al. 2005). Flaxeed lignan, SDG (Secoisolariciresinol Diglycoside), can suppress the gene expression of a key enzyme in the hepatic gluconeogenesis (Prashar 2002).

Lack of physical activity is strongly associated with Impaired Glucose Tolerance (IGT). Exercise reduces the risk of developing type II diabetes by improving glucose tolerance and insulin action. Knowler et al. (2002) conducted a study on 3,234 subjects for 2.8 years and reported that 150 minutes of physical activity per week resulted in 58% reduction in the incidence of diabetes. People from high socio-economic status have five times higher prevalence of glucose intolerance as compared to people from lower socio-economic status (Mohan et al. 2003). Chandalia et al. (2000) reported that high fibre diet reduced plasma total cholesterol, triglyceride concentrations and VLDL-C concentrations by 6.7, 0.2 and 12.5 percent respectively and also reduced plasma glucose by 10 percent.

Menopause is a natural process that women go through as the child-bearing years come to an end and the ovaries cease to release eggs every month. Flaxseeds contain high levels of omega-3 fatty acids and lignans, which are fi-

brous phytoestrogens and in the digestive tract, bacteria change lignans into hormone-like compounds that mimic estrogen in the body. Lignan which is the major component of flaxseed and a main precursor of enterodiol and enterolactone is required to balance the female hormones. During menopause, when estrogen levels are declining, replacing or augmenting estrogen with phytoestrogens can lessen symptoms such as hot flashes (Evale 2000). However, the health benefits of flaxseed are not fully utilized because of its low consumption due to lack of knowledge.

Hence, the present study has been done to see the effect of supplementation of flaxseed powder on nutrient intake, blood glucose and menopausal symptoms of diabetic females.

MATERIALS AND METHODS

Selection of Subjects: A sample of 90 diabetic female subjects free from serious complications, aged 45 – 55 yrs were selected from the OPD of PAU Hospital, Civil Hospital and Punjab Mata Nagar, Ludhiana. These subjects were equally divided into three groups that is, E1, E2 and C respectively.

Lifestyle Related Information: The information regarding lifestyle pattern like frequency of physical activity and relaxing techniques was collected through personal interview technique using the especially structured schedule.

Nutrient Intake and Menopausal Information: Dietary intake of the subjects was recorded by "24 hour recall method" for three consecutive days using standardized containers before and after the supplementation. The average nutrient intake was calculated using MSU Nutriguide computer programme (Song et al. 1992). The average raw amounts (g) of each and every item of food consumed for each subject was fed in the hardware and nutritive value of diets were recorded. Information related to menopause was recorded with the help of questionnaire before and after the supplementation in all the three groups.

Blood Glucose Levels: Fasting blood glucose and post prandial blood glucose levels were analyzed by standardized methods given by Trinder (1969) before and after the supplementation period.

Supplementation of Flaxseed: Flaxseeds were procured from Director's farm, PAU, Ludhiana and were cleaned, washed, sun dried and roasted at 60°C for 5 minutes and grinded in a coffee grinder. Flaxseed in powdered form was supplemented in amount 15 g and 20 g to E_1 and E_2 groups respectively for a period of 60 days. The powder was provided in zip lock bags on weekly basis and the intake of flaxseed powder by the experimental groups was monitered once in a week and it was observed that the subjects were actually consuming the flaxseed powder. The subjects were advised to add flaxseed powder to cooked food (*dhal*, vegetable), stuffed in *chapatti*, curd or take as such with water or milk. They were also advised to keep flaxseed powder in a refrigerator so as to prevent rancidity of powder due to presence of high amounts of PUFA.

Statistical Analysis: The data was analyzed in computer with the help of various statistical tools such as mean, standard error (SE), percentage. To test the significance student's 't' test was applied using Microsoft Excel Computer Programme Package.

