IV. RESULTS AND DISCUSSION

The findings of the study captioned "**Bone Health and Risk Assessment of Menopausal Women for Osteoporosis and Strategic Diet Care Practices using Calcite Enriched Recipes**" are presented under the following headings.

Phase I	:	Collection of Data on Demographic Profile, Anthropometric Measurements, Physical Activity, Exposure to Sunlight and Diet Pattern
Phase II	:	Association of Risk Factors of Osteoporosis among Selected Subjects
Phase III	:	Development of Calcite (eggshell) Incorporated Recipes and Promotion of Bone Health through Awareness

Phase I Collection of Data on Demographic Profile, Anthropometric Measurements, Physical Activity, Exposure to Sunlight and Diet Pattern

In phase I of the study, demographic profile, anthropometric measurements, physical activity, exposure to sunlight and diet pattern of selected subjects were discussed.

Table VIII represents the demographic profile of selected subjects.

Table VIII - Demographic Profile of Selected Subjects

(N=1036)

	N	%
Religion		
Hindu	880	84.9
Muslim	113	10.9
Christian	43	4.1
Marital Status		
Married	1034	99.8
Unmarried	2	0.2
Age		
40-45	434	41.8
46-50	373	36.0
51-55	111	10.7
56-60	118	11.3
Type of Family		
Joint	237	22.8
Extended	58	5.6
Nuclear	741	71.5
Education		
Professional Degree	20	1.9
Graduate or Post Graduate	228	22.0
Intermediate or diploma	40	3.8
High school	311	30.0
Middle school	309	29.8
Primary school	128	12.3
Socio Economic Status*		
Upper	88	8.5
Upper middle	296	28.5
Lower middle	269	25.9
Upper lower	289	27.9
Lower	94	9.0
Occupation		
Unemployed	428	41.3
Employed	544	52.5
Entrepreneur	64	6.1

*Modified Kuppuswamy scale (Sheikh, 2018)

Demographic profile is considered as important and used in various studies for different purposes. It acts as representative of a larger population of that particular group of study subjects, in experimental studies it allows to compare the control group with experimental group and in qualitative study it allows to determine the appropriateness of the study. The demographic data in present study serves as a representative group of menopausal stage women and to analyze that particular group of people (Marshall, 1996 and Furler *et al.,* 2012).

The table VIII depicts the demographic data of selected subjects. Among the religion of selected subjects, 84.9 percent were Hindus, 10.9 percent were Muslims and 4.1 percent were Christians. Nearly 99.8 percent of the subjects were married and the rest of them were unmarried.

Subjects have been classified into four groups based on their age from 40 to 60 years. The table VIII reveals that a maximum number of subjects ie., 434 (41.8 percent) were between 40 - 45 years. This was followed by the age group of 46-50 which had 373 (36.0 percent) subjects. Further 118 (11.3 percent) subjects were under the age group of 56-60 followed by 111(10.7 percent) subjects between 51-55 years.

Among the 1036 subjects a majority (71.5 percent) belonged to the nuclear family followed by 22.8 percent of them living in joint family. A least number of 5.6 percent lived with extended families.

Regarding the educational qualifications of the subjects, nearly 59.8 percent of subjects went to middle school or high school. About 22 percent of subjects were either graduates or postgraduates followed by 12.3 percent who had primary education and 3.8 percent had diploma certificates. Only a minimum of 1.9 percent of the subjects were professional degree holders.

With respect to the income status 28.5 percent of the subjects belonged to the upper middle class followed by 28 percent who fell under the category of upper lower. Another 27.9 percent belonged to the lower middle class followed by 9.0 percent and 8.5 percent in lower and upper class respectively.

As far as the occupational status was concerned, 544 (52.5 percent) had regular employment, 428 (41.3 percent) subjects were unemployed and 64 (6.1 percent) subjects were entrepreneurs.

Risk Assessment of osteoporosis of selected subjects:

Osteoporosis Risk assessment was done based on three tools namely ORAI (Osteoporosis Risk Assessment Instrument), OST (Osteoporosis Self-assessment Tool) and SCORE (Simple Calculated Osteoporosis Risk Estimation).

Initially a pilot study was conducted among 60 subjects and the most relevant tool was identified and selected to perform the further study.

During the pilot study, a smaller group of subjects (N=60) were selected to study the effectiveness of the risk assessment tools. During this, bone mineral density was measured for the selected subjects and it revealed that a majority of 63.3 percent subjects were osteoporotic or osteopenic which is classified as “at risk “ followed by 22 subjects (36.6 percent) who were normal and it is depicted in the figure II.

Subsequently risk assessment was done by using all the three methods namely ORAI (Osteoporosis Risk Assessment Instrument), OST (Osteoporosis Self-assessment Tool), SCORE (Simple Calculated Osteoporosis Risk Estimation). According to the assessment done using ORAI, 19 were at no risk and 41 subjects were at risk. Use of OST risk assessment tool revealed 17 subjects were at no risk and 43 were at risk. The results from the SCORE tool indicated 16 subjects were no risk and further 44 subjects were at risk.

The measured BMD was compared with the values arrived at all three methods as shown in the figure III.

It revealed that the prediction using ORAI scale as the closest to the measured BMD values. There was a significant relationship between ORAI and BMD, compared to the other two risk assessment methods, the ORAI tool was chosen as the referred method to conduct the study on the larger sample size.

Figure II represent the Bone Mineral Density of selected subjects.

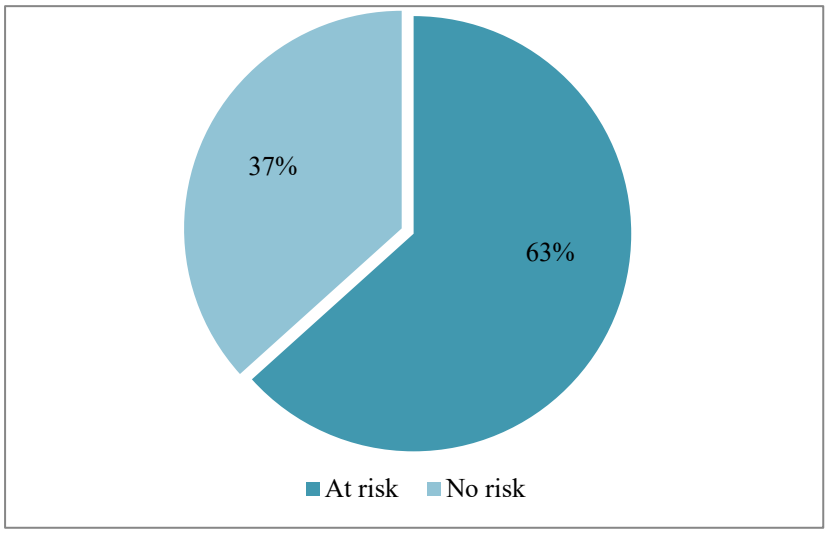


Figure II - Bone Mineral Density of Selected Subjects (N=60)

Figure III represents the osteoporosis risk of selected subjects using various tools like OST, ORAI, SCORE and Bone Densitometry.

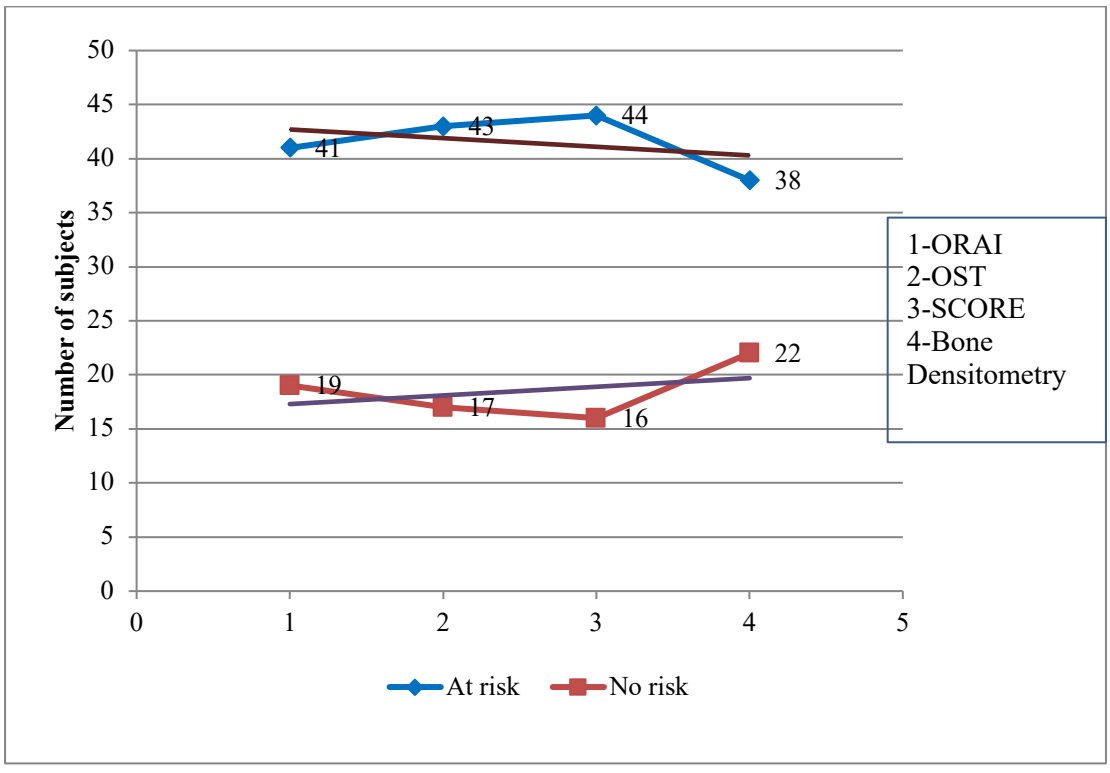


Figure III - Osteoporosis Risk Assessment using various Tools like OST, ORAI, SCORE and Bone Densitometry

Table IX depicts the comparison of BMD with osteoporosis risk assessment tools.

Table IX - Comparison of BMD with Osteoporosis Risk Assessment Tools (N=60)

BMD (Bone Mineral Density)		**ORAI* (Osteoporosis Risk Assessment Instrument)**		**OST** (Osteoporosis Self assessment Tool)**		**SCORE*** (Simple Calculated Osteoporosis Risk Estimation)**		**P Value**	**Pearson Chi Square value**
At risk	No risk	At risk	No risk	At risk	No risk	At risk	No risk	0.000	14.78
38	22	41	19	43	17	44	16		

* Cadarette *et al.,* 2000 **Koh *et al.,* 2001 ***Lydick *et al.,* 1998

Bone mineral density is a test used to determine the density of the bone. It is a simple painless and fast scanning procedure. The table IX represents a comparison of BMD with other osteoporosis risk assessment tools like ORAI, OST, and SCORE. It indicates that prediction of ORAI scale is more closer with the directly measured Bone Mineral Density. According to ORAI, 41 subjects are at risk and 19 are at no risk of osteoporosis. This was closest to 38 at risk and 22 not at risk identified by BMD, there was a significant relationship between ORAI and BMD. Similar study performed by Motaghi *et al.,* (2011) also suggested that ORAI scale was adequately sensitive to evaluate postmenopausal women and the test could be used as a screening test to determinate low bone mineral density.

Table X shows the risk assessment of osteoporosis among selected subjects using ORAI tool.

Table X - Risk Assessment of Osteoporosis among Selected Subjects using ORAI

(N=1036)

Risk assessment using ORAI	No Risk		At Risk		Total
	N	%	N	%	
Tiruppur district	116	36.9	198	63.1	314
Coimbatore district	242	33.5	480	66.5	722
Total	358	34.5	678	65.4	1036

***** Cadarette *et al.,* 2000

Osteoporosis Risk Assessment Instrument is a basic online tool to assess the osteoporosis risk, so that it reduces the number of people for diagnosis and so that people can take preventive measures to avoid low bone density. Table X indicates the osteoporosis risk assessment performed by the ORAI tool. Where 65.4 percent of the subjects were at risk of osteoporosis and only 34.5 percent of them were not at risk. In both Tiruppur and Coimbatore districts at risk subjects were higher than the no risk subjects.

Table XI represents the menopausal stages of selected subjects.

Table XI - Menopausal Stages of Selected Subjects

(N=1036)

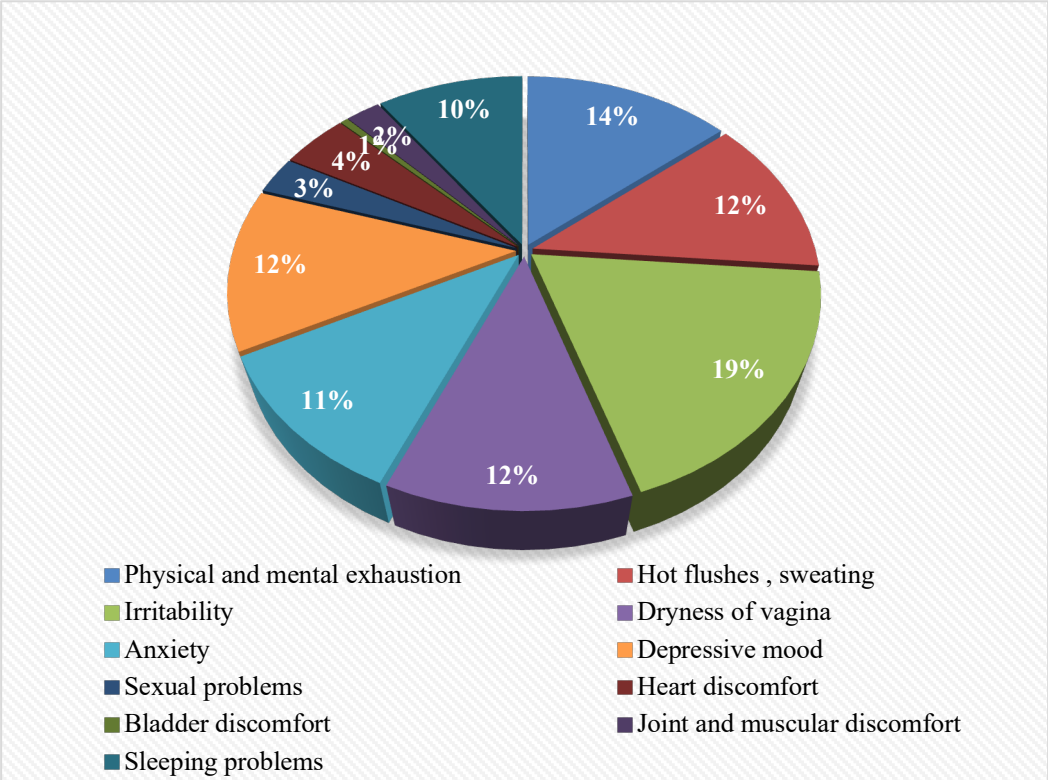
Menopausal stage*	N	%
Perimenopause	496	47.8
Menopause	286	27.6
Postmenopause	254	24.5
Total	1036	100

*WHO, 1996

The table XI represents the menopausal stages of selected subjects. As the table shows 47.8 percent of subjects were under the perimenopausal stage, 27.6 percent were under menopause and a minimum subjects according to 24.5 percent were under the postmenopausal stage.

Menopausal Symptoms of Selected Subjects:

Figure IV depicts the menopausal symptoms experienced by selected subjects.



*Multiple responses

Figure IV - Menopausal Symptoms of Selected Subjects

Figure IV reveals the type of symptoms experienced by the subjects during menopause. About 19 percent of the subjects reported irritability. Other studies also indicates irritability as one of the most common emotional problem faced by menopausal women. Seventy percent of women revealed themselves being not tolerant and easily annoyed (De Wit *et al.,*2021), followed by 14 percent who said they experienced mental and physical exhaustion. About 12 percent of them suffered from hot flushes, sweating, dryness of vagina, anxiety and depressive mood. About 10 percent of the women had problem with their sleep and 5 percent of the women had sexual problems, joint and muscular discomfort, bladder discomfort and heart discomfort.

Table XII depicts the data on physical activity of the selected subjects.

