

OSTEOPOROSIS IN LATE ADULTHOOD AND CONSUMPTION OF GINGELLY SEEDS – AN INTERVENTION STUDY

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Abstract- Osteoporosis is a serious public health issue, it is estimated that one in three Indian women over the age of 50 years will suffer from osteoporotic fractures. This study aimed to determine the knowledge regarding osteoporosis among subjects, nutrient intake, socioeconomic profile, the impact of an intervention on BMD in a sample of Indian subjects living in different areas of Moradabad city and the development of a product using Gingelly seed powder. A total of 80 subjects, aged 50-60 years were selected. Out of these, 40 subjects were taken as a control and 40 as experimental group. The experimental group was asked to take Gingelly seeds in any form whereas the control group were asked not to take Gingelly seeds in any form for a period of 6 months. After the intervention, it was found that there was an increase in the BMD of subjects however the difference was non –significant in a period of 6 months. The difference can be made significant by increasing the period of study which can be tested in future research. In case of product development there was no significant difference between control and A (10 %), control and B (5 %) but there a was significant difference between control and most acceptable Gingelly biscuits i.e. C (15 %). The food consumed by subjects was found to be deficient in milk, milk products, meat and fish but high in green leafy vegetables which are known to be inhibitors of calcium. A set of 20 multiple choice questions related to osteoporosis was used for the knowledge test and it was found that knowledge about osteoporosis was poor among the osteoporotic subjects among which 35 per cent of the subjects a had low knowledge level (below 33 %).

Keywords- Osteoporosis, BMD (Bone Mineral Density), Gingelly seeds, late adulthood, Inhibitors.

Introduction

Osteoporosis is a serious skeletal disorder with increased susceptibility to fracture. This is due to micro architectural deterioration of bone tissue and therefore, a decrease in bone mineral density (BMD) and bone strength. Number of factors determined bone strength throughout life including family history, gender, ethnicity, age, menstrual status, dietary habits (particularly intake of calcium) and the amount of sun exposure and weight bearing exercise. Osteoporosis is defined as a disease in which the density and quality of bone is reduced, leading to weakness of the skeleton and increased risk of fractures, particularly of the spine, wrist, hip, pelvis and upper arm. The term osteoporosis is derived from Greek word, the word “osteo” means bones and “porosis” means spongy, which describes the appearance of osteoporotic bones when they are broken in half and the inside composition is examined. Although calcium and vitamin D are the most recognized nutrients for bone health, it is important to note that many other nutrients such as magnesium, zinc, vitamin K and phosphorus are also essential for bone health [1]. Gingelly seeds must carefully consider the enriched source of minerals like copper, calcium, magnesium which provide relief from osteoporosis and strengthens the bones, joints and blood vessels. In the population of osteoporotic subjects no study assessed the impact of Gingelly seeds among osteoporotic subjects. So, considering the seriousness of the problem and calcium content of gingelly seeds an experimental study was conducted among osteoporotic subjects to investigate the impact of gingelly seeds on the bone mineral density of osteoporotic subjects compared to control group and simultaneously develop biscuits using Gingelly seeds and assessing its consumer acceptability.

Materials and Methods

After approval by the institutional ethical committee and written informed consent, 80 osteoporotic subjects aged between 50-60 years belonging to different areas of Moradabad city were included in this experimental study. The study was conducted in three phases. In phase, I general information about the subjects and their family and medical history was collected by interviewing the subjects. For dietary survey, subjects were given out the developed proforma for filling in diet consumed by them for one day. Household measures such as *katories*, glasses and models of chapattis of different diameter were shown to assist them to fill in the amounts correctly. For anthropometric data, measurements were taken in triplicate and average value was recorded. In phase, II osteoporotic subjects were allocated into two groups based on purposive sampling technique. Experimental and control groups consisting of 40 subjects each. The bone mineral density of the subjects was noted from their medical reports. The experimental group was asked to consume 10 gms of Gingelly seeds in any form for a period of 6 months daily as whole. Gingelly seeds contain about 88 mg of calcium per tablespoon of seeds. Just a quarter cup of natural Gingelly seeds provides more calcium than a whole cup of milk. A quarter cup of raw natural Gingelly seeds has 351 mg of calcium while one cup of non-fat milk has 316.3 mg and one cup of whole milk has only 291 mg of calcium. Additionally, they are alkaline whereas milk is acidic [17].