RESULTS AND DISCUSSION

General and Lifestyle Related Information of the Subjects

As depicted in Table 1 it was observed that mean duration of diabetes was 3.15 ±2.54, 4.17±2.63 and 4.52±1.76 years in E_1, E_2 and C group respectively. It was observed in the present study that 40.0, 63.3 and 43.3 percent of the subjects were in the age group 45-50 years, while rest of the subjects were in the age group 50-55 years. Further, it was seen that maximum subjects in all the three groups, that is, 80, 73.3 and 63.3 percent had monthly income Rs < 10,000. The average monthly income of the subjects was Rs.15679±1545.34, Rs. 17974± 1562.82 and Rs. 19892±1762.73 in all the three groups respectively. It was observed that monthly per capita income of the three groups was Rs. 4000±341, Rs. 5790±458 and Rs. 3891±249. The data further revealed that majority of the subjects, that is, 56.7 and 80 percent of E_1 and E_2 groups used to dine out rarely, whereas in group C only 10 percent of the subjects used to dine out rarely. Diabetic information of the subjects showed that the main cause of the disease was obesity, that is, 66.7, 60 and 63.4 percent subjects in group E_1, E_2 and C respectively and the second major cause was heredity. Symptoms experienced by majority of the subjects were polydipsia, tiredness and excessive sweating.

Table 1: General and diabetic information of the subjects (n=30 each)

Characteristics	*E1*	*E2*	*C*
Duration of Diabetes (yrs) (Mean ± SE) Age (Yrs)	3.15 ±2.54	4.17±2.63	4.52±1.76
45-50	12(40)	19(63.3)	13 (43.3)
50-55	18 (60)	11 (36.7)	17 (56.7)
Occupation			
Housewife	23 (76.7)	25 (83.3)	19 (63.3)
Service	7 (23.3)	5 (16.7)	11 (36.7)
Monthly Income			
< 10,000	24 (80)	22 (73.3)	19 (63.3)
10,000 – 20,000	5 (16.7)	6 (20)	6 (20)
> 20,000	1 (3.3)	2 (6.7)	5 (16.7)
Per Capita Income			
1000-2500	11 (36.7)	15 (50)	22 (73.3)
2500-5000	17 (56.7)	6 (20)	6 (20)
> 5000	2 (6.6)	9 (30)	2 (6.7)
Frequency of Eating Out			
Once a week	-	-	1 (3.3)
Fortnightly	8 (26.6)	6 (20)	12 (40)
Monthly	5 (16.7)	-	14 (46.7)
Rarely	17 (56.7)	24 (80)	3 (10)
Etiology of Disease			
Obesity	20 (66.7)	18 (60)	19 (63.4)
Heredity	8 (26.7)	9 (30)	10 (33.3)
Others	2 (6.6)	3 (10)	1 (3.3)
*Signs and Symptoms**			
Polydipsia	18 (60)	16 (53.3)	20 (66.7)
Polyurea	13 (43.3)	15 (50)	16 (53.3)
Polyphagia	13 (43.3)	8 (26.7)	9 (30)
Loss of weight	8 (26.7)	7 (23.3)	2 (6.7)
Tiredness	20 (66.7)	15 (50)	19 (63.3)
Nocturea	12 (40.0)	11 (36.7)	13 (43.3)
Excessive sweating	14 (46.7)	15 (50)	16 (53.3)
Itching	4 (13.3)	5 (16.7)	8 (26.7)
Headache	4 (13.3)	14 (46.7)	12 (40)
Delayed healing	3 (10.0)	1 (3.3)	0 (0)
Hypertension	8 (26.7)	16 (53.3)	9 (30)
Physical Exercise			
Yes	4 (13.3)	11(36.7)	7 (23.3)
No	26 (86.7)	19 (63.3)	23 (76.7)
Type of Physical Exercise			
Walking	3 (75)	8 (72.7)	5 (71.4)
Yoga	1 (25)	2 (18.2)	2 (28.5)
Gym	-	1 (9.0)	-
Time Spent on Physical Exercise (Mins)			
15 – 30	4 (100)	8 (72.2)	1 (14.2)
30-45	-	3 (27.3)	4 (57.2)
45-60	-	-	2 (28.5)
Frequency of Physical Exercise			
Daily	-	5 (45.4)	4 (57.1)
Twice a week	1 (25)	2 (18.1)	3 (42.8)
Thrice a week	1 (25)	-	-
Once a week	2 (50)	4 (36.3)	-
*Relaxation Technique**			
Watching T.V.	30 (100)	30 (100)	30 (100)
Listening music	8 (26.7)	7 (23.3)	3 (10)
Reading newspaper/magazines	10 (33.3)	18 (60)	15 (50)
Meditation	-	3(10)	5(16.7)
Sleep Hours			
< 6	5 (16.7)	3 (10)	2 (6.7)
6-8	22 (73.3)	27 (90)	26 (86.6)
>8	3 (10)	-	2 (6/7)