Table XII - Physical Activity of Selected Subjects

(N=1036)

Physical activity*	N	%
High	248	23.9
Moderate	408	39.4
Low	380	36.7
Total	1036	100

***** Craig *et al.,* 2003

The physical activity of selected subjects was observed and classified into three criteria based on International Physical Activity Questionnaire (Craig *et al.,* 2003). Table XII reveals that, 408 (39.4 percent) subjects undertook moderate physical activity followed by 380 (36.7 percent) subjects and 248 (23.9 percent) subjects who had low and high amount of physical activity respectively. A study Anjana *et al.,* (2014) also suggested that large percent of subjects donot perform high physical activity, hence in order to prevent diseases steps must be initiated in India.

Table XIII presents the data on sun exposure pattern of selected subjects.

Table XIII - Sun Exposure Pattern of Selected Subjects

(N=1036)

Sun exposure*	N	%
Inadequate (<30 mins)	562	54.2
Adequate (>30 mins)	474	45.8
Total	1036	100

*Harinarayan, 2018

Table XIII reflects the exposure to sunlight of the selected subjects. It was noticed that 45.8 percent of the subjects had adequate exposure of greater than 30 minutes and 54.2 percent had inadequate exposure. Various researches conducted on sun exposure among women in various parts of India stated that most of the women have inadequate exposure to sunlight (Ghosh *et al.,* 2021 and Vasudevan *et al.,* 2021).

Table XIV represents the sun exposure timings of selected subjects.

Table XIV - Sun Exposure Timings of Selected Subjects

Timing	More than 30 mins		Less than 30 mins		Total	
	N	%	N	%	N	%
Between 7 and 9 am	379	36.6	428	41.3	807	77.9
Between 9 and 11 am	420	40.5	329	31.8	749	72.3
Between 11 am and 1 pm	237	22.9	389	37.5	626	60.4
Between 1 and 3 pm	103	9.9	210	20.2	313	30.2
Between 3 and 5 pm	138	13.3	189	18.2	327	31.6
Between 5 and 7 pm	402	38.8	368	35.5	770	74.3

***Multiple responses**

The table XIV further details the sun exposure timing of the selected subjects. As can be seen, 749 (72.3 percent) subjects were exposed to sun light between 9 and 11am. Among the 749 (72.3 percent) subjects it was revealed that 420 (40.5 percent) were exposed to more than 30 minutes where as the remaining 329 (31.8 percent) were exposed to less than 30 minutes. Only 313 (30.2 percent) subjects were exposed to sun light between 1 and 3pm. Among the 313(30.2 percent) subjects, 103 (9.9 percent) were exposed for over 30 minutes and 210(20.2 percent) were exposed below 30 minutes.

A vast majority of 807 (77.9 percent) subjects were exposed to sun light early in the morning between 7am to 9 am, followed by 770 (74.3 percent) subjects who were exposed to sunlight at dawn between 5 and 7pm. India being a tropical country, 313(30.2 percent) subjects were exposed to sunlight between 1 and 3pm which is a sizeable number.

Dietary Habits of Selected Samples:

Figure V depicts the diet pattern of selected subjects.

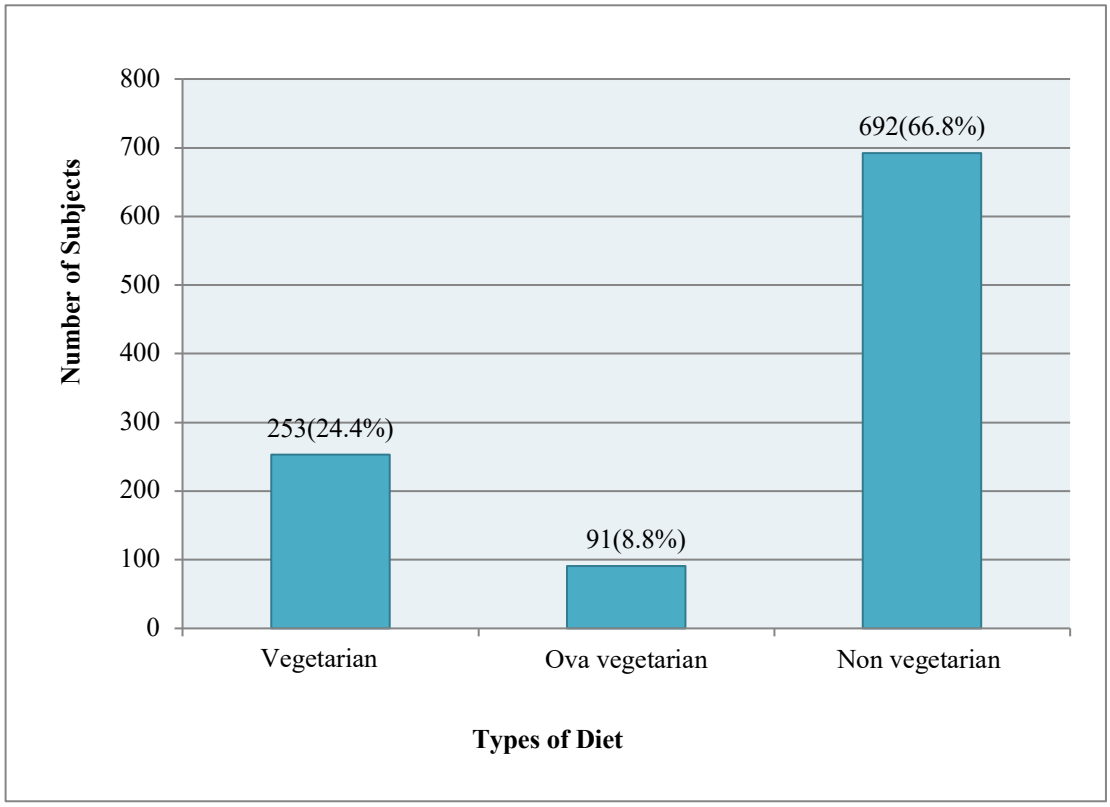


Figure V - Diet Pattern of Selected Subjects (N=1036)

As the figure V depicts, among 1036 selected subjects, maximum of 692 were non-vegetarians, 253(24.4 percent) subjects were vegetarians and 91(8.8 percent) of them were ova vegetarians. Among southern states in India, Telengana has highest number of people who are non-vegetarians (98.7 percent) which is followed by other southern states (Prathap *et al.,* 2019).

Table XV highlights the mean nutrient intake of selected subjects.

Table XV - Mean Nutrient Intake of Selected Subjects

(N=1036)

Nutrients	Mean	RDA
Sedentary Workers		
Energy *	1286 ±89.22	1660
Carbohydrates **	220±53.33	130
Protein *	51±14.98	36.0
Fat *	21±7.87	20
Fibre*	27±9.07	25
Moderate Workers		
Energy *	1950±27.72	2130
Carbohydrates **	327±62.92	130
Protein *	70±10.53	36.0
Fat *	37±15.54	25
Fibre*	39±9.48	30

(*ICMR,2017 ; ** FSSAI,2021)

Subjects were classified as performing sedentary and moderate workers based on their occupation**.** Nutrient intake was calculated for the selected subjects through a 24 hour diet recall method. From the collected data, the amount of nutrients were calculated according to IFCT (2017). The mean nutrient consumption was also arrived from the collected data.

The table XV shows the mean value of energy consumed by sedentary and moderate lifestyle subjects at 1286 and 1950 K. calories respectively. Mean Carbohydrate of the selected subjects were 220 g and 327 g for sedentary and moderate work subjects respectively. Similarly fat intake was at 21 and 37g respectively. The protein intake was measured at 51 g and 70 g for the above subjects. In all the nutrients, the intake by subjects performing moderate work is more than that of subjects doing sedentary nature of work. This also indicates that subjects consume adequate nutrients compared with daily requirement, therefore energy, carbohydrate, protein, fat, fibre intake may not be the risk factor of osteoporosis .

Table XVI shows the calcium intake pattern of selected subjects.

Table XVI - Calcium Intake Pattern of Selected Subjects

(N=1036)

Calcium Intake of the Selected Subjects*		**Total**	**Percentage**
Adequate	**(** >600 mg/ day)	394	38.0
Inadequate	Less intake (<600mg/day)	428	41.3
	Very less intake (<300mg/day)	214	20.7
	Total	1036	100

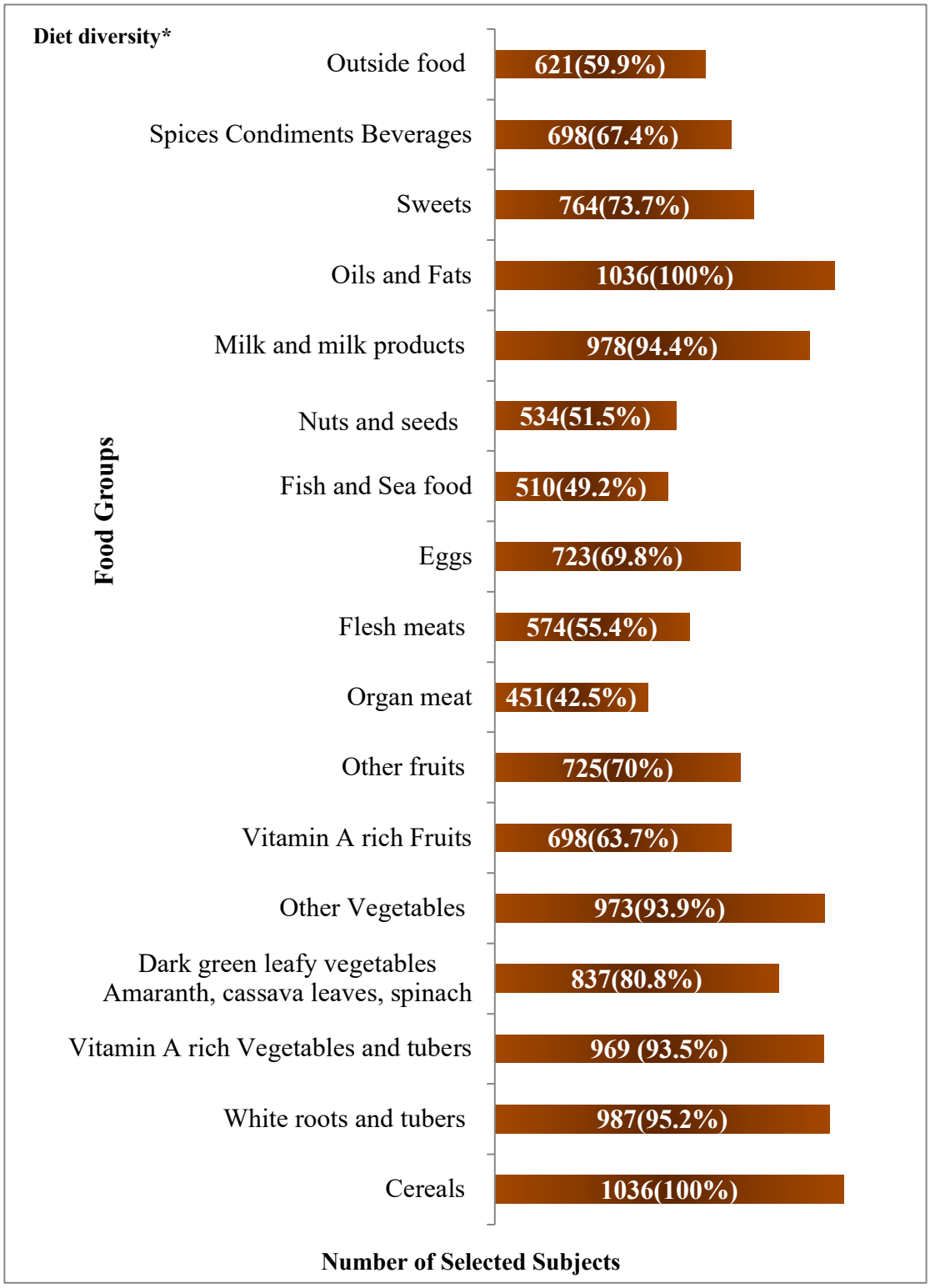
*ICMR,2010

Calcium is the most important mineral that is required to maintain the optimal health of bones and avoid the onset of osteoporosis. As per Recommended Dietary Allowance by ICMR (2010) the adequate amount of calcium required to be consumed by an average adult is estimated to be 600 mg/day. Of the total subjects, 394 were found to be consuming more than 600 mg/day. 428 (41.3 percent) subjects had a lower intake between 301 to 599mg /day. Further 214 (20.7 percent) subjects had a very low intake of less than 300 mg per day which makes them likely target for the onset of osteoporosis. The average calcium intake in India is inadequate which is nearly 429 mg. In India, calcium requirement was met minimum for about 35 percent to 45 percent except Gujarat, though West Bengal met more than 70 percent of RDA, it remains inadequate intake of calcium (Balk *et al.,* 2017) (Harinarayan *et al.,* 2021).

Diet diversity of selected subjects

The figure VI indicates diet diversity of the selected subjects. Dietary Diversity is defined as the number of different foods or food groups consumed. Almost all subjects consumed cereals followed by oils and fats. Organ meat was consumed by 451(42.5 percent) subjects. Fish and sea food was consumed by 510 (49.2 percent) subjects. A total of 698 (67.4 percent) subjects consumed fruits rich in Vitamin A. There were about 725 (70 percent) subjects who consumed other fruits. A majority of 973 (93.9 percent) subjects consumed other vegetables and 837 (80.0 percent) of them consumed dark green leafy vegetables like amaranth, spinach etc. Study by Gupta *et al.,* (2020) states that women partake less diversity of foods than other household members in their family.

Figure VI shows the diet diversity of selected subjects.



***Rajendran,2017 *Multiple responses**

Figure VI - Diet Diversity of Selected Subjects

Food Frequency Intake of Selected Subjects

Food frequency questionnaire was used to collect the information on various range of food groups consumed by our selected subjects. It was designed in such a way that it focused on the calcium rich foods included under various food groups. The following series of graphs and bar charts indicate the consumption pattern of various food groups on a daily, weekly, monthly basis etc

Consumption of legumes has known benefits in the maintenance of bone health which can help to compensate the lack of estrogen and it is beneficial to the bone through modulation of OPG and RANKL gene expression (Park e*t al.,*2013). Figure VII depicts the consumption pattern of legumes among the selected subjects. It was noticed that bengal gram whole was consumed by maximum number of people on a daily and weekly basis. Also the consumption of soya was the least on daily and weekly basis among the four legumes studied. Coimbatore being one of the efficient cropping zone of Bengal gram (Pradipa *et al.,* 2018) might be a reason for consumption by maximum number of subjects on a daily and weekly basis.

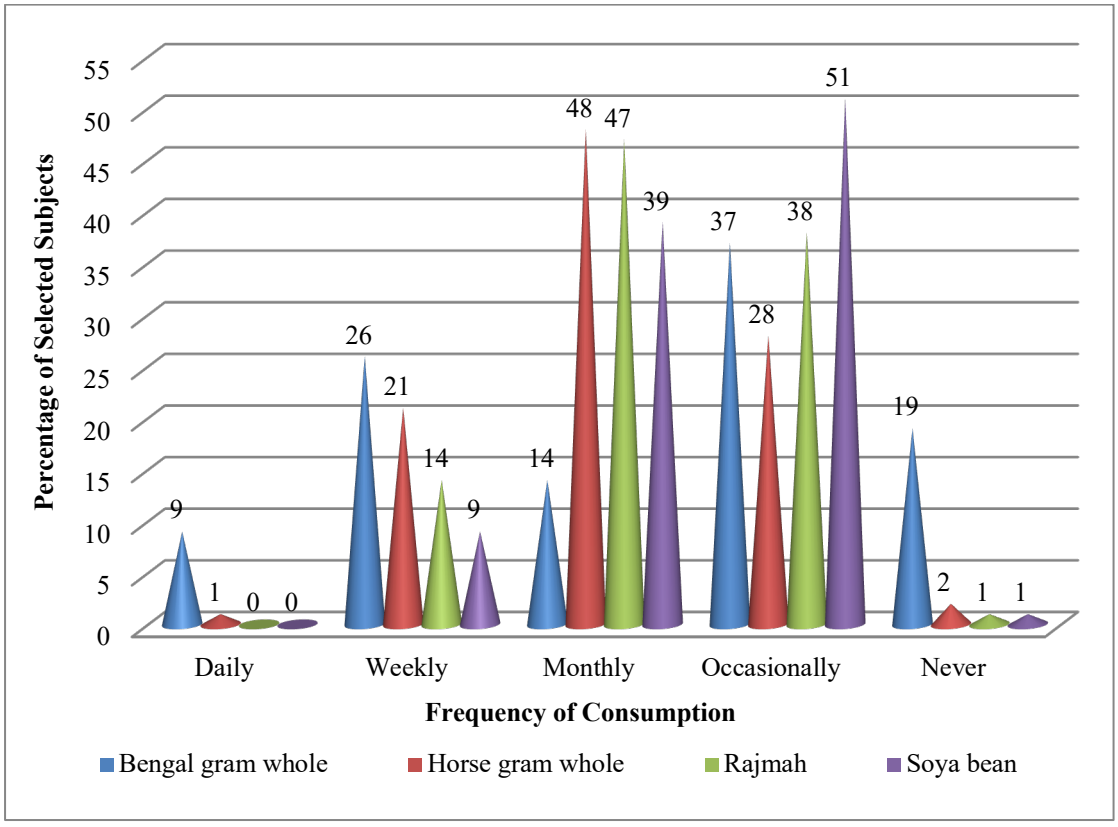


Figure VII - Consumption Pattern of Legumes

Millets are good source of anti-oxidants, rich in fibre, comprising more minerals which are very beneficial to maintain good health. Millets like ragi and pearl millet contain minerals like calcium and phosphorous which are very important to maintain bone health (Dayakar *et al.,* 2017). Figure VIII illustrates the consumption pattern of millets among the selected subjects.