Whereas control group was asked, not to take Gingelly seeds in any form for the same period. The bone mineral density was noted after 6 months. In phase III, Gingelly biscuits were prepared and evaluated for sensory quality using sensory score card and a 9 point hedonic scale by semi-trained panel of 15 judges comprising the staff and students of Department of Home Science (TMU), Moradabad in order to select best level of incorporation. Consumer acceptance of most acceptable biscuits was carried out among 100 teaching, non-teaching and students (day scholars as well as hostlers) of TMU, school children, housewives, businessman, service class, government servants and elder people. The consumers were served with one serving of the biscuits and opinion was solicited whether the product was acceptable, the opinion were tabulated and expressed in per cent basis.

Amount of raw ingredients in control and gingelly biscuits

Ingredients	Control (100 % RWF)	A (95% RWF + 5 % GSP)	B (90% RFW + 10% GSP)	C (85% RWF + 15 % GSP)
Refined wheat flour	100 g	95 g	90 g	85 g
Gingelly seed powder	-	5 g	10 g	15 g
Ghee	45 g	45 g	45 g	45 g
Powdered sugar	45 g	45 g	45 g	45 g
Ammonia	1 g	1 g	1 g	1 g
Baking powder	1 g	1 g	1 g	1 g
Milk	8 g	8 g	8 g	8 g

RWF- Refined wheat flour, GSP- Gingelly seed powder

Statistical analysis

The collected data was tabulated and analyzed statistically with the help of approved statistically techniques. Simple statistical techniques as frequency, percentage, mean scores and standard deviation were calculated. In order to compare observation in respect of each respondent before and after bone mineral density (BMD), paired t-test was applied and in case of sensory evaluation ANOVAs test was applied.

Results & Discussion

There were 80 osteoporotic subjects enrolled in the study with no dropouts. Patients in both the groups had comparable demographic variables like age, gender, weight, educational status, occupation, family income, family type, no. of children , activity pattern (Table 1).

Table 1 Socio-economic profile of the subjects.

S. No.	Particular	Experimental group (N =40)		Control group (N=40)		Total (N= 80)	
		N	%	N	%	N	%
1.	Age (years)						
	50-55	35	87.5	30	75	65	81.3
	55-60	5	12.5	10	25	15	18.7
2.	Sex						
	Male	3	7.5	15	37.5	18	22.5
	Female	37	92.5	25	62.5	62	77.5
3.	Marital status						
	Married	40	100	39	97.5	79	98.75
	Widow	-	-	1	2.5	1	1.25
	Single	-	-	-	-	-	-
	Divorced	-	-	-	-	-	-
4.	Educational status						
	Illiterate	5	12.5	4	10	9	11.3
	High school	30	75	15	37.5	45	56.2
	Intermediate	-	-	17	42.5	17	21.2

	Graduate	5	12.5	4	10	9	11.3
	Post graduate	-	-	-	-	-	-
5.	Occupation						
	Service	3	7.5	7	17.5	10	12.5
	Business	-	-	8	20	8	10
	House wife	37	92.5	25	62.5	62	77.5
	Retired	-	-	-	-	-	-
6.	Activity pattern						
	Sedentary	40	100	40	100	80	100
	Moderate	-	-	-	-	-	-
	Heavy	-	-	-	-	-	-
7.	Family income						
	<1,00,000 annually	2	5	2	5	4	5
	1 to 2.5 lakh	37	92.5	38	95	75	93.75
	2.5 to 5 lakh	1	2.5	-	-	1	1.25
	>10,00,000 lakh	-	-	-	-	-	-
8.	Family type						
	Nuclear	35	87.5	35	87.5	70	87.5
	Joint	5	12.5	5	12.5	10	12.5
	Extended	-	-	-	-	-	-
9.	No. of children						
	<2	15	37.5	18	45	33	41.3
	Two	15	37.5	12	30	27	33.7
	>2	2	5	8	20	10	12.5
	None	8	20	2	5	10	12.5
10.	Type of housing						
	Own	21	52.5	22	55	43	53.75
	Rented	18	45	18	45	36	45
	Government quarters	1	2.5	-	-	1	1.25
	Any other	-	-	-	-	-	-
11.	Vehicles						
	Nothing	1	2.5	-	-	1	1.25
	Cycle	2	5	3	7.5	5	6.25
	Two wheeler	37	92.5	37	92.5	74	92.5
12.	Electricity facility						

	Yes	40	100	40	100	80	100
	No	-	-	-	-	-	-
13.	Water facility						
	Hand pump	4	10	4	10	8	10
	Well water	-	-	-	-	-	-
	Tap water	36	90	36	90	72	90
	Any other	-	-	-	-	-	-
14.	Source of information						
	Radio	1	2.5	-	-	1	1.25
	T.V.	39	97.5	40	100	79	98.75
	Calendar	-	-	-	-	-	-
	Newspaper	-	-	-	-	-	-
	Hoardings	-	-	-	-	-	-
	S.M.S.	-	-	-	-	-	-
	Internet	-	-	-	-	-	-
	Campaigns	-	-	-	-	-	-