Figures in parenthesis are percentages
* Multiple Responses

As seen in Table 1, data regarding lifestyle revealed that majority of the subjects, that is, 86.7, 63.3 and 76.7 percent of subjects in E_1, E_2 and C groups did not perform any physical exercise and 13.3, 36.7 and 23.3 percent of subjects in all the three groups performed physical exercise and the time spent was 15-30 minutes. Walking was the most common physical exercise adopted by 75, 81.8 and 71.4 percent subjects in all the three groups. Mozaffarian et al.

(2009) reported that the persons who are physically active had an 82% lower incidence of diabetes. Sigal et al. (2006) recommended that a person who is suffering from type 2 diabetes mellitus should engage in at least 150 minutes per week of moderate-intensity aerobic activity (50%–70% of maximum heart rate) and resistance training 3 times per week to improve glycemic control and reduce cardiovascular disease risk. Klein et al. (2004) stated that a moderate weight loss in combination with increased activity improved insulin sensitivity and glycemic control in patients with Type 2 diabetes and prevented development of Type 2 diabetes in high-risk persons (that is, those with impaired glucose tolerance). It was observed in the present study that watching TV was the major relaxation mode adopted by all the subjects, while reading magazines or newspapers was the second most popular way of relaxation among 33.3, 60 and 50 percent of the subjects in all the three groups respectively. Very few subjects, that is, 26.7, 23.3 and 10 percent of the subjects relaxed by listening to music. Yadav (2007) reported that music has been medically proven as a way of healing and calming frayed nerves, weary minds and fatigued bodies. A research conducted on 500 post operative surgery patients for a period of 29 months reported that patients felt relaxed and recovered faster than those patients who were not provided music therapy. Further, it was seen that 10 and 16.7 percent subjects relaxed by meditation in group E_2 and C respectively. It was observed that 73.3, 90 and 86.6 percent of subjects used to sleep for 6-8 hours, whereas 16.7, 10 and 6.7 percent of the subjects in all the three groups respectively used to sleep for < 6 hours. Further, only 10 and 6.7 percent subjects in group E_1 and C used to sleep for > 8 hours. Many studies conducted earlier had proven that the brain without adequate sleep and rest cannot maintain biochemical balances needed for effective functioning of heart as well as other organs of the body. Sleep disturbances affects mood and work capacity, thus the body is devoid of opportunity for recuperation and repair (Mohan 1996).

Nutrient Intake

The mean daily nutrient intake by the subjects before and after the supplementation is given in Table 2.