Majority of subjects consumed all the millets occasionally and no millet was consumed on daily basis by subjects. Only one to five percent of subjects consume millets on weekly basis. Among the millets consumed on monthly basis, majority of subjects nearly 40 percent consumed ragi. Close to 70 percent of the respondents expressed that they consumed foxtail millet, kodo millet, banyard and little millet on an occasional basis. It was also found in the study by Kane *et al.,* (2021) that the millets were not consumed on regular basis. The reason given by subjects were that, the millet recipes were not preferred at home because of their taste which was not much liked.

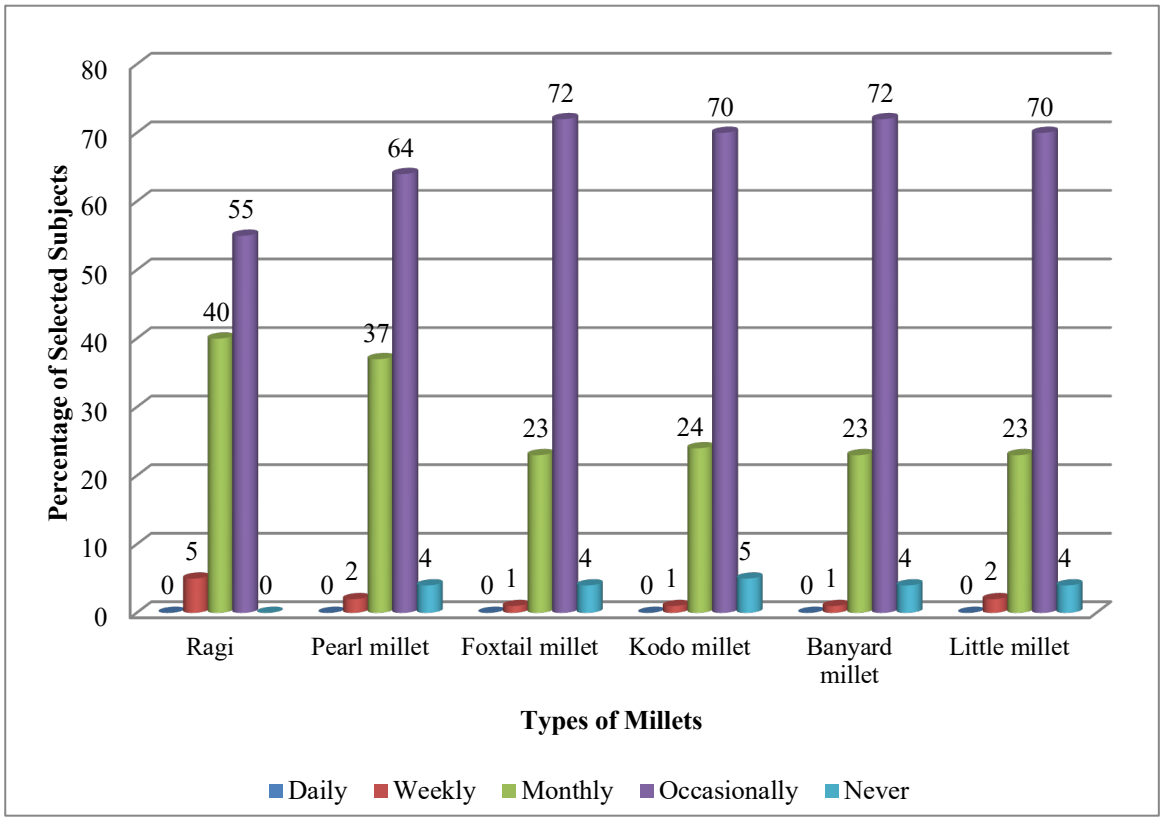


Figure VIII - Consumption Pattern of Millets

Green leafy vegetables represent a rich source of beneficial bioactive components including nitrate (Blekkenhorst *et al.,* 2017) and vitamin K, both of which may have beneficial effects on bone (Klein-Nulend *et al.,* 2014 and Mott *et al.,* 2019). Figure IX depicts the consumption pattern of vegetables and greens. Curry leaves being one of the most common ingredient used in India (Devarajan and Mohanmarugaraja, 2017) and corriander leaves were consumed by a majority of the subjects (99 and 97 percent) on a daily basis. Drumstick leaves were consumed 42 percent by majority of subjects on monthly basis. Drumstick leaves, knoll khol, cauliflower greens and amaranth were not consumed on a daily basis by any of the subjects.

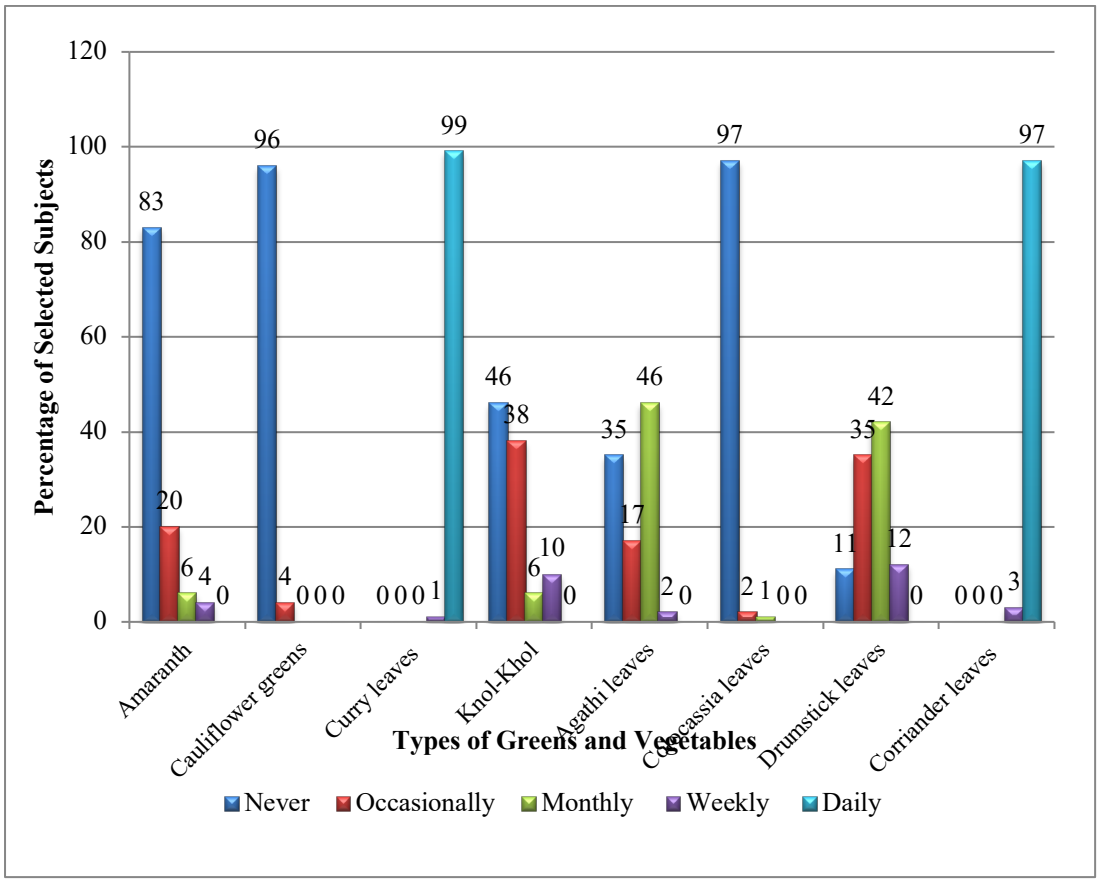


Figure IX - Consumption Pattern of Greens and Vegetables

The Figure X depicts the nuts and oilseeds consumption pattern of selected subjects.

Nuts are usually rich in magnesium and calcium. Intake of nuts rich in these minerals aids in the mineralization of bone thereby maintain bone health (Ros, 2010). Mustard seeds were consumed by 100 percent of the subjects on daily basis. This was followed by cumin seeds where 76 percent of the subjects consumed them on a daily basis. Coconut at 67 percent was the maximum consumed on a weekly basis. Gingelly seeds were consumed by a maximum of 63 percent subjects on a monthly basis. Almond was consumed daily by only six percentage of the subjects and maximum number of subjects consumed only occasionally. The calcium intake of the subjects through nuts and oil seeds on daily basis was acquired only through mustard seeds and cumin seeds, though most of the subjects have taken on regular basis this might have contributed only minimum calcium to their daily requirement since these ingredients are used only in less quantity in Indian cusine.

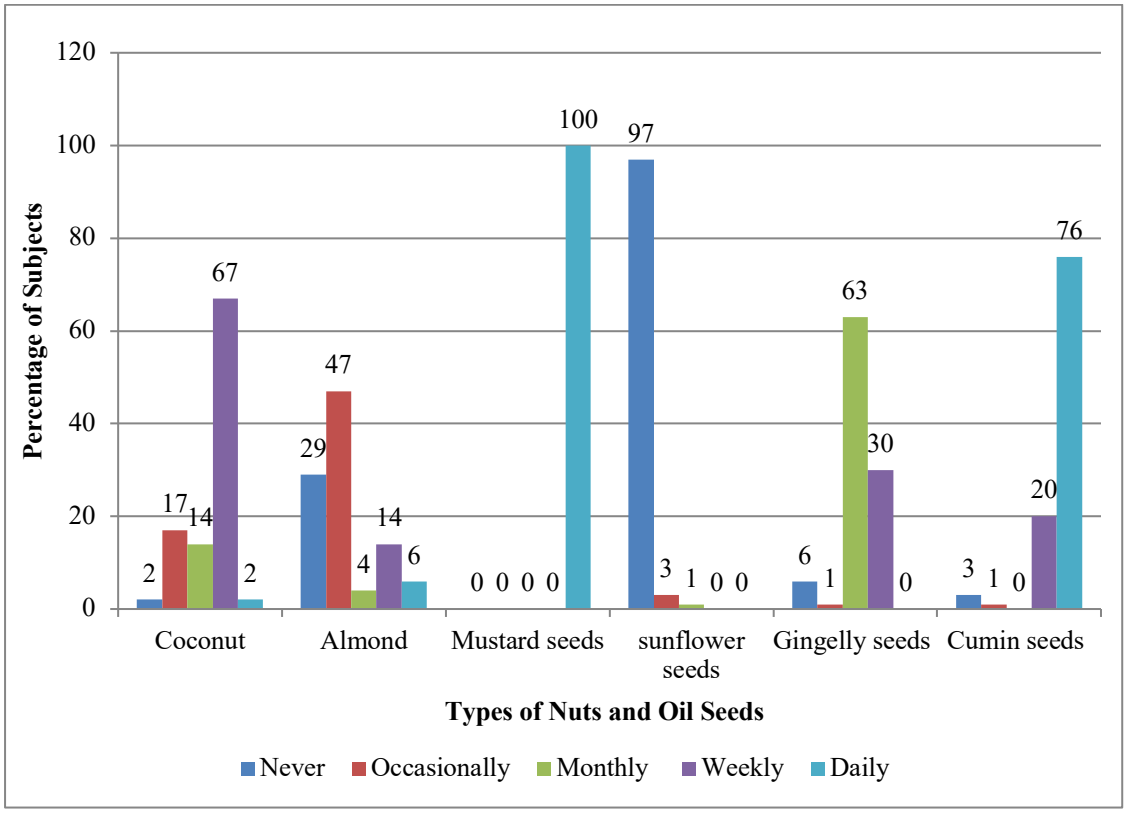


Figure X - Consumption Pattern of Nuts and Oil Seeds

The family history is a record of the health conditions of ones family, since family members share their genetic information with their children there are more chances for transmitting diseases to them. Hence when family history is known then diseases or disorders can be prevented (Blazer *et al.,* 2006).

Among the family history of the selected subjects, blood pressure was the most commonly experienced disorder with 502 (48.5 percent) subjects reporting the same. This was followed by diabetes and obesity with 327(31.6 percent) and 263 (25.4 percent) subjects respectively. Around 221(21.3 percent) subjects (just over 20 percent) experienced osteoporosis. Very less number of 41(4 percent) subjects reported cardio vascular disease. Forty five subjects had a history of epilepsy. Figure XI depicts the family history of selected subjects.

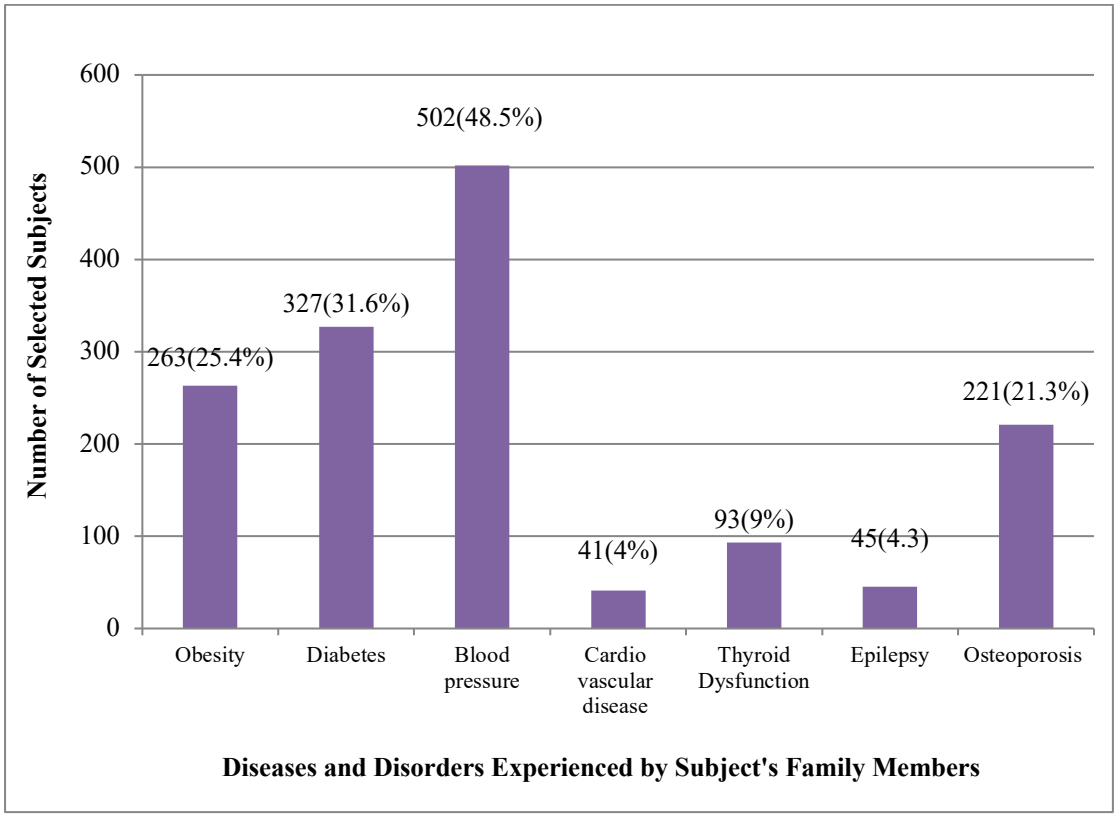


Figure XI - Family History of Selected Subjects

Similar to the family history, the self-history also reveals blood pressure (with either high or low) as the most prevalent condition among the selected subjects. About 357 (34.4 percent) subjects were under medication for one disorder or the other.