The results regarding socio-economic profile of the subjects is presented in Table 1 which reveals majority of the subjects (81.3 %) were of the age (50-55 years) whereas only 18.7 per cent population was lying in the age group 55-60 years. In experimental group more of the population (87.5 %) were in the age group of (50-55) years as compared to that in control group (75 %). Researchers have shown that the chances of osteoporosis are more in females after mid-age [12]. Similar was found in the present study as of the total osteoporotic subjects (77.5 %) were females. The ratio of male to female in the experimental and control group was 0.08 in experimental group and 0.6 in the control group. Almost, all the subjects (98.75 %) in both the groups were married.

Educational achievement of parents is one of the important factors influencing the nutritional well-being of children and education of the female is also strongly related to earnings and food expenditure [7][10]. It is common to collect information on education of the household members in socioeconomic surveys. Education level of household members reflects the investment in human capital [2]. In the present study about 11.3 per cent population was illiterate and rest of the population was educated up to high school (56.3 %) and graduate (11.3 %) but none was post graduate. Similar distribution was found among experimental and control group. The occupation of the adults in the household is often an important part of baseline information [2]. All the female subjects were housewives whereas male subjects were either in service (16.3 %) or doing some kind of business (10 %). All the subjects were engaged in sedentary types of activities. A total of 5 per cent population was earning less than one lakh rupees annually and above 90 per cent population was earning between 1 to 2.5 lakh rupees annually in total as well as in both the groups.

Nuclear families were found to be more common than joint and extended families as it was found that 87.5 per cent subjects were having nuclear family whereas 12.5 per cent subjects were having joint family. Above 50 per cent subjects were having their own houses and rest of the population were living either in rented houses or government quarters and all were having proper electricity and water facility in their houses. The source of information for almost all the population (98.75 %) was television and few subjects (1.25 %) were using radio.

Table 2 Family and medical history of the subjects.

S. No.	Particulars	Experimental group		Control group		Total	
		N	%	N	%	N	%
1.	Family history of osteoporosis						
	Yes	-	-	-	-	-	-
	No	40	100	40	100	80	100
2.	Mobility						
	Uses walking aid	-	-	-	-	-	-
	Independent	40	100	40	100	80	100
	Uses wheel chair	-	-	-	-	-	-
3.	If menopause has occurred						
	Yes	37	100	25	100	62	100

4.	No	-	-	-	-	-	-
	If yes, at what age?						
	<40	10	27	5	20	15	24.2
	40-45	20	54.1	15	60	35	56.5
	45-50	7	18.9	-	-	7	11.3
	50-55	-	-	5	20	5	8
5.	Ever taken contraceptive pills?						
	Yes	37	100	25	100	62	100
	No	-	-	-	-	-	-
6.	Smoking status						
	Non	19	47.5	25	62.5	44	55
	Previous	21	52.5	15	37.5	36	45
	Current	-	-	-	-	-	-
7.	Exercise activity						
	Regularly	4	10	2	5	6	7.5
	Irregularly	-	-	-	-	-	-
	Not at all	36	90	38	95	74	92.5

The result regarding family and medical history of the subjects is presented in Table 2 which indicated that none of the subjects in the present study had family history of osteoporosis. All the osteoporotic subjects of both the groups, experimental and control were independent i.e. they did not use any walking aid for walking or moving. Osteoporotic fractures are the most common in post-menopausal women due to rapid decline in oestrogen [6]. Almost all the women of both the groups had menopause. The present study indicated that most of the women (35 %) had menopause between the age of 40 to 45 years while 15 per cent had their menopause at the age of less than 40 years. Rest 7 and 5 per cent women had menopause between the age of 45-50 years and after 50 years, respectively. Researches have shown that nutrition and possibly dietary calcium intake specifically, may be associated with the age of menarche and the rate of bone loss is most dramatic within first year of life after menopause if dietary calcium is insufficient [5]. A lack of knowledge regarding smoking consumption as a risk factor for osteoporosis has been identified [11] and it was also found in the present study as (55 %) subjects were non-smokers and (45 %) subjects were previous smokers.

Table 3. Per cent RDA intake of the subjects.