Energy and Protein: The data revealed that the initial mean daily intake of energy among the subjects in E_1, E_2 and C groups was 1920± 9.06, 2019±3.22 and 1970±6.34 Kcal respectively. The final mean intake was 1899±8.96, 1989±7.26 and 1960±6.23 Kcal in all the three groups, respectively. The mean daily intake in the three groups was more than the suggested intake of 1500 Kcal (Raghuram et al. 2007). However, there was a highly significant ($p \leq 0.01$) decrease in energy intake in group E_1 and E_2 but a non-significant decrease in energy intake was observed in group C. A highly ($p \leq 0.01$) significant decrease was observed in all the three groups. The data revealed that the initial and final mean daily intake of protein was 69.23± 3.96, 81.68±2.18**,** 74.91±3.91g and 67.46±3.19, 78.23±4.12, 73.31±9.23g respectively, in all the three groups. The intake of protein was higher than the suggested intake of 50-60 g (Ghafoorunissa and Krishnaswamy 2000). The decrease in the experimental groups could be due to presence of fibre which increases transit time and delays gastric emptying thus gives the feeling of fullness, hence it decreased the consumption of energy rich foods and pulses. Moreover, the increased protein intake could be due to the reason that Punjabis are fond of milk and milk products like *lassi*, curd and pulses are the daily regimen of Punjabi population. Further, a decrease in the consumption of visible fat and refined cereals by the subjects resulted in the decreased intake of total energy. A recent study on 400 men showed that by reducing energy intake there is decrease in the occurrence of atherosclerosis by 40 percent and it also improves insulin sensitivity, reduce BMR and decreases free radicals (Khosla 2008).

Carbohydrates: The initial and final mean intake of carbohydrates was 292.2±3.26, 329.39±8.12, 281.28±6.33g and 284.9±4.19, 309.14±3.26, 278.60±3.91g respectively. The intake of carbohydrates was found to be less as compared to the suggested intake range of 300-340 g (Ghafoorunissa and Krishnaswamy 2000). A highly significant decrease was observed in group E_1 ($p \leq 0.01$) and E_2 ($p \leq 0.05$), whereas a non-significant decrease was observed in group C. The decrease in carbohydrate intake could be due to low intake of cereals, roots and tubers and sugar and jaggery. Fung et al. (2002) reported that replacing high glycemic index carbohydrate foods with low glycemic index carbohydrate foods improved glycemic control in diabetic subjects.

Table 2: Mean daily intake of nutrients of the subjects before and after the supplementation (Mean ± SE) (n=30 each)

Nutrient	*Before*	*After*	*Difference*	*% Change*	*Paired t-value*	*Suggested intake*[*]
Energy (Kcal)						1500[#]
E1	1920±9.06	1899±8.96	-21	1.0	3.92[•]	
E2	2019±3.22	1989±7.26	-30	1.4	2.98[•]	
C	1970±6.34	1960±6.23	-10	0.5	1.04[NS]	
Carbohydrate (g)						300-340[*]
E1	292.2±3.26	284.9±4.19	-7.3	2.4	2.96[•]	
E2	329.39±8.12	309.14±3.26	-13.25	4.1	2.07[••]	
C	281.28±6.33	278.60±3.91	-3.68	0.7	1.02[NS]	
Protein (g)						50-60[*]
E1	69.23±3.96	67.46±3.19	-1.77	2.5	6.19[•]	
E2	81.68±2.18	78.23±4.12	-3.45	4.2	8.23[•]	
C	74.91±3.91	73.31±9.23	-1.6	2.1	7.10[•]	
Total Fat (g)						40-60[*]
E1	59±1.26	58±1.96	-1	1.6	7.91[•]	
E2	63±2.31	60±3.96	-3	4.7	2.99[•]	
C	61±1.92	59±3.21	-1	1.6	3.21[•]	
Saturated Fat (g)						<20[*]
E1	36.16±3.96	35.01±3.91	-1.15	3.1	6.21[•]	
E2	33.22±2.81	32.19±3.61	-1.05	3.1	2.99[•]	
C	42.91±3.91	42.01±3.01	-0.9	2.0	3.21[•]	
Unsaturated Fat (g)						18.56[*]
E1	28.12±3.33	28.19±6.19	0.07	0.2	1.23[NS]	
E2	32.09±9.16	31.16±7.23	-0.93	2.8	3.92[•]	
C	31.98±3.21	31.09±3.18	-0.89	2.7	6.19[•]	
Dietary Fibre						40[*]
E1	36.17±3.91	42.73±7.16	3.44	9.5.8	7.92[•]	
E2	41.90±2.68	47.71±3.19	5.81	13.8	6.13[•]	
C	39.65±6.19	38.23±1.96	-1.43	3.6	2.61[••]	