Osteoporosis, diabetes and thyroid function were reported by 426 (41.1 percent), 245 (23.6 percent) and 240 (23.2 percent) subjects respectively which correlates to the study by Delitala *et al.,* (2020) lower thyroid hormone results in demineralisation of bone, thereby subjects with osteoporosis tend to have thyroid dysfunction. Least number of 8 subjects reported fractures as shown in figure XII.

*Multiple responses

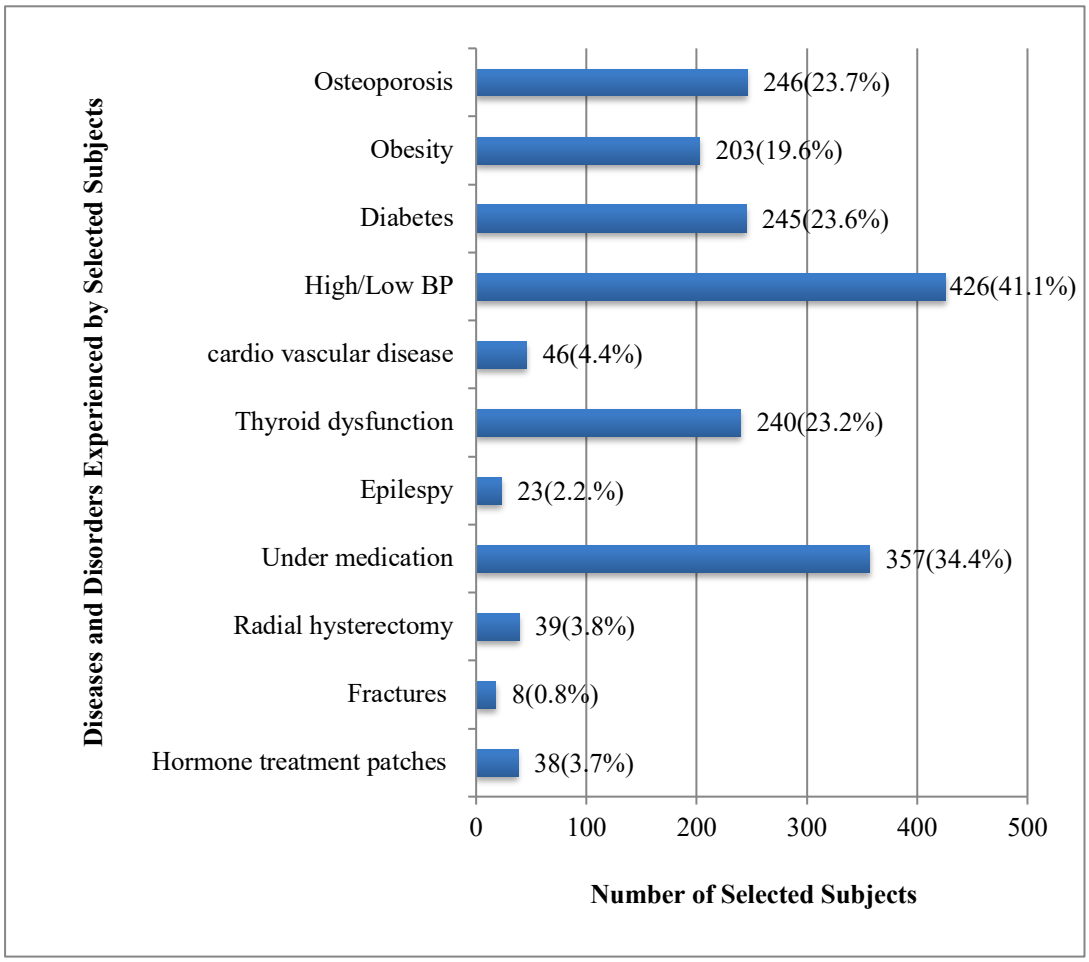


Figure XII - Self-History of Selected Subjects

Table XVII depicts the Body Mass Index of selected subjects.

Table XVII - Body Mass Index (BMI) of Selected Subjects

(N=1036)

BMI* Category	N	%
Underweight (<18.5)	262	25.3
Normal (18.5 - 22.9)	288	27.8
Overweight (23 - 24.9)	283	27.3
Obese(>=25)	203	19.6
	1036	100

*Asia Pacific Guidelines, 2017

Body Mass Index is the measure of body fat with respects to ones height and weight. BMI is calculated as per the formula weight divided by height in meter square. BMI is one of the risk factor of osteoporosis, when the BMI is less there are more chances of osteoporosis (Lee *et al.,* 2020 and Ha *et al.,* 2020). Table XVII depicts the BMI category of the selected subjects. A maximum of 288 subjects (27.8 percent) had a normal BMI. This was closely followed by the overweight category which had 283 subjects (27.3 percent subjects). About 262 subjects (25.3 percent) were under weight. A least number of 203 subjects (19.6 percent) were obese. Lee *et al.,* (2020) also found similar result in which women with a BMI < 18.5 kg/m^2 showed the highest risk for osteoporosis.

Table XVIII depicts the Knowledge on osteoporosis of selected subjects.

Table XVIII - Osteoporosis Knowledge Assessment of Selected Subjects

(N=1036)

Knowledge Assessment Scores*	N	%
Less than 50% of the score	680	65.6
More than 50% of the score	356	34.4
	1036	100

*OKAT (Winzenberg *et al.,* 2003)

In terms of preventing or managing health disorders, awareness on that particular disorder is an important factor. Hence testing and spreading of awareness remains the first step in management (Gopinathan *et al.,* 2016). Table XVIII depicts the scores on osteoporosis knowledge assessment of selected subjects. Majority of subjects

(65.6 percent) scored less than 50 percent score which represents inadequate knowledge of the study subjects relatively similar to that of study done by Senthilraja *et al.,* (2019) and 34.36 percent of subjects have scored above 50 percent of total score. This indicated that subjects had less knowledge on osteoporosis which could have been a risk factor for the same.

Phase II: Association of Risk Factors of Osteoporosis among Selected Subjects

Risk factors associated with osteoposis like Calcium intake, physical activity, BMI, exposure to sunlight and knowledge on osteoporosis were assessed and its associtaion with at risk subjects of various age groups are discussed below.

Table XIX shows the osteoporosis risk of selected subjects sing ORAI tool.

Table XIX- Risk Assessment using ORAI Tool

(N=1036)

	No risk		**At risk**		**Total**
	N	**%**	**N**	**%**	
Risk Assessment using ORAI *	358	34.6	**678**	65.4	1036

***** Cadarette *et al.,*2000

Risk assessment using ORAI methiod revelaed that 678 subejcts (65.4 percent) were at risk for the onset of Osteoporosis. The remaining 34.6 percent were not at risk as per the assessment tool. Low bone density was prevalant among nearly half or more than half of the menopausal subjects in India (Aggarwal *et al.,* 2011 and Shariati-Sarabi *et al.,* 2018). From this at risk subjects were identified to find the risk factors relating osteoporosis.

Table XX depicts the BMI of at risk subjects based on their age group.

Table XX- Body Mass Index of At Risk Subjects

(N=678)

BMI of At-Risk Subjects	Age group (Years)								Total	
	40-45		46-50		51-55		56-60			
BMI*	N	%	N	%	N	%	N	%	N	%
Underweight (<18.5)	66	27.0	99	37.5	19	26.0	22	22.7	206	30.4
Normal (18.5 - 22.9)	75	30.7	49	18.6	17	23.3	21	21.6	162	23.9
Overweight (23 - 24.9)	66	27.0	57	21.6	15	20.5	23	23.7	161	23.7
Obesity (>=25)	37	15.1	59	22.3	22	30.1	31	32.0	149	22.0
Total	244		264		73		97		**678**	

*Asia Pacific Guidelines, 2017

The BMI of subjects at risk as determined by the ORAI tool is depicted table XX. A majority of 206 (30.4 percent) subjects were classified under the category of underweight. Ninety nine of the 206 (30.4 percent) underweight subjects were in the age group of 46-50. This was followed by 162 (23.9 percent) subjects who had a normal BMI. Seventy five (30.7 percent) out of 162 (23.9 percent) subjects who had normal BMI were in the age group of 40-45. About 161 (23.7 percent) of the at risk subjects fell under the overweight category. Sixty six (27.0 percent) subjects were in the age groups of 40-45 years. And a total of 149 (22.0 percent) subjects were obese. Fifty nine (22.3 percent) subjects who were obese were in the age groups of 46-50 years. From this a risk factor of osteoporosis were assessed implying the first objective of the study.

Table XXI -Calcium Intake of At-Risk Subjects

(N=678)

Calcium Intake of At-Risk Subjects		Age group								Total	
		40-45		46-50		51-55		56-60			
		N	%	N	%	N	%	N	%	N	%
Calcium intake*	Adequate (>600mg)	57	23.4	70	26.5	13	17.8	27	27.8	167	24.6
	Low (600-300mg)	106	43.4	124	47.0	31	42.5	32	33.0	293	43.2
	Very low (<300mg)	81	33.2	70	26.5	29	39.7	38	39.2	218	32.1
	Total	244	100	264	100	73	100	97	100	**678**	100

*ICMR, 2010

Calcium is most important nutrient required to maintain bone mass. If intake of calcium decreases, there is bone loss thereby causing skeletal disorder and fractures (Rosen, 2019). A majority of 293 (43.2 percent) subjects had a very low calcium intake. Among the low intake group 106 (43.4 percent) subjects were in the age group of 40-45. A total of 218 (32.1 percent) subjects consumed very low level of calcium (<300mg). Among this group a majority of 81 (33.2 percent) subjects were again in the age group of 40-45s. One hundred and sixty seven (24.6 percent) subjects had adequate intake of calcium. Among this 70 (26.5 percent) belonged to the age group of 46-50.

Table XXII shows the physical activity of at risk subjects.

Table XXII - Physical Activity of At-Risk Subjects

(N=678)

Physical Activity of At-Risk Subjects	Age group								Total	
	40-45		46-50		51-55		56-60			
	N	%	N	%	N	%	N	%	N	%
Low	85	34.8	64	24.2	18	24.7	43	44.3	210	31.0
Moderate	85	34.8	112	42.4	26	35.6	19	19.6	242	35.7
High	74	30.3	88	33.3	29	39.7	35	36.1	226	33.3
Total	244	100	264	100	73	100	97	100	678	100

***** Craig *et al.,* 2003

Proper lifestyle choices are important in preventing osteoporosis and fracture. Physical activity is a critical factor in the prevention and treatment of low bone mass (Carter and Hinton., 2014). Physical activity of at risk subjects is discussed in the above table. It reveals that 210 (31 percent) subjects had a low level of Physical activity. Among the 210 (31 percent) subjects a majority of 85 (34.8 percent) subjects were in the age group of 40-45 years. About 226 (33.3 percent) subjects had a high level of Physical activity. Among this group 88 (33.3 percent) subjects belonged to the age group of 46-50 years. A maximum of 242 (35.7 percent) subjects had moderate Physical activity. Within this group 112 (42.4 percent) subjects were in the age group of 46-50. Study by Angeles *et al.,* (2010) suggests that Participating in moderate intensity physical activity decreased the risk of osteoporosis in both pre and postmenopausal women.

Table XXIII represents the sun exposure pattern of at risk subjects.

Table XXIII - Sun Exposure Pattern of At Risk Subjects

(N=678)

Sun exposure of At Risk Subjects	Age group								Total	
	40-45		46-50		51-55		56-60			
	N	%	N	%	N	%	N	%	N	%
Inadequate (<30minutes)	146	59.8	177	67.0	44	60.3	62	63.9	429	63.3
Adequate (>30 minutes)	98	40.2	87	33.0	29	39.7	35	36.1	249	36.7
Total	244	100	264	100	73	100	97	100	**678**	100

*Harinarayan, 2018

Vitamin D aids in the prevention of osteoporosis. For most of the people sunlight is an important source of vitamin D, which helps in the maintenance of bone health. Four hundred and twenty nine out of the 678 at risk subjects had inadequate exposure to sun light. A maximum of 177 (67.0 percent) within the inadequate exposure group were in the age group of 46-50 years. 249 (36.7 percent) subjects had adequate exposure to sun light. Within this group 98 subjects were in the age group of 40-45 years study by Ghosh *et al.,* (2021) also reveals the maximum of old age subjects had inadequate exposure to sunlight.

Table XXIV represents the osteoporosis knowledge assessment of at risk subjects.

Table XXIV - Osteoporosis Knowledge Assessment of At Risk Subjects

(N=678)

Osteoporosis Knowledge Assessment*	Age group								Total	
	40-45		46-50		51-55		56-60			
Scores Obtained	N	%	N	%	N	%	N	%	N	%
< 50%	117	48.0	186	70.5	57	78.1	90	92.8	450	66.4
>50%	127	52.0	78	29.5	16	21.9	7	7.2	228	33.6
Total	244	100	264	100	73	100	97	100	**678**	100

*OKAT (Winzenberg *et al.,* 2003)

It was necessary to evaluate the knowledge of the subjects on osteoporosis in order to identify the association between knowledge levels and the risk of onset of osteoporosis (Gopinathan *et al.,* 2016). The table XXIV represents the scores obtained by at risk subjects. Two hundred and twenty eight subjects scored above 50 percent and 450 (66.4 percent) subjects scored below 50 percent across all age groups. Majority of subjects (52 percent) who scored above 50 percent were between, 40 to 45 years and a majority of subjects (70.5 percent) who scored below 50 percent belonged to 46-50 years age category. Only 33.62 percent of at risk subjects had awareness on osteoporosis which is considerably similar to the study performed by Shaki *et al.,* (2021), where 37.9 percent subjects had awareness in osteoporosis.

Table XXV describes the association of overall risk factor of osteoporosis among at risk subjects.

Table XXV- Association of Overall Risk Factors of Osteoporosis

Variable	Mean SD	SE	F-value	Sig
Age	1.93±0.85	0.03	24.054	.000*
Calcium Intake	0.20±0.40	0.02	11.510	.001*
BMI	0.15±0.36	0.01	1.946	.163
Knowledge	2.37±1.13	0.04	76.314	.000*
Sun Exposure	0.49±0.50	0.03	4.373	.004*
Physical Activities	0.32±0.47	0.01	37.056	.000*

The table XXV shows the analysis between Age with Calcium, BMI, Knowledge, Sun Exposure, and Physical Activities. There is a statistically significant (at one percent level) difference among the means of the Age, Calcium, Knowledge, and Physical Activities with Risk and No-Risk respondents and there is no statistically significant relationship between BMI with Risk and No-Risk respondents. As the F value indicates, knowledge has the most association with Risk and no risk subjects followed by physical activity, age, calcium intake and finally exposure to sunlight. This is contrary to the study by Beyazal *et al.,* (2016) which found that there was no association between calcium intake and negligible positive correlation between osteoporosis risk and BMI.

To perform further study, among 678 at risk subjects 416 sub samples were selected to perform Bone Mineral Density (BMD) screening based on the subjects willingness to participate in awareness session, willingness to undergo BMD assessment and subjects having a smart phone.

Table XXVI reveals the Bone Mineral Density of selected sub samples with respective to their menopausal stages.

Table XXVI - Bone Mineral Density and Menopausal Stages of Selected Sub Samples

(N=416)

	Bone Mineral Density						**Total**	
	Normal BMD>-1		**Osteopenia -1 to -2.5**		**Osteoporosis <-2.5**			
Menopausal stages*	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Perimenopause	77	61.1	76	45.2	44	36.1	197	47.4
Menopause	40	31.7	52	31.0	28	23.0	120	28.8
Post menopause	9	7.1	40	23.8	50	41.0	99	23.8
Total	126		168		122		**416**	

*WHO,1996

Table XXVI shows the BMD of the selected subjects with respect to their menopausal stage. As revealed above 77 (61.1%) respondents at perimenopause stage have normal BMD. Around 76 (45.2%) subjects in the perimenopause stage were found to be osteopenic. Nearly 44 (36.1%) subjects in the same perimenopause were found to be osteoporotic. Almost 52 (31%) women in the menopause stage were found to be osteopenic. This was followed by 40 (23.8%) women who had a normal BMD in the Menopausal stage. A maximum of 50 (41%) post menopausal women were found to be osteoporotoic. This was followed by 40 subjects of the same group, who were osteopenic. A least number of 9 (7.1%) subjects in the post menopause stage had the normal Bone Mineral Density. From which one of the risk factor associated with the osteoporosis were identified. Most of the subjects were osteopenic which is similar to the study done by Looker *et al.,* (2015) where most of the post menopausal women

were osteoportic. Table XXVII highlights the socioeconomic status with respect to Bone Mineral Density of selected sub samples.