S. No.	Nutrient	Experimental group		Control group		Total	
		N	%	N	%	N	%
1.	Energy						
	< 50	31	77.5	29	72.5	60	75
	50-75	7	17.5	11	27.5	18	22.5
	75-100	2	5	-	-	2	2.5
	> 100	-	-	-	-	-	-
2.	Protein						
	< 50	6	15	9	22.5	15	18.75
	50-75	10	25	5	12.5	15	18.75
	75-100	24	60	26	65	50	62.5
	> 100	-	-	-	-	-	-
3.	Fat						
	< 50	-	-	-	-	-	-
	50-75	3	7.5	1	2.5	4	5
	75-100	37	92.5	39	97.5	76	95
	> 100	-	-	-	-	-	-
4.	Calcium						
	< 50	36	90	35	87.5	71	88.75
	50-75	3	7.5	4	10	7	8.75
	75-100	1	2.5	1	2.5	5	2.5
	> 100	-	-	-	-	-	-
5.	Carbohydrate						
	<50	-	-	14	35	14	17.5
	50-75	7	17.5	8	20	15	18.75
	75-100	20	50	7	17.5	27	33.75
	> 100	13	32.5	11	27.5	24	30

The results regarding per cent RDA (recommended dietary allowances) intake of the subjects is presented in Table 3 which revealed that maximum subjects (75 %) of both the groups were consuming energy less than 50 per cent of the RDA whereas 22.5 per cent subjects were consuming energy between 50-75 per cent of the RDA and only 2 per cent subjects were consuming energy between 75-100 per cent of the RDA. Regarding protein intake, most of the subjects (62.5 %) were consuming protein between 75-100 per cent of the RDA and 18.75 per cent subjects were consuming protein between 50-75 and less than 50 per cent of the RDA. The fat intake of the population was found to be better as compared to the intake of other nutrients. As majority of the

subjects were consuming fat between 75 to 100 per cent of the RDA and only 5 per cent subjects were consuming fat between 50-75 per cent of the RDA.

The dietary calcium intake among women living in India have been found to be much lower and are commonly associated with the fibre, oxalate and phytate intake from rice and cereals [13] these are known inhibitors of dietary calcium absorption and hence further, enhance the problem of low dietary calcium intake within Indian population. Similar was found in the present study, as majority of the subjects (88.75%) were taking calcium less than 50 per cent of the RDA. About 8.75 per cent of the subjects were consuming calcium between 50-75 per cent of the RDA and only 2.5 per cent subjects were consuming 75-100 per cent of the RDA.

Dietary carbohydrate intake in the experimental group was higher as compared to control group as 50 per cent subjects of experimental group were consuming carbohydrate between 75 and 100 per cent of the RDA but only 27.5 per cent subjects of control group were consuming carbohydrate between 75 and 100 per cent of the RDA, 30 per cent subjects were consuming carbohydrate more than 100 per cent of the RDA, 18.75 per cent subjects were consuming carbohydrate between 50 and 75 per cent of the RDA and only 17.5 per cent subjects were consuming carbohydrate less than 50 per cent of the RDA. Other studies have also reported high carbohydrate intakes in Indian women of 57 per cent [14] and 55 per cent of total energy intake. This probably reflects a high intake of carbohydrate foods such as cereals and bread.

Table 4. Distribution of subjects according to frequency of food groups consumption.

S. No.	Food group	Experimental group		Control group		Total	
		N	%	N	%	N	%
1.	Cereals						
	Daily	40	100	40	100	80	100
	3/week	-	-	-	-	-	-
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-
	Never	-	-	-	-	-	-
2.	Pulses						
	Daily	37	92.5	32	80	69	86.25
	3/week	-	-	1	2.5	1	1.25
	2/week	-	-	-	-	-	-
	1/week	3	7.25	7	17.5	10	12.5
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-
	Never	-	-	-	-	-	-
3.	Milk and milk products						
	Daily	5	12.5	5	12.5	10	12.5
	3/week	12	30	13	32.5	25	31.25
	2/week	4	10	4	10	8	10
	1/week	3	7.5	3	7.5	6	7.5
	Monthly	-	-	-	-	-	-
	Occasionally	1	2.5	-	-	1	1.25
	Rarely	15	37.5	15	37.5	30	37.5
	Never	-	-	-	-	-	-
4.	Meat and fish						
	Daily	-	-	3	7.5	3	3.75
	3/week	-	-	-	-	-	-
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	4	10	-	-	4	5
	Never	36	90	37	92.5	73	91.25
5.	Vegetables (roots)						
	Daily	37	92.5	37	92.5	74	92.5
	3/week	3	7.5	3	7.5	6	7.5
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-