[•] Significant 1 %
[••] Significant 5 %
[NS] Non significant
[*] Ghafoorunissa and Krishnaswamy (2000)
[#] Raghuram et al. (2007)

Total Fat: The initial and final mean daily intake of fat was 59±1.26**,** 63±2.31**,** 61±1.92g and 58±1.96**,** 60±3.96, 59±3.21g in all the three groups. The intake was slightly higher in all the three groups as compared to the suggested intake of 40-60g (Ghafoorunissa and Krishnaswamy 2000). It was observed in the present study that total fat intake decreased ($p \leq 0.01$) significantly in all the three groups. The decrease in the fat intake was due to change in consumption pattern from *parantha* to *chapatti*. Cheryl (2010) reported that lecithin present in the flaxseed breaks up the fat present in food which has left in the digestive tract. These are unwanted fats that are trapped in the body and these fats do not turn into body fat. Gupta (2003) suggested that less than 10 per cent intake of saturated fat should be taken for diabetics and ratio of MUFA: PUFA should be 1: 1. The mean daily intake of saturated fat in all the three groups was 36.16±3.96, 33.22±2.81, 42.91± 3.91g and 35.01±3.91, 32.19±3.61, 42.01±3.01g before and after supplementation. The intake was more than the suggested intake of <20 g (Ghafoorunissa and Krishnaswamy 2000). A highly significant ($p \leq 0.01$) decrease was observed in the experimental groups. Gerhard (2004) reported that there was a significant ($p \leq 0.001$) reduction in body weight (1.53kg) with low fat diet as a low fat and high fibre diet promoted weight loss in diabetic patients. Further, the data revealed that the mean daily intake of unsaturated fat before and after the supplementation was 28.12±3.33, 32.09±9.16, 31.98±3.21g and 28.19±6.19, 31.16±7.23, 31.09±3.18g in all the three groups respectively. The intake was higher than the suggested intake of 18.56 g as suggested by Ghafoorunissa and Krishnaswamy (2000). A non-significant increase was observed in group E_1, whereas a highly significant ($p \leq 0.01$) decrease was observed in group E_2 and C. In comparison to people from other states, Punjabis are more vulnerable to heart attacks, hypertension and diabetes due to high fat content in their diet like butter, *desi ghee*. Moreover, there is mushrooming growth

of fast food corners in the city which resulted in the wrong eating habits.

Dietary Fibre: The initial and final mean daily intake of dietary fibre was 36.17±3.91, 41.90±2.68, 39.65±6.19 and 42.73±7.16, 47.71±3.19, 38.23±1.96 in all the three groups, respectively. The intake was almost equal to the suggested intake of 40 g as suggested by Ghafoorunissa and Krishnaswamy (2000). A highly significant ($p \leq 0.01$) increase was observed in group E_1 and E_2, whereas a significant ($p \leq 0.05$) decrease was observed in group C. Jukka et al. (2003) stated that fibre intake is associated with reduced risk of type 2 diabetes. Evidence from epidemiological studies supports the beneûcial effects of high intakes of fruits and vegetables, with possible reductions of over 80 % in CHD, 70 % in stroke and 90 % in T2DM by following Mediterranean diets, which are low in energy and high in ûbre (Willett 2006).