Table XXVII - Socio Economic Status and Bone Mineral Density of Selected Sub Samples

(N=416)

Socio economic status*	Bone Mineral Density						Total	
	Normal BMD>-1		Osteopenia -1 to -2.5		Osteoporosis <-2.5			
	N	%	N	%	N	%	N	%
Upper	16	12.9	14	8.3	5	4.1	35	8.4
Upper middle	40	32.3	52	30.8	27	22.0	119	28.6
Lower middle	30	24.2	46	27.2	34	27.6	110	26.4
Upper lower	29	23.4	38	22.5	38	30.9	105	25.2
Lower	9	7.3	19	11.2	19	15.4	47	11.3
Total	124	29.8	169	40.6	123	29.6	**416**	**100**

*Modified Kuppuswamy scale (Sheik, 2018)

Table XXVII highlights the Socio Economic status along with Bone Mineral status of the selected subjects. The table further reveals that the maximum number of subjects who had normal BMD belonged to the upper middle class segment of the society. Among the osteopenic subjects a majority of 52 (30.8 percent) subjects again belonged to upper middle class category. Thirty eight (22.5 percent) subjects who were osteoporotic belonged to the upper lower category, similarly study by Kim *et al.,* (2015) revealed that low family income had a significant relationship with low bone density. Among the 3 categories of normal, osteopenic and osteoporotoic, a maximum of 169 (40.6 percent) subjects were found to be osteopenic.

Table XXVIII - Bone Mineral Density and Physical Activity of Selected Sub Samples

(N=416)

Bone Mineral Density	**Normal BMD >-1**		**Osteopenia -1 to -2.5**		**Osteoporosis <-2.5**		**Total**		**P Value**	**Chi square value**
Physical activity*	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**		
High	40	31.7	39	23.2	18	14.8	97	23.3	0.028	14.15
Moderate	49	38.9	64	38.1	55	45.1	168	40.4		
Low	37	29.4	65	38.7	49	40.2	151	36.3		
Total	126	30.3	168	40.4	122	29.3	**416**	**100**		

*IPAQ (Craig et *al.,* 2003)

The table XXVIII depicts the association between BMD and physical activity. It indicates that the maximum number of 65 (38.7 percent) subjects performing low physical activity were osteopenic. The maximum number of 64 (38.1 percent) subjects performing moderate physical activity were also identified as osteopenic. A maximum of 40 (31.7 percent) subjects who had the high physical activity had a normal BMD. A least number of 18(14.8 percent) subjects who had high physical activity were prone to osteoporosis. Lack physical activity is one of the important modifiable risk factor of osteoporosis, hence proper physical, activity aids in prevention of osteoporosis (Borer, 2005; Carter *et al.,* 2014 and Pinheiro *et al.,* 2020).

Table XXIX highlights the bone mineral density and sun exposure pattern of selected sub samples.

Table XXIX - Bone Mineral Density and Sun Exposure Pattern of Selected Sub Samples

(N=416)

Bone Mineral Density	**Normal BMD >-1**		**Osteopenia -1 to -2.5**		**Osteoporosis <-2.5**		**Total**		**P value**	**Chi Square value**
Sun exposure*	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**		
Inadequate <30 mins	41	32.5	100	59.5	86	70.5	27	54.6	0.000	38.805
Adequate >30 mins	85	67.5	68	40.5	36	29.5	189	45.4		
Total	126	100	168	100	122	100	**416**	100		

*Harinarayan, 2018

Table XXIX elaborates the relationship between BMD and sun exposure of the selected subjects. The data highlights that maximum number of subjects (59.5 percent) with inadequate sun exposure were osteopenic. This was followed by 86 (70.5 percent) subjects who had inadequate sun light exposure were under the category of osteoporotic. Least number of 41(32.5 percent) subjects with inadequate sun light exposure had normal BMD. In contrast a majority of 85 (67.5 percent) subjects with adequate sun exposure had normal BMD. This was followed by 68 (40.5 percent) subjects with adequate sunlight being osteopenic. Only a least number of 36 (29.5 percent) subjects with adequate sun exposure were reported to be osteoporotic which is similar with the study done by Ardawi *et al.,* (2011) where least number of subjects has inadequate exposure to sunlight.

Table XXX related the nutrient intake and bone mineral density of selected sub samples.

Table XXX- Nutrient Intake and Bone Mineral Density of Selected Sub Samples

(N=416)

	Correlation	
	Pearson Correlation	**Sig. (2-tailed)**
Energy	0.171**	0.000
Carbohydrate	0.096*	0.050
Protein	0.202**	0.000
Fat	0.060	0.222
Fibre	0.183**	0.000

The table XXX relates the nutrient intake of sub sample with their bone mineral density. The table depicts that higher protein intake was associated with higher BMD (Sahni *et al.,* 2014) and fibre also had a significant relationship with bone mineral density unlike those of which fat did not have significant relation with bone mineral density. Among the nutrients protein had the strongest association with bone mineral density as its correlation value is higher than other nutrients.

Table XXXI- Calcium Intake and Bone Mineral Density of Selected Sub Samples

(N=416)

Calcium Intake*		**Bone Mineral Density**						**Total**		**P-value**	**Chi-square value**
		Normal BMD>-1		**Osteopenia -1 to -2.5**		**Osteoporosis <-2.5**					
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**		
Adequate	(>=600mg)	60	47.6	49	29.2	15	12.3	124	29.8		
Inadequate		48	38.1	72	42.9	41	33.6	161	38.7	0.00	59.87
Low intake 600-300mg											
Very low intake <300 mg		18	14.3	47	28.0	66	54.1	131	31.5		
Total		126		168		122		**416**			

*ICMR, 2010

The Table XXXI highlights the relationship between calcium intake and BMD. Maximum number of 66 (54.1 percent) subjects who had very low intake of calcium were osteoporotic in nature. A least number of 18 (14.3 percent) subjects in the same category (Less calcium intake) had the normal BMD. A majority of 72 (42.9 percent) subjects who had low intake (300-600 mg) were osteopenic. Forty one subjects (29.2

percent) under the same category were found to be osteoporotic. Among the subjects with a adequate calcium intake a majority of 60 (47.6 percent) subjects had the normal BMD. Nevertheless , 12.3 percent subjects with adequate calcium intake were osteoporotic which is similar to the research carried out by Unni *et al.,* (2010) in which the least number of subjects were osteoporotic who consumed adequate calcium.

Table XXXII - Association of Calcium Intake and Bone Mineral Density of Selected Sub Samples

(N=416)

	B value	**R^2**	**F**	**T**	**P value**
Constant	1.916	0.16	10.689	-12.673	0.000
Calcium intake	0.001			3.269	0.001

The Value of R^2 was 0.16. It revealed that BMD was explained by calcium intake to the extent of 16 percent. The value of F = 10.69, it showed that calcium intake alone significantly explained the BMD value. The estimated T value also confirmed the above result. Hence, null hypothesis (H0) is rejected. The estimated regression coefficient of calcium intake was positive. It indicated that increase in calcium intake had increased the BMD value of the selected samples.

Table XXXIII -Knowledge and Bone Mineral Density of Selected Sub Samples

(N=416)

Knowledge	**Bone Mineral Density***						**Total**	**P Value**	**Chi square value**
	Normal BMD >-1		**Osteopenia -1 to -2.5**		**Osteoporosis <-2.5**				
	N	**%**	**N**	**%**	**N**	**%**			
Less than 50% of the score	78	25.7	120	39.5	106	34.9	304	0.000	20.049
More than 50% of the score	48	42.8	48	42.9	16	14.3	112		
Total	126	30	168	40	122	29	416		

*WHO, 2007

Lack of awareness on osteoporosis is one of its significant risk factor. Thus, there is a need of standardized approach in promoting knowledge on bone health and healthy behaviors to decrease the risk of osteoporosis (Idrees *et al.,* 2018). Table XXXIII illustrates the association between BMD and the knowledge levels of the selected subjects. Majority of 120 subjects (39.5 percent) who had low knowledge Levels were found to be osteopenic. This was followed by 106 subjects (34.9 percent) with low knowledge levels and they were classified under the osteoporotic category. With respect to people with high awareness levels 48 subjects (42.9 percent) each fell under the category of normal BMD and osteopenic. A least number of 16 (14.3 percent) subjects with adequate knowledge were found to be osteoporotic.

The table shows that there was a statistically significant association between the knowledge of women about osteoporosis before awareness and BMD risk of the women respondents (X2(2) = 20.049a). This conveys that knowledge on osteoporosis is one of the risk factor of osteoporosis from which imply to a part of first objective of the study. According to Al-Ayyadhi *et al.,* 2020 similar result was identified which stated that inadequate knowledge on osteoporosis had positive association with BMD.

Phase III Development of Calcite (eggshell) Incorporated Recipes and Promotion of Bone Health through Awareness

Colour and texture:

The Eggshell powder was heated upto 900^0C. This was taken out at different temperatures for observation. At different temperatures, the color of the eggshell powder varied. During the final stage, the Eggshell calcite was white in color. The eggshell calcite powder resembled fine crystalline powder.

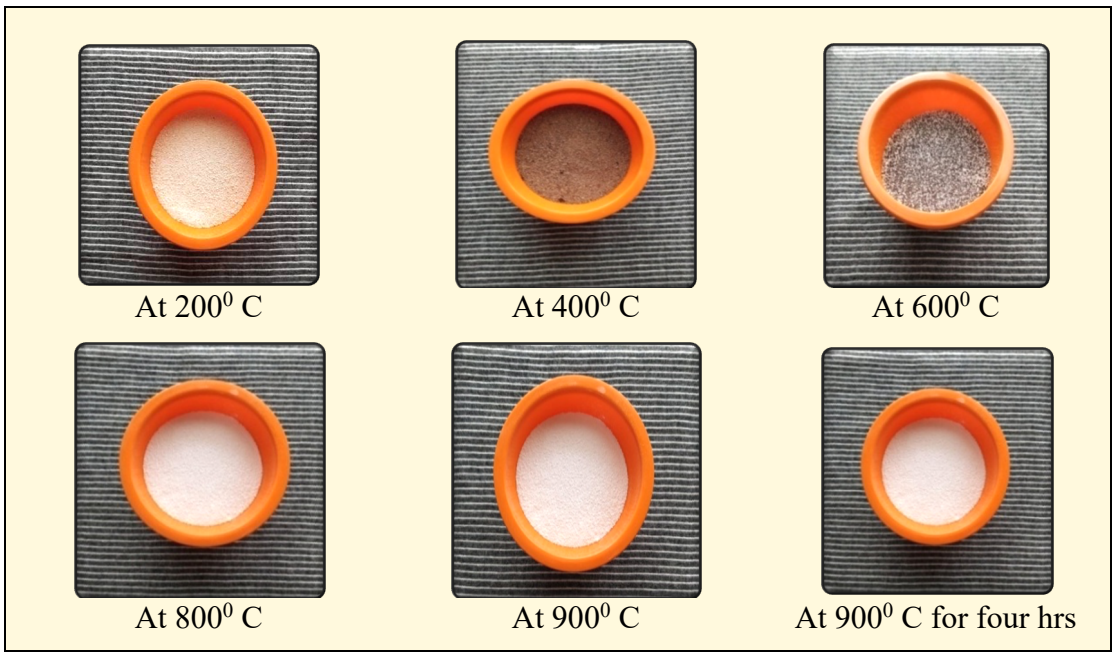


Plate 7 - Colour of Calcite Powder at Various Temperatures

Size and Surface morphology:

To know the size and surface morphology, the eggshell was viewed under a Field Emission Scanning Electron Microscope (FESEM). The eggshell powder and the developed eggshell calcite were compared and analyzed. Figure 2.1 and 2.2 are the Eggshell powder and Eggshell calcite powder respectively. The eggshell powder is viewed with the taking distance of 9.85 mm and at 5.0kV, the size of every particle falls between 40 – 1 micrometer sets. And the Figure 2.2 was viewed at a working distance of 5.93 mm at 5 KV. It showed that the particles of eggshell calcite powder measured between 157-81nanometer in size. The eggshell powder was roughly crystalline in structure. The Eggshell calcite powder was approximately spherical in shape as shown in Figure XIII.

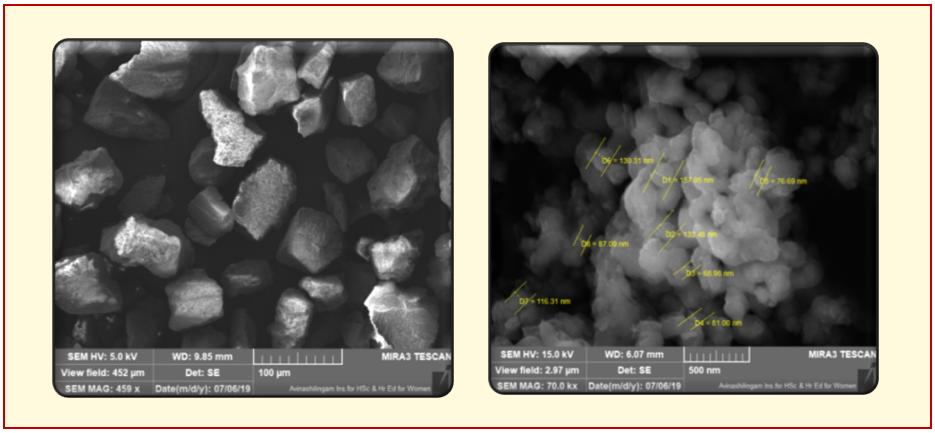


Figure XIII - Shape and Size of Calcite Powder

Calcium analysis of eggshell calcite powder:

Calcium estimation was done based on the AOAC method. And it was estimated that 97 percent of Calcium is present in the eggshell calcite powder.

Heavy Metal Analysis:

Table XXXIV -Estimation of Heavy Metals

S.No	Test Parameters	Test Result - Egg Shell powder	Test Result - Egg shell calcite powder
1	Lead	BDL* (DL:0.1 mg/kg)	BDL(DL:0.1 mg/kg)
2	Cadmium	BDL(DL:0.03 mg/kg)	BDL(DL:0.03 mg/kg)
3	Mercury	BDL (DL:0.1 mg/kg)	BDL(DL:0.1 mg/kg)
4	Arsenic	BDL(DL:0.05 mg/kg)	BDL(DL:0.05 mg/kg)

*Below Detectable Limit

Heavy metal analysis was done based on the AOAC.15.01. Lead, Cadmium, Mercury, Arsenic was analyzed and the results showed that all the heavy metals were below the detectable limit in both the eggshell powder and eggshell calcite powder.

Determination of Moisture:

Moisture content was determined by the AOAC 930.15 method. It was found that the eggshell calcite powder does not contain any inherent moisture.

Determination of Ash:

The ash content of eggshell powder was determined with the AOAC 942.05 method and it was found that eggshell contains 53.9 percent ash.

Sensory Evaluation of all the Formulated Recipes

After the development of calcite powder, a total of fifty calcite incorporated recipes were formulated under five categories namely starter, main dish, dessert, snacks, and Ready to Eat products. Under each of the above five categories, ten recipes each were developed. Around 50 recipes were prepared by incorporating the developed calcite powder in three variations as 250mg, 350mg and 450mg. After development of recipes, organoleptic evaluation was carried out with semi-trained panel members and the results were discussed.

Variety of dishes increases the food consumption thereby increasing the nutrient intake. The effect of variety on intake is generally thought to operate via the mechanism of sensory-specific satiety, the decline in the palatability of a food as it is consumed relative to uneaten foods that differ in sensory qualities (Embling *et al.,* 2021). Therefore variety of dishes should be included in a meal, considering which 50 variety of recipes are prepared in the present study and their sensory attributes were determined. The results are discussed below.