	Never	-	-	-	-	-	-
6.	Green leafy vegetables						
	Daily	33	82.5	34	85	67	83.75
	3/week	7	17.5	6	15	3	16.25
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-
	Never	-	-	-	-	-	-
7.	Other vegetables						
	Daily	35	87.5	37	92.5	72	90
	3/week	3	7.5	5	12.5	8	10
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-
	Never	-	-	-	-	-	-
8.	Sugars and jiggery						
	Daily	40	100	40	100	80	100
	3/week	-	-	-	-	-	-
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-
	Never	-	-	-	-	-	-
9.	Eggs						
	Daily	3	7.5	2	5	5	6.25
	3/week	4	10	3	7.5	7	8.75
	2/week	1	2.5	1	2.5	2	2.5
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	10	25	11	27.5	21	26.25
	Never	22	55	23	57.5	45	56.25
10.	Oils seeds and nuts						
	Daily	-	-	-	-	-	-
	3/week	-	-	-	-	-	-
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	90	22.5	11	27.5	20	25
	Never	31	77.5	29	72.5	60	75
11.	Fats and oils						
	Daily	40	100	40	100	40	100
	3/week	-	-	-	-	-	-
	2/week	-	-	-	-	-	-
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	-	-	-	-	-	-
	Never	-	-	-	-	-	-
12.	Fruits						
	Daily	15	37.5	10	25	25	31.25
	3/week	5	12.5	-	-	5	6.25
	2/week	10	25	10	25	20	25
	1/week	-	-	-	-	-	-
	Monthly	-	-	-	-	-	-
	Occasionally	-	-	-	-	-	-
	Rarely	10	25	20	50	30	37.5

Never	-	-	-	-	-	-
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The food frequency approach asks respondents to report their usual frequency of consumption of each food from a list of foods for a specific period [19]. Researchers can use information from food frequency questionnaires to derive dietary diversity scores [15]. The rationale behind these scores is that greater diversity is associated with a wider range of ingested nutrients, which enhances that the likelihood that the body’s nutritional needs will be met. They reported positive relationships between dietary diversity and overall nutrient intake as well as certain anthropometric indices of nutritional status. Frequency consumption of cereals, pulses, green leafy vegetables, fruits, oils/fats, meat/fish/eggs/other flesh foods, roots and tubers, other vegetable, milk and milk products and sugar and jaggery is presented in Table 4. It was found that cereals, fats and oils and sugar and jiggery were being consumed daily while consumption of other food groups varied from daily to never. Most of the subjects (92.5 %) were consuming root vegetables daily followed by its consumption thrice a week (7.5 %) and the percentage was equal in both the groups. The consumption of green leafy vegetables was found to be good in the present study as 83.75 per cent subjects were consuming green leafy vegetables daily and 16.25 per cent subjects were consuming thrice in a week. This might have been one of the reasons of lesser absorption of calcium because of the presence of oxalates and phytates in green vegetables. Similarly, most of the subjects (90 %) were consuming other vegetables daily and rest of the subjects (10 %) were consuming thrice in a week.

Most of the subjects (91.25 %) were never consuming meat and fish, 5 per cent subjects were rarely consuming meat and fish and only 3.75 per cent subjects were consuming daily. A total of 43.75 per cent population was eggatarian, out of which 6.25 per cent were taking eggs on daily basis, while 26.25 per cent subjects were rarely consuming it. The usual pattern of pulses consumption among the population was daily (86.25 %) followed by once in a week (12.5 %) and then thrice in a week ((2.5 %). The consumption of milk and milk products, which are well known good sources of calcium, was found to be subnormal as only 12.5 per cent subjects were consuming milk daily. 31.25 per cent subjects were consuming fruits daily followed by thrice in week (6.25), once in a week (25) and rarely (37.5).

Table 5. BMI of the subjects

S.No.	Nutritional status	BMI (kg/m ²)	Experimental group		Control group		Total	
			N	%	N	%	N	%
1.	Underweight	<18.5	2	5	2	5	4	5
2.	Low weight normal	18.5-20	-	-	-	-	-	-
3.	Normal	20-25	37	92.5	30	75	67	83.7
4.	Obesity grade I	25-30	1	2.5	8	20	9	11.3
5.	Obesity grade II	>30	-	-	-	-	-	-

Nutritional anthropometry defined as the “measurements, particularly, stature, (height or length) and weight, represent the most common tool for assessing the nutritional status in societies with significant level of protein energy malnutrition (PEM) [14]. The results regarding BMI (body mass index) of the subjects are presented in Table 5. When whole population was categorised in different levels of nutritional status according to BMI it was found that 92.5 per cent subjects were in normal category whereas rest of the (7.5 %) subjects were having varying degrees of malnutrition. There was no difference in the nutritional status according to BMI among experimental and control group.