Blood Glucose Levels

Table 3 depicts the mean initial and final levels of fasting blood sugar (FBS) and post prandial blood sugar (PPBS) in the subjects. FBS levels before the supplementation period were 135.75±2.09, 132.73±2.15 and 133.85±2.01 mg/dl and after supplementation period it decreased to 127.01±2.26, 115.46± 2.00 and 132.89±2.05 mg/dl, respectively and Post Prandial Blood glucose levels were analyzed as 190.4±8.44, 188.23±8.77 and 189.11±2.72 mg/dl and after supplementation it decreased to 175.23±8.52, 152.23±6.67 and 187.46±2.73 mg/dl in all the three groups respectively. A highly significant (pd"0.01) decrease in FBS and PPBS levels, that is, 8.74 mg/dl, 17.26 mg/dl and 15.16 mg/dl, 35.99 mg/dl was observed in group E_1 and E_2 respectively, whereas a non-significant decrease in group C was observed. The mean values of fasting and post prandial blood glucose levels were higher in all the groups as compared to normal range. The reduction in blood glucose levels of experimental groups could be due to the flaxseed powder supplementation, being a rich source of both soluble and insoluble fiber. Insoluble fiber found in flaxseed helps to slow the release of sugar into the bloodstream following a meal, preventing spikes in blood glucose levels and hence could decrease blood glucose levels. Similar results has also been reported by Nazni et al. (2006) who conducted a study on 25 diabetic subjects and supplemented flaxseed powder in bread form for 90 days and reported a significant reduction in blood glucose levels after supplementation.

MENOPAUSAL SYMPTOMS BEFORE AND AFTER THE SUPPLEMENTATION

The findings of the present study revealed that the main problem of menopausal women was hot flushes (Table 4). Majority of the subjects, that is, 100, 90 and 96.7 percent in group E_1, E_2 and C experienced hot flushes daily, whereas 10 and 3.3 percent subjects in group E_2 and C experienced weekly and after supplementation 40 and 46.7 percent subjects in group E_1 and E_2 experienced hot flushes weekly, whereas 40 and 43.3 percent and 20 and 10 percent subjects in group E_1 and E_2 experienced hot flushes fortnightly and monthly respectively. Bruce (2008) fed 40 g flaxseed to 85 postmenopausal women and the control group was on placebo for 3 months and it was found that the median

Table 3: Mean fasting and post prandial blood glucose levels of the subjects before and after the supplementation (Mean ± SE) (n=30 each)

Blood glucose levels (mg/dl)	*Before*	*After*	*Difference*	*% Change*	*t-value*	*Normal range (mg/dl)*
E1						
Fasting	135.75±2.09	127.01±2.26	8.74	6.4	13.41*	70-110#
Post prandial	190.4 ±8.44	175.23±8.52	-15.16	7.9	3.66*	120-140#
E2						
Fasting	132.73±2.15	115.46± 2.00	-17.26	13.0	3.25*	70-110#
Post prandial	188.23±8.77	152.23±6.67	-35.99	19.1	5.06*	120-140#
C						
Fasting	133.85±2.01	132.89±2.05	- 0.96	0.7	0.14NS	70-110#
Post prandial	189.11±2.72	187.46±2.73	-1.65	0.8	0.94NS	120-140#

* Significant 1 %
¨ Significant 5 %
NS Non significant
Raghuram et al. (2007)

number of hot flashes dropped by 38% during flaxseed supplementation whereas placebo showed no significant effect. It was observed that night sweats were observed in 100, 100 and 96.7 percent subjects in groups E_1, E_2 and C respectively, while 33.3 and 3.3 percent subjects in group C experienced night sweats weekly and fortnightly. After supplementation 43.3 and 56.7 percent, 30 and 30 percent and 26.7 and 13.3 percent subjects experienced night sweats weekly, fortnightly and monthly respectively. It was observed that 76.7, 83.3 and 100 percent subjects in group E_1, E_2 and C experienced burning sensation weekly, whereas 16.7 and 16.7 percent subjects in group E_1 and E_2 experienced it fortnightly. After supplementation 56.7, 40 and 3.3 percent subjects in group E_1 experienced burning sensation fortnightly, monthly and never respectively. Majority of the subjects in the present investigation, that is, 83.3, 73.3 and 70 percent in group E_1, E_2 and C experienced joint pain weekly and 16.7, 26.7 and 30 percent subjects in group E_1, E_2 and C experienced joint pain fortnightly, never and fortnightly respectively. After supplementation, the reduction in the frequency of joint pain was observed. Data revealed that all the subjects in group E_1 experienced depression daily but after supplementation 36.7, 40 and 23.3 percent subjects experienced this problem weekly, fortnightly and monthly respectively. In group E_2, 73.3 and 26.7 percent subjects experienced depression daily and weekly respectively but after supplementation 60, 33.3 and 6.7 percent subjects experienced depression weekly, fortnightly and monthly respectively. Dodin et al. (2005) also conducted the study on 199 menopausal females and reported decreased severity of menopausal symptoms after 12 months of study period. The decrease in depression could be due to the presence of n-3 fatty acids which relieve depression. The decrease in the occurrence of menopausal symptoms could be due to the presence of phytoestrogens known as lignans are present in flax-