Table XXXV depicts the scores for sensory characteristic in the aspect of appearance of formulated ten starter recipes.

Table XXXV- Scores for Sensory Characteristic with Respect to the Aspect of Appearance of Formulated Starter Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Garlic soup	7.66± 0.24	7.60± 0.50	7.60± 0.50
Horse gram dhal soup	7.83± 0.24	7.86± 0.22	7.86± 0.22
Agathi soup	7.83± 0.24	7.83± 0.24	8.43± 0.56
Soya chunks kebab	7.56± 0.34	7.86± 0.22	7.86± 0.22
Thoothuvalai soup	8.13± 0.29	8.26± 0.41	7.06± 0.37
Vallarai soup	7.13± 0.29	7.13± 0.29	7.13± 0.29
Egg fingers	7.80± 0.31	7.83± 0.30	7.90± 0.43
Modakathan soup	7.36± 0.35	7.46± 0.44	7.46± 0.44
Greengram dhal sprouts salad	8.06± 0.62	8.20± 0.62	8.13± 0.58
Strawberry, cucumber salad	8.53± 0.29	8.53± 0.29	8.53± 0.29

The table XXXV represents the appearance scores for the starters. Among the starters prepared, all 3 samples of Strawberry, cucumber salad scored highest than the other 9 starters. This was closely followed by the sample 1 and sample 2 of the Thoothuvalai soup. Sample 1, sample 2 and sample 3 of the Green gram dhal sprouts salad stood 3rd among the 10 starters. With scores of 7.13 for all 3 samples, the Vallarai soup got the least scores in terms of appearance.

Table XXXVI shows the scores for sensory characteristic with respect to the aspect of appearance of formulated 10 main dishes.

Table XXXVI- Scores for Sensory Characteristic with Respect to the Aspect of Appearance of Formulated Main Dishes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Spanish omelette	8.43± 0.52	8.50± 0.43	8.56± 0.43
Mughlai paratha	8.16± 0.58	8.23± 0.53	8.26± 0.45
Cabbage ragi adai	8.66± 0.30	8.66± 0.30	8.60± 0.28
Wheat garlic pasta	8.00± 0.75	8.06± 0.67	8.03± 0.63
Ragi rotti	8.26± 0.72	7.90± 0.38	8.33± 0.67
Methipulav	8.03± 0.69	8.03± 0.71	7.96± 0.67
Amaranth leaves dosa	7.90± 0.60	7.83± 0.55	8.03± 0.78
Mint rice	7.90± 0.68	8.06± 0.77	6.60± 0.68
Manathakkali leaves rice	6.63± 0.66	6.00± 0.63	8.10± 0.54
Bajra kichdi	8.20± 0.45	8.20± 0.45	7.30± 0.41

The table XXXVI illustrates the scores for sensory characteristic with respect to the aspect of appearance of formulated main dishes. Among all the dishes prepared sample 1 and sample 2 of Cabbage ragi adai scored higher than the rest of the dishes. This was followed by sample 3 of Cabbage ragi adai. Sample 3 of Spanish omelette scored third place. The sample of Manathakkali leaves rice scored the least when compared to other main dishes and the sample of the same recipe scored the second least when compared to other main dishes.

Table XXXVII depicts scores for sensory characteristic on aspect of appearance of the 10 formulated dessert recipes.

Table XXXVII - Scores for Sensory Characteristic on Aspect of Appearance of Formulated Dessert Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Dates and almond brownie	8.30± 0.41	8.30± 0.41	8.33± 0.40
Carrot kheer	7.13± 0.29	7.46± 0.63	7.30± 0.52
Almond rabdi	7.13± 0.29	7.46± 0.63	7.30± 0.52
Fruit custard	7.13± 0.29	7.46± 0.63	7.30± 0.52
Fig ladoo	7.46± 0.44	7.50± 0.46	7.40± 0.47
Sweet yogurt	7.70± 0.36	7.86± 0.35	7.66± 0.58
Ragi semolina payasam	8.40± 0.54	8.60± 0.40	8.43± 0.41
Shrikhand	8.13± 0.58	8.16± 0.55	8.13± 0.61
Banana honey dessert	7.16± 0.58	7.23± 0.53	7.26± 0.45
Sweet bajra porridge	7.80± 0.64	8.00± 0.50	7.86± 0.48

The table XXXVII reveals the scores for the taste aspect of appearance of formulated dessert recipes. Among all the dessert recipes prepared samples 2, 3, and 1 of Ragi semolina payasam scored first, second, and third respectively when compared to other desserts. However, sample 1 of the Carrot kheer, Almond rabdi and Fruit custard desserts scored the least when compared to the rest of the desserts.

Table XXXVIII depicts the scores for sensory characteristic with respect to the aspect of appearance of formulated 10 snacks recipes.

Table XXXVIII -Scores for Sensory Characteristic of Appearance of Formulated Snacks Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Egg patties	7.86± 0.78	8.00± 0.68	8.06± 0.49
Flaxseed ladoo	8.22± 0.55	8.22± 0.55	8.25± 0.58
Multigrain bread paneer	8.00± 0.00	7.96± 0.74	8.10± 0.76
Soyabean vada	6.00± 0.00	6.00± 0.00	6.00± 0.00
Peanut chikki	6.00± 0.00	7.53± 0.63	7.53± 0.63
Kothimbirvadi	7.53± 0.63	8.16± 0.30	8.16± 0.30
Paneer cutlet	7.56± 0.17	8.06± 0.17	8.06± 0.17
Sesame seed balls	8.56± 0.36	8.56± 0.36	8.40± 0.47
Ragi banana pancake	8.50± 0.43	8.50± 0.43	8.50± 0.43
Wheat flour appam	8.53± 0.29	8.53± 0.29	8.43± 0.17

The table XXXVIII depicts the scores for the sensory characteristic of appearance of formulated snack recipes. Samples 1 and 2 of the Sesame seed balls scored the highest than all other dishes followed by Sample 1 and Sample 2 of the Wheat flour appam which stood second. Sample 3 of the Wheat flour appam scored third. Samples 1,2,3 of Soyabean vada and sample 1 of Peanut chikki scored least in the above table.

Table XXXIX represents scores for sensory characteristic appearance of formulated ready to eat products.

Table XXXIX- Scores for Sensory Characteristic of Appearance of Formulated Ready to Eat Products

Name of the Recipe	Sample 1	Sample 2	Sample 3
Drumstick leaves podi	7.50± 0.46	7.50± 0.62	8.00± 0.56
Curry leaves podi	8.06± 0.25	8.20± 0.41	8.20± 0.45
Groundnut chutney podi	8.16± 0.44	8.13± 0.54	8.56± 0.35
Garlic rice podi	8.50± 0.42	8.50± 0.42	8.40± 0.43
Thoor dhal podi	8.43± 0.45	8.43± 0.45	7.93± 0.49
Sesame seed podi	7.93± 0.37	8.03± 0.53	8.16± 0.55
Kollupodi	8.30± 0.67	8.26± 0.65	7.13± 1.04
Sundaikkai vathal podi	7.46± 0.97	7.53± 0.12	6.20± 0.86
Amla murabba	6.33± 0.89	6.70± 0.75	6.70± 0.75
Pumpkin seeds podi	7.23± 0.53	7.40± 0.50	7.53± 0.54

The table XXXIX highlights the scores for the appearance of formulated Ready-to-Eat products. Sample 3 of Groundnut chutney podi scored the highest among all other dishes followed by Sample 1 and Sample 2 of the Garlic rice podi which scored the second. Samples 1 and 2 of Thoor dhal podi scored third. Sample 3 of Sundakkai vathal podi scored the least in the above table. This was followed by sample 1 and sample of Amla murabba which had the second least acceptance scored.

Table XL depicts scores for flavor of formulated starter recipes.

Table XL - Scores for Sensory Characteristic of Flavour of Formulated Starter Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Garlic soup	7.73± 0.31	7.73± 0.31	7.73± 0.31
Horse gram dhal soup	7.90± 0.20	7.90± 0.20	7.90± 0.20
Agathi soup	7.96± 0.12	7.96± 0.12	8.10± 0.50
Soya chunks kebab	7.53± 0.35	7.56± 0.37	7.56± 0.37
Thoothuvalai soup	8.20± 0.72	8.23± 0.67	8.23± 0.67
Vallarai soup	7.20± 0.41	7.20± 0.41	7.20± 0.36
Egg fingers	8.13± 0.35	8.13± 0.35	8.13± 0.35
Modakathan soup	7.56± 0.45	7.56± 0.45	7.56± 0.45
Green gram dhal sprouts salad	8.60± 0.40	8.60± 0.40	8.60± 0.40
Strawberry, cucumber salad	8.86± 0.05	8.86± 0.05	8.86± 0.05

The table XL represents the scores for the sensory characteristic of flavor of the formulated Starter recipes. Samples 1, 2 and 3 of the Strawberry cucumber salad jointly scored the highest of all other dishes followed by samples 1, 2 and 3 of the Green gram dhal sprouts salad which stood second. Samples 2 and 3 of Thooduvalai soup scored third. Samples 1, 2 and 3 of Vallarai soup scored the least in terms of flavor when compared to other dishes.

Table XLI highlights scores for sensory characteristic of flavour of formulated main dishes.

Table XLI - Scores for Sensory Characteristic of Flavour of Formulated Main Dishes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Spanish omelette	8.46± 0.44	8.46± 0.44	8.53± 0.44
Mughlai paratha	8.23± 0.74	8.46± 0.51	8.43± 0.65
Cabbage ragi adai	8.86± 0.12	8.86± 0.12	8.90± 0.38
Wheat garlic pasta	8.63± 0.34	8.60± 0.34	8.60± 0.34
Ragi rotti	7.86± 0.76	7.93± 0.79	8.06± 0.65
Methi pulav	7.86± 0.76	7.93± 0.79	8.06± 0.65
Amaranth leaves dosa	8.23± 0.70	8.36± 0.64	8.30± 0.65
Mint rice	7.76± 0.56	7.70± 0.56	7.76± 0.56
Manathakkali leaves rice	6.86± 0.81	6.90± 0.78	6.70± 0.79
Bajra kichdi	8.26± 0.70	8.26± 0.70	8.26± 0.69

The table XLI highlights the scores for the sensory characteristic of flavor of formulated main dishes. Sample 3 of the Cabbage ragi adai scored the highest in terms of flavor among all dishes followed by sample 1 and 2 of the same dish which stood second. Sample 1 of the Wheat Garlic pasta scored third for flavor. Samples 1 of the Manathakkali leaves rice scored the least when compared to other dishes.

Table XLII depicts the scores for sensory characteristic in the aspect of flavour of formulated dessert recipes.

Table XLII- Scores for Sensory Characteristic of Flavour of Formulated Dessert Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Dates and almond brownie	8.40± 0.50	8.06± 0.88	8.43± 0.49
Carrot kheer	8.86± 0.08	8.86± 0.01	8.86± 0.01
Almond rabdi	7.43± 0.35	7.43± 0.35	7.26± 0.35
Fruit custard	7.46± 0.53	7.50± 0.53	7.50± 0.37
Fig ladoo	7.43± 0.71	7.50± 0.65	7.63± 0.65
Sweet yogurt	8.40± 0.26	8.23± 0.03	8.23± 0.02
Ragi semolina payasam	8.06± 0.47	8.16± 0.25	8.10± 0.25
Shrikhand	8.20± 0.72	8.23± 0.67	8.23± 0.63
Banana honey dessert	7.23± 0.84	7.46± 0.61	7.43± 0.65
Sweet bajra porridge	7.36± 0.06	7.16± 0.01	7.43± 0.13

The table XLII depicts the scores for sensory characteristic of the flavor of the formulated dessert recipes. Sample 2 of Sweet bajra porridge scored the least in the above table. Sample 1 of both dishes Sweet yogurt and Dates and almond brownie scored the third followed by sample 3 of Dates and almond brownie as the second. All the 3 samples of Carrot kheer topped the above respective table with respect to flavor.

Table XLIII discusses the scores for sensory characteristic of flavour of formulated snacks recipes.

TABLE XLIII - Scores for Sensory Characteristic of Flavour of Formulated Snacks Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Egg patties	8.00± 0.84	7.93± 0.79	8.20± 0.56
Flaxseed ladoo	8.16± 0.61	8.13± 0.61	8.16± 0.48
Multigrain bread paneer	7.63± 0.29	8.20± 0.90	8.20± 0.70
Soyabean vada	5.73± 0.41	5.76± 0.41	5.76± 0.82
Peanut chikki	7.83± 0.24	7.83± 0.24	7.83± 0.24
Kothimbir vadi	8.40± 0.28	8.40± 0.28	8.40± 0.28
Paneer cutlet	8.06± 0.17	8.06± 0.17	8.06± 0.17
Sesame seed balls	8.56± 0.36	8.56± 0.36	8.56± 0.36
Ragi banana pancake	8.36± 0.54	8.36± 0.54	8.36± 0.54
Wheat flour appam	8.43± 0.45	8.43± 0.31	8.40± 0.28

The table XLIII reveals the scores for the sensory characteristic of flavor of formulated snack recipes. Sample 1 of Soyabean vada scored the least when compared to other snack recipes. All the three samples of Kothimbir vadi along with the 3rd sample of Wheat flour appam scored the third. Samples1 and 2 of Wheat flour appam stood second. All three samples of Sesame seed balls stood first for flavours.

Table XLIV depicts scores for sensory characteristic of flavour of formulated ready to eat products.

TABLE XLIV - Scores for Sensory Characteristic of Flavour of Formulated Ready to Eat Products

Name of the Recipe	Sample 1	Sample 2	Sample 3
Drumstick leaves podi	7.50± 0.46	7.50± 0.46	7.40± 0.50
Curry leaves podi	8.33± 0.58	8.26± 0.56	8.33± 0.48
Groundnut chutney podi	8.13± 0.54	8.10± 0.57	8.16± 0.48
Garlic rice podi	8.53± 0.38	8.50± 0.46	8.50± 0.46
Thoor dhal powder	8.30± 0.64	8.16± 0.81	8.26± 0.72
Sesame seed podi	8.06± 0.42	7.76± 0.84	8.26± 0.45
Kollu podi	8.50± 0.45	8.23± 0.56	8.33± 0.44
Sundaikkai vathal podi	7.10± 0.96	7.03± 0.91	7.06± 0.96
Amla murabba	6.56± 0.97	6.60± 0.98	6.73± 0.09
Pumpkin seeds podi	7.43 ± 0.72	7.50± 0.62	7.33± 0.61

Table XLIV shows the scores for sensory characteristic of flavor of formulated ready-to-eat products. Sample 1 of Garlic rice podi topped the above table for flavour in the ready-to-eat products. Sample 1 of Kollu podi scored the second, followed by samples 2 and 3 of Garlic rice podi as third. Sample 1 of Amla murabba scored the least in terms of flavor when compared to the other formulated ready-to-eat products.

Table XLV depicts scores for sensory characteristic of colour of formulated starter recipes.

Table XLV - Scores for Sensory Characteristic of Colour of Formulated Starter Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Garlic soup	7.60 ± 0.60	7.60 ± 0.06	7.83 ± 0.30
Horse gram dhal soup	7.86 ± 0.29	7.86 ± 0.29	7.83 ± 0.24
Agathi soup	7.83 ± 0.24	8.03 ± 0.54	7.63 ± 0.29
Soya chunks kebab	7.63 ± 0.29	7.63 ± 0.29	7.83 ± 0.30
Thoothuvalai soup	8.00 ± 0.50	8.00 ± 0.50	8.13 ± 0.39
Vallarai soup	7.13 ± 0.35	7.20 ± 0.41	7.26 ± 0.31
Egg fingers	8.10 ± 0.28	8.10 ± 0.28	7.93 ± 0.41
Modakathan soup	7.73 ± 0.25	7.73 ± 0.25	7.70 ± 0.25
Greengram dhal sprouts salad	8.56 ± 0.31	8.56 ± 0.31	8.56 ± 0.31
Strawberry, cucumber salad	8.26 ± 0.41	8.60 ± 0.20	8.60 ± 0.20

The table XLV reveals the scores for the sensory characteristic of colour of formulated starter recipes. Sample 1 of Vallarai soup scored the least when compared to other starter recipes. Sample 2 and sample 3 of Strawberry, cucumber salad scored first among all the starter recipes. All the three samples of Green gram dhal sprouts salad scored second. Finally sample 1 of Strawberry cucumber salad scored third among the colour of all starter recipes.