Table 6. Distribution of subjects according to their knowledge level

S. No.	Knowledge level	Knowledge score (%)	Experimental group		Control group		Total	
			N	%	N	%	N	%
1.	Low	0 -33	8	20	20	50	28	35
2.	Medium	33 – 66	32	80	20	50	52	75
3.	High	66 -100	-	-	-	-	-	-

It is important to identify the level of the osteoporosis knowledge and common misconceptions in women. Studies that have looked at osteoporosis knowledge in women have consistently found a lack of knowledge in women of all ages [1][3]. The results regarding knowledge level of the osteoporotic subjects is presented in Table 6 which revealed that average score regarding knowledge about the causes, consequences and prevention of osteoporosis was very low (41.4 %) and maximum osteoporotic subjects (75 %) were having knowledge between (33-66 %) whereas none of the subjects’ knowledge was identified in the high level which ranged from 66 to 100 per cent score. Differences were found in the knowledge level of the experimental and control groups, the reason for which might be attributed to the factors like low educational status of experimental subjects and secondly more of the females in experimental group who were only housewives and thus less sharing of knowledge with other people.

Table 7: Impact of intervention.

S. No.	BMD	Experimental group				Control group			
		Before intervention		After intervention		Before intervention		After intervention	
		N	%	N	%	N	%	N	%

1.	> -1.0	-	-	-	-	-	-	-	-
2.	-1.0 to -2.4	9	22.5	32	80	2	5	1	2.5
3.	-2.5	23	57.5	2	5	10	25	8	20
4.	-2.6	-	-	6	15	26	65	27	67.5
5.	-2.7	8	20	-	-	2	5	4	10

All the osteoporotic subjects were divided into two groups, experimental and control group. The experimental group was instructed to take 100 g gingelly seeds daily whereas control group was asked not to take gingelly seeds in any form. The results regarding impact of intervention is presented in Table 7 which revealed that before intervention 22.5 per cent experimental subjects had bone mineral density between -1.0 to -2.4 whereas in control group only 5 per cent subjects had bone mineral density in this range. Maximum subjects had bone mineral density of -2.5 in the experimental 57.5 per cent whereas in control group 65 per cent subjects had bone mineral density of -2.6. After intervention it was seen that no subject had bone mineral density of -2.7, which was in 20 per cent subjects before intervention. So, all the subjects moved to higher level and 80 per cent subjects had bone mineral density of -2.5 and -2.6. This might be attributed to increased calcium intake in the form of gingelly seeds as the improvement in bone mineral density was low or negligible in case of control group. About 65 per cent subjects before intervention and 67.5 per cent subjects after intervention had bone mineral density of -2.6. Before intervention only (5 %) subjects had bone mineral density of -2.7 and the number even increased after six months which could be attributed to lack of exercise by more number of subjects in control group (95 %) as compared to experimental group (90 %) as various researches indicates that regular weight bearing exercise during childhood and adolescence can help attain a high peak bone mass (PBM) by inducing bone formation and reducing the rate of bone remodelling [8].

Table 8: Sensory evaluation of Gingelly biscuits by semi-trained panel.

S. No.	Parameters	Control	A	B	C
1.	Appearance	7.2	7.1	7.2	7.5
2.	Colour	7.1	7.0	7.3	7.7
3.	Taste	8.4	6.7	7.5	8.6
4.	Texture	7.5	7.4	6.7	7.9
5.	Flavour	7.7	7.3	7.6	8
6.	Overall acceptability	8.1	7.3	8	8.8

Results regarding sensory evaluation of biscuits using sensory score card is presented in Table 8. The biscuits prepared from 15 per cent level of incorporation of Gingelly powder were highly acceptable as its flavour, texture, taste, colour and overall acceptability were highly acceptable as compared to other levels of incorporation. The biscuits (A) scored highest (7.7) with respect to colour as compared to biscuits containing Gingelly seed powder (B) 5 per cent (7); (C) 10 per cent (7.3) and control (7.1). Similarly C biscuit (with 15 % Gingelly powder) scored highest for all the sensory parameters including taste (8.6), texture (7.9), appearance (7.5), flavour (8) and overall acceptability (8.8).

Table 9: Hedonic scale by semi-trained panel.

S.No.	Parameters	Control	A	B	C
1.	Like extremely	-	-	-	-
2.	Like very much	84.6	-	76.9	100
3.	Like moderately	15.3	92.3	23.0	
4.	Like slightly	-	-	-	-
5.	Neither like nor dislike	-	8.3	-	-
6.	Dislike slightly	-	-	-	-
7.	Dislike moderately	-	-	-	-
8.	Dislike very much	-	-	-	-
9.	Dislike extremely	-	-	-	-

The hedonic scale method measures the level of liking of foods or any other product. Hedonic testing is popular because it may be used with untrained people as well as experienced panel members [18]. When the biscuits developed were judged on hedonic scale (Table 9), it was found that "C" biscuits were liked very much by 100 per cent people whereas "B" and control were liked very much by 76.9 and 84.6 per cent but none of the panelist graded "A" biscuits in the category "very much". (92.3 %) people were liked moderately A biscuits as compared to B (23.0 %) and control (15.3 %) and (7.3 %) neither like nor dislike A biscuits. The next liking of the panelist was "B" biscuits i.e. with biscuits with 10 per cent level of gingelly seed powder incorporation followed by 5 per cent level of incorporation; however the liking was less than that for the control biscuits.