Table 4: Menopausal symptoms of the subjects before and after supplementation (n=30 each)

Symptoms	*Before*					*After*				
	4 (Daily)	*3 (Weekly)*	*2 (Fortnightly)*	*1 (Monthly)*	*0 (Never)*	*4 (Daily)*	*3 (Weekly)*	*2 (Fortnightly)*	*1 (Monthly)*	*0 (Never)*
E_1										
Hot flushes	100	-		-	-	-	40	40	20	-
Night sweats	100	-	-	-	-	-	43.3	30	26.7	-
Burning sensation	-	76.7	16.7	6.6	-	-	-	56.7	40	3.3
Joint pain	-	83.3	16.7	-	-	-	66.7	10	23.3	-
Depression	100	-	-	-	-	-	36.7	40	23.3	-
Irritation	-	-	73.3	26.7	-	-	-	53.3	46.7	-
Lack of sleep	90	10	-	-	-	-	-	96.7	-	3.3
Fatigue	100	-	-	-	-	-	93.3	-	-	6.7
Headache	70	30	-	-	-	10	-	80	10	-
E_2										
Hot flushes	90	10	-	-	-	-	46.7	43.3	10	-
Night sweats	100	-	-	-	-	-	56.7	30	13.3	-
Burning sensation	-	83.3	16.7	-	-	-	-	76.7	16.7	6.6
Joint pain	-	73.3	-	-	26.7	-	60	26.7	13.3	-
Depression	73.3	26.7	-	-	-	-	60	33.3	6.7	-
Irritation	-	10	90	-	-	-	-	63.3	36.7	-
Lack of sleep	73.3	26.7	-	-	-	-	80	13.3	6.7	-
Fatigue	83.3	10	6.7	-	-	-	23.3	66.7	10	-
Headache	63.3	26.7	10	-	-	-	96.7	3.3	-	-
C										
Hot flushes	96.7	3.3	-	-	-	93.3	6.7	-	-	-
Night sweats	63.4	33.3	3.3	-	-	63.4	30	6.7	-	-
Burning sensation	-	100	-	-	-	-	96.7	3.3	-	-
Joint pain	-	70	30	-	-	-	100	-	-	-
Depression	93.3	6.7	-	-	-	93.3	3.3	-	-	-
Irritation	56.7	30	-	13.3	-	56.7	30	-	13.3	-
Lack of sleep	100	-	-	-	-	100	-	-	-	-
Fatigue	76.7	6.7	16.6	-	-	73.3	10	16.6	-	-
Headache	53.3	43.3	3.3	-	-	53.3	43.3	3.3	-	-

seed which are helpful in balancing the hormones among menopausal women. Reduction in other symptoms like Irritation, lack of sleep, fatigue and headache was also observed in both the experimental groups whereas not much change was observed in group C.

CONCLUSION

The present study revealed that supplementation of 20g flaxseed powder has proved more benefits for menopausal diabetic females as compared to 15g in improving glucose levels and menopausal symptoms as flaxseed is a good source of fibre which delays post prandial blood glucose absorption and phytoestrogens tend to balance hormones. In the light of the above discussion it could be concluded that maximum improvement was observed in the subjects of E_2 group followed by E_1 group.

RECOMMENDATIONS

People should be encouraged to use flaxseed powder as it is natural, safe and have no side effects. It helps to lower blood glucose levels and menopausal symptoms and could be easily included in our daily diet to the cooked *dhal*, vegetable, curd, stuffed in *chapatti* or consumed as such with water.

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