Table XLVI highlights scores for sensory characteristic of colour of formulated main dishes.

Table XLVI - Scores for Sensory Characteristic of Colour of Formulated Main Dishes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Spanish omelette	8.50 ± 0.50	8.56 ± 0.35	8.63 ± 0.34
Mughlai paratha	8.16 ± 0.58	8.16 ± 0.58	8.23 ± 0.41
Cabbage ragi adai	8.76 ± 0.15	8.63 ± 0.22	8.76 ±0.15
Wheat garlic pasta	8.13 ± 0.48	8.16 ± 0.48	8.16 ± 0.48
Ragi rotti	8.26 ± 0.45	8.13 ± 0.39	8.26 ± 0.45
Methi pulav	8.16 ± 0.77	8.16 ± 0.77	8.23 ± 0.72
Amaranth leaves dosa	8.13 ± 0.48	8.06 ± 0.37	8.10 ± 0.54
Mint rice	8.10 ± 0.54	8.26 ± 0.37	8.13 ± 0.51
Manathakkali leaves rice	6.30 ± 0.41	6.53 ± 0.29	6.56 ± 0.25
Bajra kichdi	8.30 ± 0.64	8.36 ± 0.58	8.43 ± 0.45

Table XLVI depicts the scores for sensory characteristic of colour of formulated main dishes. Sample 1 and sample 3 of Cabbage ragi adai topped the above table for colour among other main dishes. Sample 2 of Cabbage ragi adai and sample 3 of Spanish omlette scored the second followed by sample 2 of Spanish omlette as third. Sample 1 of Manathakkali leaves rice scored the least in terms of colour when compared to the other formulated main dishes.

Table XLVII depicts the scores for sensory characteristic in the aspect of colour of formulated dessert recipes.

TABLE XLVII - Scores for Sensory Characteristic of Colour of Formulated Dessert Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Dates and almond brownie	8.26 ± 0.41	8.36 ± 0.39	8.03 ± 0.81
Carrot kheer	8.26 ± 0.41	8.26 ± 0.41	8.20 ± 0.52
Almond rabdi	8.80 ± 0.16	8.80 ± 0.16	8.80 ± 0.16
Fruit custard	7.23 ± 0.59	7.40 ± 0.57	7.40 ± 0.57
Fig ladoo	7.56 ± 0.53	7.70 ± 0.49	7.73 ± 0.45
Sweet yogurt	7.56 ± 0.49	7.63 ± 0.58	7.53 ± 0.61
Ragi semolina payasam	8.56 ± 0.42	8.56 ± 0.42	8.56 ± 0.42
Shrikhand	8.13 ± 0.78	8.23 ± 0.72	8.26 ± 0.72
Banana honey dessert	7.93 ± 0.86	8.10 ± 0.73	7.93 ± 0.84
Sweet bajra porridge	8.26 ± 0.41	8.36 ± 0.39	8.03 ± 0.81

The table XLVII depicts the scores for sensory characteristic of the colour of the formulated dessert recipes. Sample 1 of fruit custard scored the least in terms of color characteristic among all the dessert recipes. Sample 1, 2 & 3 Almond rabdi scored first among all the dessert dishes prepared. Similarly samples 1, 2 & 3 Ragi semolina payasam scored second for the colour characteristic. Sample 2 of both Sweet bajra porridge and dates and almond brownie had a score of 8.36 and stood joint third.

Table XLVIII discusses the scores for sensory characteristic of colour of formulated snacks recipes.

TABLE XLVIII - Scores for Sensory Characteristic of Colour of Formulated Snacks Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Egg patties	8.06 ± 0.67	8.06 ± 0.65	8.26 ± 0.53
Flaxseed ladoo	8.20 ± 0.78	8.26 ± 0.72	8.33 ± 0.64
Multigrain bread paneer	8.10 ± 0.82	8.10 ± 0.82	8.16 ± 0.64
Soyabean vada	6.06 ± 0.45	6.13 ± 0.51	5.73 ± 0.75
Peanut chikki	8.00 ± 0.00	8.00 ± 0.00	7.83 ± 0.24
Kothimbir vadi	8.30 ± 0.25	8.30 ± 0.25	8.30 ± 0.25
Paneer cutlet	8.33 ± 0.36	8.33 ± 0.36	8.33 ± 0.36
Sesame seed balls	8.46 ± 0.51	8.46 ± 0.51	8.40 ± 0.54
Ragi banana pancake	8.40 ± 0.54	8.16 ± 0.30	8.96 ± 0.02
Wheat flour appam	8.95 ± 0.03	8.66 ± 0.24	7.60 ± 0.60

The table XLVIII highlights the scores for sensory characteristic in the aspect of the colour of formulated snacks recipes. Sample 3 of Ragi banana pancake was on top of the above table with a best score of 8.96. This was followed by sample 1 of Wheat flour appam in the second place with a score of 8.95. Sample 2 of wheat flour appam scored the third. Sample 3 of soya been vada scored the least in terms of colour when compared to other recipes from the above table.

Table XLVII depicts scores for sensory characteristic of colour of formulated ready to eat products.

Table XLIX- Scores for Sensory Characteristic of Colour of Formulated Ready to Eat Products

Name of the Recipe	Sample 1	Sample 2	Sample 3
Drumstick leaves podi	7.33 ± 0.40	7.33 ± 0.40	7.43 ± 0.59
Curry leaves podi	8.33 ± 0.48	8.26 ± 0.49	8.33 ± 0.58
Groundnut chutney podi	8.46 ± 0.48	8.46 ± 0.48	8.50 ± 0.59
Garlic rice podi	8.23 ± 0.41	8.23 ± 0.41	8.23 ± 0.41
Thoor dhal powder	8.10 ± 0.43	8.10 ± 0.43	7.96 ± 0.58
Sesame seed podi	8.23 ± 0.25	8.13 ± 0.22	8.10 ± 0.33
Kollupodi	8.40 ± 0.52	8.40 ± 0.52	8.40 ± 0.52
Sundaikkai vathal podi	7.63 ± 0.76	7.56 ± 0.70	7.70 ± 0.79
Amla murabba	6.36 ± 0.54	6.00 ± 1.19	6.10 ± 1.29
Pumpkin seeds podi	6.66 ± 0.81	6.93 ± 0.59	7.00 ± 0.73

Table XLIX shows the scores for sensory characteristic of colour of formulated ready-to-eat products. Sample 3 of Groundnut chutney podi with a score of 8.5 topped the above table for colour in the ready-to-eat products which was followed by Sample 1 and 2 of the same dish which scored the second with a score of 8.46 Samples 1 & 3 of Curry leaves podi came in the third place. Sample 2 of Amla murabba scored the least in terms of colour when compared to the other formulated ready-to-eat products.

Table L depicts scores for sensory characteristic of texture of formulated starter recipes.

Table L - Scores for Sensory Characteristic of Texture of Formulated Starter Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Garlic soup	7.80± 0.37	7.80± 0.37	7.80± 0.31
Horse gram dhal soup	7.76± 0.47	7.76± 0. 47	7.80± 0.56
Agathi soup	8.10± 0.44	8.10± 0.43	8.23± 0.47
Soya chunks kebab	7.33± 0.74	7.40± 0.67	7.40± 0.67
Thoothuvalai soup	8.53± 0.39	8.56± 0.38	8.56± 0.36
Vallarai soup	6.86± 0.37	6.90± 0.37	7.00± 0.43
Egg fingers	8.00± 0.39	8.00± 0.39	8.10± 0.44
Modakathan soup	7.63± 0.59	7.63± 0.59	7.66± 0.56
Greengram dhal sprouts salad	8.26± 0.29	8.26± 0.35	8.20± 0.36
Strawberry, cucumber salad	8.53± 0.38	8.86± 0.08	8.83± 0.09

The table L depicts the scores for the sensory characteristic of texture of formulated starter recipes. Samples 2 and 3 of Strawberry cucumber salad scored the first and second in terms of texture among the formulated starter recipes followed by samples 2 and 3 of Thoodhuvalai soup which stood third. Sample 1 of Vallarai Soup scored the least in the above respective table.

Table LI shows scores for sensory characteristic of texture of formulated main dishes.

TABLE LI - Scores for Sensory Characteristic of Texture of Formulated Main Dishes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Spanish omelette	8.50± 0.43	8.56± 0.39	8.63± 0.28
Mughlai paratha	7.96± 0.45	8.00± 0.49	8.13± 0.49
Cabbage ragi adai	8.76± 0.18	8.86± 0.07	8.90±0.08
Wheat garlic pasta	8.76± 0.16	8.86± 0.06	8.90± 0.05
Ragi rotti	8.16± 0.72	8.00± 0.65	8.13± 0.55
Methipulav	8.03± 0.42	8.03± 0.37	8.16± 0.39
Amaranth leaves dosa	8.16± 0.55	8.23± 0.55	8.33± 0.54
Mint rice	8.00± 0.45	7.93± 0.45	7.86± 0.72
Manathakkali leaves rice	7.53± 0.29	7.53± 0.29	7.67± 0.48
Bajra kichdi	8.23± 0.31	8.20± 0.25	8.10± 0.33

The table LI reveals the scores for sensory characteristic of texture of formulated main dishes. Samples 1 and 2 of Manathakkali leaves rice scored the least in terms of texture. Sample 1 of wheat garlic pasta and cabbage ragi adai scored third best score for texture with a score of 8.90, sample 3 of cabbage ragi adai and sample 3 of Wheat garlic pasta jointly stood first. The second best score for texture was grabbed by sample 2 of Cabbage ragi adai and Wheat garlic pasta jointly.

Table LII depicts scores for sensory characteristic of texture of formulated dessert recipes.

Table LII - Scores for Sensory Characteristic of Texture of Formulated Dessert Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Dates and almond brownie	7.96± 0.52	8.06± 0.52	8.13± 0.52
Carrot kheer	8.20± 0.45	8.20± 0.45	8.20± 0.45
Almond rabdi	8.73± 0.19	8.73± 0.21	8.73± 0.19
Fruit custard	7.26± 0.56	7.33± 0.56	7.20± 0.59
Fig ladoo	7.73± 0.36	7.80± 0.36	7.73± 0.36
Sweet yogurt	7.66± 0.65	7.93± 0.63	7.93± 0.63
Ragi semolina payasam	8.70± 0.27	8.70± 0.21	8.70± 0.20
Shrikhand	8.06± 0.53	8.10± 0.56	8.10± 0.54
Banana honey dessert	7.13± 0.84	7.36± 0.61	7.33± 0.65
Sweet bajra porridge	7.40± 0.61	7.46± 0.56	7.60± 0.61

The table LII highlights the scores for sensory characteristic in the aspect of the texture of formulated dessert recipes. Sample 2 of Almond rabdi was on top of the above table followed by samples 1 and 3 of the same dish in the second place. All the 3 samples of Carrot kheer scored the third. Banana honey dessert scored the least in texture when compared to other recipes from the above table.

Table LIII highlights scores for sensory characteristic of texture of formulated snacks recipes.

Table LIII - Scores for Sensory Characteristic of Texture of Formulated Snacks Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Egg patties	8.00 ± 0.73	7.96±0.69	8.10± 0.66
Flaxseed ladoo	8.20± 0.62	8.26± 0.53	8.33± 0.52
Multigrain bread paneer	8.13± 0.63	8.10± 0.63	8.13±0.58
Soyabean vada	5.83± 0.52	5.80± 0.45	5.93± 0.37
Peanut chikki	8.00± 0.00	8.00± 0.00	7.83± 0.24
Kothimbir vadi	8.16± 0.30	8.16± 0.30	8.16± 0.30
Paneer cutlet	8.26± 0.31	8.26± 0.31	8.26± 0.31
Sesame seed balls	8.43± 0.56	8.43± 0.56	8.43± 0.56
Ragi banana pancake	8.66± 0.35	8.66± 0.35	8.70± 0.12
Wheat flour appam	8.76± 0.21	8.76± 0.21	8.96± 0.01

Sample 3 of Wheat flour appam returned the best score for the texture characteristic with the highest score of 8.96. This was followed by the samples of 1 and 2 of Wheat flour appam which stood second with the score of 8.76. The Third place for texture was captured by sample 3 of Ragi banana pancake with a score of 8.70. Sample 2 of Soya bean vada scored the least in terms of texture among the snack recipes.

Table LIV shows scores for texture of formulated ready to eat products.

Table LIV- Scores for Sensory Characteristic of Texture of Formulated Ready to Eat Products

Name of the Recipe	Sample 1	Sample 2	Sample 3
Drumstick leaves podi	8.10± 0.50	8.06± 0.56	8.10± 0.50
Curry leaves podi	8.46± 0.48	8.26± 0.53	8.26± 0.53
Groundnut chutney podi	8.03± 0.63	8.03± 0.63	8.03± 0.63
Garlic rice podi	8.16± 0.30	8.13± 0.35	8.23± 0.37
Thoor dhal powder	8.40± 0.60	8.40± 0.60	8.40± 0.60
Sesame seed podi	7.60± 0.76	7.53± 0.69	7.66± 0.77
Kollu podi	5.66± 0.63	6.16± 0.12	6.60± 0.05
Sundaikkai vathal podi	6.93± 0.41	7.13± 0.22	7.26± 0.45
Amla murabba	8.80± 0.16	8.70± 0.29	8.70± 0.29
Pumpkin seeds podi	8.80± 0.16	8.70± 0.26	8.70± 0.27

Sample 1 of both Pumpkin seed podi and Amla murabba stood first in terms of texture among the Ready-To-Eat products. Recipes developed with the score of 8.70, the sample 2 and 3 of both Amla murabba and Pumpkin seeds podi scored second. Sample 1 of Curry leaves podi scored third among the Ready-To-Eat products. Sample 1 of the Kollu podi had the lest acceptable score of 5.66 for texture among the recipes.

The main reason that individuals choose particular foods is because they like the taste. While palatability of foods was found to be a major determinant of intake in an extensive review of the literature on human food intake.

Table LV depicts scores for sensory characteristic of taste of formulated starter recipes.

Table LV- Scores for Sensory Characteristic of Taste of Formulated Starter Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Garlic soup	7.86± 0.35	7.86± 0.35	7.86± 0.35
Horse gram dhal soup	7.83± 0.30	7.83± 0.30	7.83± 0.30
Agathi soup	7.90± 0.54	7.90± 0.54	8.16± 0.58
Soya chunks kebab	7.43± 0.49	7.70± 0.31	7.80± 0.36
Thoothuvalai soup	8.23± 0.70	8.36± 0.61	8.40± 0.58
Vallarai soup	6.86± 0.39	6.96± 0.29	7.20± 0.41
Egg fingers	7.83± 0.48	7.86± 0.44	8.00± 0.53
Modakathan soup	7.33± 0.40	7.43± 0.37	7.46± 0.44
Greengram dhal sprouts salad	7.90± 0.71	7.90± 0.71	7.93± 0.70
Strawberry, cucumber salad	8.13± 0.48	8.13± 0.48	8.13± 0.48

The table LVI represents the scores for the sensory characteristic of taste of formulated starter recipes. Sample 3 of Thoothuvalai Soup topped the above table followed by samples 2 and 1 of the same dish which came in second and third respectively. Sample 1 of Vallarai Soup scored the least in taste characteristic when compared to other starter recipes.

Table LVI depicts scores for sensory characteristic of taste of formulated main dishes.

Table LVI - Scores for Sensory Characteristic of Taste of Formulated Main Dishes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Spanish omelette	7.96± 0.56	8.10± 0.54	8.03± 0.58
Mughlai paratha	8.70± 0.24	8.60± 0.38	8.66± 0.32
Cabbage ragi adai	8.06± 0.60	8.06± 0.48	8.06± 0.72
Wheat garlic pasta	7.80± 0.59	7.93± 0.59	8.00± 0.62
Ragi rotti	7.96± 0.65	8.03± 0.62	8.10± 0.71
Methipulav	8.13± 0.63	8.13± 0.76	8.16± 0.66
Amaranth leaves dosa	7.96± 0.66	7.96± 0.67	8.00± 0.71
Mint rice	6.60± 0.71	6.80± 0.70	6.83± 0.68
Manathakkali leaves rice	8.23± 0.52	8.23± 0.48	8.10± 0.70
Bajra kichdi	7.66± 0.70	7.66± 0.70	7.70± 0.68

The table LXIV reveals the scores for the sensory characteristic of taste of formulated main dishes. Sample 1 of Mint rice scored the least when compared to other main dishes with respect to taste. Sample 1 and 2 of Manathakkali leaves rice scored

the third with the score of 8.23. Sample 1 of Mughlai paratha with a score of 8.70 stood first for taste among the main dish recipes prepared.