Table 10 Consumer acceptability of the gingelly biscuits using sensory score card

S. No.	Parameters	Biscuit (15 % gingelly seed powder)
1.	Colour	7.2

2.	Taste	8.9
3.	Texture	8.75
4.	Flavour	8.15
5.	Overall acceptability	8.7

Consumer attitudes towards any food products depend upon one's tradition, culture, food habits, environment, geographical location and economic status. Consumer acceptability test was carried for calcium enriched gingelly biscuits through sensory score card and hedonic scale and results are presented in Table 10, which revealed that consumers of all age groups, right from childhood to old age accepted the product and were eager to purchase the product if made available. Twenty adolescents girls were selected from Teerthanker Mahaveer University and rest of the consumers were selected from neighbourhood. Among, the school aged children (age range 10-15 years) the acceptability of the product was high. The results regarding sensory scores by the consumers also showed that biscuits with 15 per cent gingelly seed powder were well accepted as the biscuit scored well in terms of colour (7.2), flavour (8.15), texture (8.75), taste (8.9) and overall acceptability (8.75) by the consumers. Similar were the findings, when the biscuits were rated according to the hedonic scale. The biscuits were liked moderately by 50 per cent of the consumers and 40 per cent liked the biscuits very much. Also, 10 per cent consumers liked the biscuits extremely, indicating the good acceptability of the biscuits among the common masses and thus suggesting the commercialization of the biscuits.

Table 11 Nutrient composition of gingelly biscuits

S.No.	Nutrients	Gingelly biscuits		Control biscuits	
		Per 100 gm	Per biscuits	Per 100 gm	Per biscuit
1.	Energy	406.1	69.2	450.6	66.99
2.	Protein	6.4	0.72	5.60	0.72
3.	Carbohydrate	26.25	7.7	59.4	8.41
4.	Fat	26.25	3.75	23.15	3.3
5.	Calcium	129.59	19.16	22.69	3.097
6.	Fibre	0.33	0.048	0.15	0.02

Table 12 Cost calculation of gingelly biscuits

S.No.	Ingredients	Gingelly biscuits		Control biscuits	
		Per 100 gm	Per biscuits	Per 100 gm	Per biscuit
1.	Refined wheat flour	.85	.12	1	.14
2.	Ghee	1.8	.26	1.8	.26
3.	Powdered sugar	.90	.13	.90	.13
4.	Baking powder	.05	.007	.05	.007
5.	Ammonia	.05	0.007	.05	0.007
6.	Milk	.15	.021	.15	.021
7.	Til	.75	.10	-	-
		4.55 + 40% of goods	0.65+ 40% of goods	3.95+ 40% of goods	.57+ 40% of goods
	Total	6.37	.91	5.53	.80

The nutrient composition of the most acceptable gingelly biscuits is presented in Table 11 in comparison with control biscuits. It was observed that gingelly biscuits recorded higher calcium content 129.59 mg than the control biscuits 22.69 mg. Each gingelly biscuits provided 19.16 mg calcium as compared to 3.097 mg calcium in control biscuits. The cost of the control and experimental biscuit (c) is presented in the Table 12; it is clear from the table that the cost of 100 gm gingelly biscuits is Rs.5.53 for control biscuits. The cost is significantly higher, (less than Re 1/-) because of the addition of a gingelly seeds, which are costly and available at Rs 100/kg. Thus the replacement of gingelly biscuits with normal biscuits in osteoporotic subjects will result in 6 times higher intake of calcium without any additional burden on the consumer's pocket.

Since gingelly seeds are used for oil extraction and thus the meal remaining after oil extraction will be available at cheaper rate, which if incorporated in the biscuits, will cut down the cost of gingelly biscuits but, before incorporating gingelly meal into the biscuits it is important to estimate the calcium content of the meal, as whether there are any losses of calcium during oil extraction. Further, the nutrient composition of the biscuit was done in the present research by calculation method, which is one the limitation of the study due to the time constraint. The nutrients of the biscuit should have been done by analysis method. The another important aspect is the estimation of dietary fibre and anti-nutrients (oxalates and phytates) in the biscuits which hinder the bioavailability of calcium. so, these aspects can be taken up for further research in future.

Conclusion

According to World Health Organization, osteoporosis occupied second position on a number of health issues. The word osteoporosis is derived from Greek word "osteo" means bones and "porosis" means holes. Osteoporosis afflicts an estimated two billion people worldwide, mostly due to calcium deficiency. The prevalence of osteoporosis is disproportionately high in developing countries due to both nutritional (calcium, vitamin D, protein, phosphate, vitamin K, magnesium and other trace elements and vitamins) and non-nutritional factors (hormonal effect, genetic predisposition, cigarette smoking, alcohol

consumption and body mass index). The disease is commonly prevalent in late adults, because as we get older the rate of bone resorption becomes greater than bone generation due to deficiency of calcium reservoirs and other metabolic changes that occurs inside the body. According to National Institute of Arthritis and Musculoskeletal and Skin Diseases, osteoporosis shows a greater burden for women after menopause. One of every two women and one of every four men over age of 50 will likely have an osteoporosis related fractures in their life time. The best way to find out if a person has osteoporosis is to have a bone mineral density test at various places in the body. So, considering the seriousness of the problem the present study was planned with the objective to develop the Gingelly biscuits and study the effectiveness of Gingelly seeds as a vehicle to tackle osteoporosis among adulthood. The study was conducted in three phases. In phase 1 baseline survey was done in which adults of 50 to 60 years were selected from Harthala, Chandan Nagar and M.D.A. colony of Moradabad city by purposive sampling and their general information, nutrient intake, knowledge regarding osteoporosis, family and medical history and anthropometric measurements were assessed. In phase 2, impact of Gingelly seeds on BMD was assessed. The total respondents selected were divided into two groups- experimental and control group each consisting of 40 subjects and bone mineral density of the subjects were noted from their medical reports. The experimental group was asked to consume 100 gram Gingelly seeds daily whereas control group was asked not to take Gingelly seeds at all in any form for a period of 6 months. The bone mineral density was noted after 6 months.

In phase 3, Gingelly biscuits were prepared by incorporating Gingelly seeds powder in the standard recipe at 5 %, 10 %, 15 % levels. The biscuits were evaluated for sensory quality using sensory score card and 9 point hedonic scale by semi-trained panel of 15 judges and then consumer acceptance of most acceptable biscuits was carried out among 100 people. The results of the present study are summarised as follows:

1. Most of the subjects (81.3 %) were in the age group of 50-55 years and rest of the subjects were in the age of 55-60 years. Among them, 77.5 per cent were female and rest of the subjects were male. Majority of the subjects were married and literate. All the subjects were engaged in sedentary type of activities. Most of the subjects belonged to nuclear families and 80 per cent families had either two or less than two children. Majority of the subjects was earning between 1 to 2.5 lakh annually. Above 50 per cent subjects were having their own houses and all were having proper water and electrical facility and all were having television as a source of information.
2. Regarding body mass index most of the subjects were in normal category. None of the subject was having family history of osteoporosis and all were independent. All the women were menopause and ever taken contraceptive pills. About 55 per cent subjects were previous smokers and most of the subjects were never doing exercise.
3. Diet was found to be particularly deficient in calcium and energy with hardly meeting the 50 per cent of the RDA. Intake of fat, protein and carbohydrate were also low as compared to RDA.
4. Knowledge about osteoporosis was found to be poor among the population with 35 per cent of adults being unaware about osteoporosis.
5. Frequency consumption of oils seeds and nuts, eggs and meat and fish was found to be very low and low in milk and milk products.
6. After intervention positive change in bone mineral density was found to be common in experimental group, whereas negative change was found among control group. Although the change was insignificant when paired t test was applied. This might be due to the short duration of intervention to obtain any significant result through dietary intervention. So, it is recommended to carry out the intervention for a longer of time (minimum 9 months) in future studies.
7. The results regarding product development revealed that Gingelly seeds can be incorporated in biscuits up to 15 per cent and also can be commercialized as found acceptable in consumer trial.
8. It was discovered from the study that intervention is needed-
 - On education, as the knowledge of subjects regarding osteoporosis was found to be very poor.
 - On diet, as the dietary intake was notably deficient in calcium and energy and other important nutrients.
 - On dietary practices, as food frequency information revealed that the consumption of milk and milk products, oils seeds and nuts, eggs and meat and fish was quite low in the families of osteoporotic subjects.

For future studies it is recommended that while performing such type of studies, nutrition education should be simultaneously included in the intervention so as to improve the total dietary intake.

Conflict of interest statement

Declaration of interests. The authors declare no competing interests.

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