Table LVII scores for sensory characteristic of taste of formulated dessert recipes.

Table LVII - Scores for Sensory Characteristic of Taste of Formulated Dessert Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Dates and almond brownie	8.13± 0.48	8.13± 0.48	8.20± 0.49
Carrot kheer	8.50± 0.32	8.50± 0.32	8.50± 0.32
Almond rabdi	8.73± 0.23	8.73± 0.23	8.73± 0.23
Fruit custard	7.16± 0.30	7.66± 0.52	7.50± 0.46
Fig ladoo	7.60± 0.43	7.93± 0.17	7.86± 0.22
Sweet yogurt	7.93± 0.25	7.96± 0.12	7.96± 0.12
Ragi semolina payasam	8.86± 0.05	8.70± 0.26	8.70± 0.26
Shrikhand	7.70± 0.49	7.70± 0.48	7.70± 0.48
Banana honey dessert	8.43± 0.56	8.43± 0.50	8.53± 0.40
Sweet bajra porridge	8.43± 0.56	8.43± 0.50	8.53± 0.40

With a score of 8.86, sample 1 of Ragi semolina payasam stood first in terms of taste. This was followed by all the three samples of Almond rabdi with the score of 8.73 came second. With a least score of 7.16, sample 1 of Fruit custard stood last in terms of taste.

Table LVIII depicts scores for sensory characteristic of taste of formulated snacks recipes.

Table LVIII - Scores for Sensory Characteristic of Taste of Formulated Snacks Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Egg patties	7.80±0.81	7.93± 0.65	8.16± 0.61
Flaxseed ladoo	8.30± 0.56	8.26± 0.56	8.23± 0.59
Multigrain bread paneer	8.33± 0.61	8.33± 0.61	8.36± 0.63
Soyabean vada	5.90± 0.50	5.96± 0.58	5.86± 0.61
Peanut chikki	8.00± 0.00	8.00± 0.00	8.00± 0.00
Kothimbir vadi	8.30± 0.25	8.30± 0.25	8.30± 0.25
Paneer cutlet	8.26± 0.31	8.26± 0.31	8.26± 0.31
Sesame seed balls	8.03± 0.29	8.03± 0.29	8.03± 0.29
Ragi banana pancake	8.50± 0.49	8.50± 0.49	8.46± 0.39
Wheat flour appam	8.83± 0.10	8.83± 0.10	8.50± 0.26

The table LVIII depicts the scores for the characteristic of taste of formulated snack recipes. Samples 1,2 of Wheat flour appam topped the table followed by samples 1, 2 of Ragi banana pancake and sample 3 of Wheat flour appam which stood second. Sample 1 of Soyabean vada scored the least when compared to other snack recipes.

Table LIX highlights scores for sensory characteristic of taste of formulated ready to eat products.

Table LIX - Scores for Sensory Characteristic of Taste of Formulated Ready to Eat Products

Name of the Recipe	Sample 1	Sample 2	Sample 3
Drumstick leaves podi	6.66 ± 0.44	6.46 ± 0.35	8.20 ± 0.45
Curry leaves podi	8.20 ± 0.45	8.20 ± 0.45	7.26 ± 0.25
Groundnut chutney podi	7.33 ± 0.24	7.53 ± 0.48	8.20 ± 0.25
Garlic rice podi	8.16 ± 0.30	8.13 ± 0.29	8.16± 0.44
Thoor dhal powder	8.10 ± 0.54	8.13 ± 0.54	8.36 ± 0.44
Sesame seed podi	8.36 ± 0.44	8.46 ± 0.48	8.40 ± 0.43
Kollu podi	8.50 ± 0.43	8.56 ± 0.39	8.50 ± 0.43
Sundaikkai vathal podi	8.23 ± 0.25	8.13 ± 0.22	8.23 ± 0.25
Amla murabba	8.43 ± 0.49	8.53 ± 0.41	8.43 ± 0.57
Pumpkin seeds podi	7.46 ± 1.00	7.43 ± 0.94	7.83 ± 0.85

The table LIX interprets the scores for taste of formulated ready-to-eat products. Sample 2 of Kollu podi tops the above table in terms of taste when compared to other formulated ready-to-eat products in taste. Sample 2 of Amla murabba scored the second and samples 1 and 3 of Kollu podi stood third. Sample 2 of Drumstick leaves podi scored the least when compared to other ready-to-eat products.

Table LX depicts scores for sensory characteristic of overall acceptance of formulated starter recipes.

Table LX- Scores for Sensory Characteristic of Overall Acceptance of Formulated Starter Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Garlic soup	7.80 ± 0.25	7.60 ± 0.50	7.60 ± 0.50
Horse gram dhal soup	7.83 ± 0.24	7.86 ± 0.22	7.86 ± 0.22
Agathi soup	7.83 ± 0.24	7.83 ± 0.24	8.26 ± 0.45
Soya chunks kebab	7.66 ± 0.24	7.70 ± 0.25	7.80 ± 0.25
Thoothuvalai soup	8.23 ± 0.67	8.23 ± 0.67	8.20 ± 0.52
Vallarai soup	7.00 ± 0.26	7.00 ± 0.26	7.00 ± 0.26
Egg fingers	8.03 ± 0.29	7.83 ± 0.40	7.86 ± 0.44
Modakathan soup	7.50 ± 0.46	7.36 ± 0.35	7.43 ± 0.37
Greengram dhal sprouts salad	8.43 ± 0.41	8.43 ± 0.41	8.43 ± 0.41
Strawberry, cucumber salad	8.53 ±0.29	8.53 ± 0.29	8.53 ± 0.29

The table LX explains the scores for the overall acceptance of formulated starter recipes. Sample 1,2 and 3 of Strawberry, cucumber salad tops the above table in terms of overall acceptance. Samples 1,2 and 3 of Green gram dhal sprouts stood second followed by samples 1 and 2 of Thoothuvalai soup third. Sample 1, 2 and 3 of Vallarai soup with the score of 7.0 scored the least when compared to other starter recipes.

Table LXI highlights scores for sensory characteristic of overall acceptance of formulated main dishes.

Table LXI - Scores for Sensory Characteristic of Overall Acceptance of Formulated Main Dishes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Spanish omelette	8.50 ± 0.43	8.50 ± 0.43	8.20 ± 0.49
Mughlai paratha	8.20 ± 0.49	8.20 ± 0.41	8.96 ± 0.02
Cabbage ragi adai	8.96 ± 0.02	8.63 ± 0.22	8.76 ± 0.19
Wheat garlic pasta	8.76 ± 0.19	8.53 ± 0.35	7.93 ± 0.72
Ragi rotti	7.93 ± 0.07	7.90 ± 0.63	8.20 ± 0.77
Methi pulav	8.20 ± 0.72	8.20 ± 0.41	8.30 ± 0.41
Amaranth leaves dosa	8.10 ± 0.38	8.36 ± 0.29	7.86 ± 0.51
Mint rice	8.03 ± 0.66	8.13 ± 0.61	8.16 ± 0.64
Manathakkali leaves rice	8.06 ± 0.72	8.13 ± 0.61	7.96 ± 0.63
Bajra kichdi	7.93 ± 0.65	8.03 ± 0.66	6.80 ± 0.49

The table LXI shows the score of the overall acceptance of formulated main dishes. Sample 1 of Cabbage ragi adai and sample 3 of Mughlai paratha top the above

table followed by sample 3 of Cabbage ragi adai and sample 1 of Wheat garlic pasta which scored the second place. And the sample 2 of Cabbage ragi adai scored the third. Sample 3 of Bajra kachdi with a score of 6.0 scored the least when compared to other main dishes.

Table LXII projects the scores for sensory characteristic of overall acceptance of formulated dessert recipes.

Table LXII- Scores for Sensory Characteristic of Overall Acceptance of Formulated Dessert Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Dates and almond brownie	8.30 ± 0.41	8.30 ± 0.41	8.30 ± 0.41
Carrot kheer	8.50 ± 0.32	8.50 ± 0.32	8.50 ± 0.32
Almond rabdi	8.63 ± 0.35	8.80 ± 0.16	8.80 ± 0.16
Fruit custard	7.30 ± 0.52	7.63 ± 0.39	7.63 ± 0.39
Fig ladoo	7.56 ± 0.53	7.63 ± 0.48	7.60 ± 0.50
Sweet yogurt	8.03 ± 0.22	7.90 ± 0.43	7.76 ± 0.53
Ragi semolina payasam	8.46 ± 0.44	8.60 ± 0.40	8.43 ± 0.41
Shrikhand	8.16 ± 0.55	8.20 ± 0.52	8.13 ± 0.61
Banana honey dessert	7.30 ± 0.67	7.36 ± 0.69	7.36 ± 0.58
Sweet bajra porridge	8.13 ± 0.51	8.16 ± 0.44	7.96 ± 0.63

The table LXII depicts the scores for the acceptance of formulated dessert recipes. Samples 2 and 3 of Almond rabdi with a score of 8.80 stood first in the above table. Sample 1 of Almond rabdi scored second with a score of 8.63. The Third place for overall acceptance among dessert recipes was graded by sample 2 of Ragi semolina payasam. Sample 1 of Fruit Custard scored the least when compared to other dessert recipes.

Table LXIII shows scores for sensory characteristic of overall acceptance of formulated snacks recipes.

Table LXIII - Scores for Sensory Characteristic of Overall Acceptance of Formulated Snacks Recipes

Name of the Recipe	Sample 1	Sample 2	Sample 3
Egg patties	8.10 ± 0.68	8.10 ± 0.57	8.06 ± 0.37
Flaxseed ladoo	8.10 ± 0.54	8.06 ± 0.53	8.10 ± 0.50
Multigrain bread paneer	8.30 ± 0.67	8.36 ± 0.59	8.36 ± 0.58
Soyabean vada	5.56 ± 0.41	5.53 ± 0.44	5.63 ± 0.54
Peanut chikki	7.66 ± 0.48	7.66 ± 0.48	7.83 ± 0.24
Kothimbir vadi	8.20 ± 0.25	8.20 ± 0.25	8.20 ± 0.25
Paneer cutlet	7.96 ± 0.22	7.96 ± 0.22	7.96 ± 0.22
Sesame seed balls	8.40 ± 0.50	8.40 ± 0.50	8.23 ± 0.31
Ragi banana pancake	8.70 ± 0.21	8.70 ± 0.21	8.70 ± 0.21
Wheat flour appam	8.90 ± 0.08	8.60 ± 0.28	8.50 ± 0.18

The table LXIII reveals the scores obtained for the overall acceptance of formulated snacks recipes. Sample 2 of Soyabean Vada scored the least from the above table. Samples 1 and 2 of Wheat flour appam scored the first and third places respectively, followed by all the three samples of Ragi banana pancake as second with identified score of 8.70.

Table LXIV depicts scores for sensory characteristic of overall acceptance of formulated ready to eat products.

Table LXIV- Scores for Sensory Characteristic of Overall Acceptance of Formulated Ready to Eat Products

Name of the Recipe	Sample 1	Sample 2	Sample 3
Drumstick leaves podi	6.66 ± 0.44	6.46 ± 0.35	8.20 ± 0.45
Curry leaves podi	8.20 ± 0.45	8.20 ± 0.45	7.26 ± 0.25
Groundnut chutney podi	7.33 ± 0.24	7.53 ± 0.48	8.20 ± 0.25
Garlic rice podi	8.16 ± 0.30	8.13 ± 0.29	8.16± 0.44
Thoor dhal powder	8.10 ± 0.54	8.13 ± 0.54	8.36 ± 0.44
Sesame seed podi	8.36 ± 0.44	8.46 ± 0.48	8.40 ± 0.43
Kollu podi	8.50 ± 0.43	8.56 ± 0.39	8.50 ± 0.43
Sundaikkai vathal podi	8.23 ± 0.25	8.13 ± 0.22	8.23 ± 0.25
Amla murabba	8.43 ± 0.49	8.53 ± 0.41	8.43 ± 0.47
Pumpkin seeds podi	7.46 ± 1.00	7.43 ± 0.94	7.83 ± 0.85

The table LXIV shows the scores for overall acceptance of formulated ready-to-eat products. Sample 2 of Kollu podi topped the above table in terms of overall acceptance when compared to other acceptance of formulated ready-to-eat products. Samples 1 and 3 of the same dish with the score of 8.50 stood third. Sample 2 of Amla murabba scored the second. Sample 2 of Drumstick leaves podi scored the least when compared to other ready-to-eat products.

Table LXV shows mean organoleptic evaluation among starters.

Table LXV - Mean Organoleptic Evaluation among Starters

	Sample 1	Sample 2	Sample 3
Appearance	8.16±0.65	8.12±0.60	8.14±0.55
Flavour	8.09±0.62	8.18±0.57	8.18±0.53
Colour	8.12±0.82	8.12±0.63	8.16±0.57
Texture	8.16±0.72	8.18±0.70	8.16±0.54
Taste	8.18±0.63	8.19±0.61	8.23±0.59
Overall acceptance	8.14±0.83	8.22±0.64	8.26±0.59

The above table shows the organoleptic evaluation of prepared starter recipes. As the table shows the average of all aspects is around 8. The highest among them is overall acceptance of sample 3 followed by sample 3 recipe of taste. Though there is not much difference, sample 1 of flavor scored least among all other organoleptic properties of all the starters developed.

Table LXVI highlights the mean organoleptic evaluation of main dishes.

Table LXVI - Mean Organoleptic Evaluation of Main Dishes

	Sample 1	Sample 2	Sample 3
Appearance	8.03±0.51	8.08±0.50	7.96±0.49
Flavour	8.02±0.44	8.11±0.49	8.14±0.56
Colour	8.12±0.59	8.17±0.56	8.03±0.45
Texture	8.07±0.50	7.92±0.61	8.05±0.57
Taste	8.07±0.65	8.11±6.51	8.11±0.49
Overall acceptance	8.10±0.56	8.14±0.54	8.13±0.44

The above table depicts the organoleptic evaluation scores of all 10 main dishes prepared in three samples. Among all the organoleptic properties of prepared main dishes, sample 2 of colour scored first among other properties. And the second place

was shared by sample 3 of flavour and sample 2 of taste among other properties. The average score of main dish recipes was between 7.92 and 8.17.

Table LXVII depicts mean organoleptic evaluation of dessert recipes.

Table LXVII - Mean Organoleptic Evaluation of Dessert Recipes

	Sample 1	Sample 2	Sample 3
Appearance	8.05±0.51	8.18±0.50	8.01±0.49
Flavour	8.12±0.54	8.11±0.48	8.24±0.50
Colour	8.02±0.48	8.16±0.46	8.03±0.51
Texture	8.15±0.49	7.32±0.60	8.25±0.48
Taste	8.17±0.55	8.12±6.41	8.21±0.59
Overall acceptance	8.20±0.38	8.04±0.62	8.32±0.52

Mean organoleptic scores of 10 developed dessert recipes are discussed in the above table. Average dessert score fall between 7.32 and 8.32. Among these organoleptic properties, the overall acceptance of sample 3 scored highest among other dessert recipe. Sample 3 of appearance scored least compared with other organoleptic factors.

Table LXVIII depicts the mean organoleptic evaluation of snacks recipes.

Table LXVIII -Mean Organoleptic Evaluation of Snacks Recipes

	Sample 1	Sample 2	Sample 3
Appearance	7.85±0.73	8.04±0.71	7.56±0.48
Flavour	7.89±0.84	8.14±0.81	8.23±0.72
Colour	8.35±0.61	8.30 ±0.53	8.28±0.45
Texture	7.07±0.50	8.02±0.61	8.06±0.61
Taste	8.12±0.45	8.59±0.31	8.21±0.51
Overall acceptance	8.58±0.33	8.52±0.44	8.23±0.42

The above table represents the organoleptic scores of all 10 recipes prepared under the snacks category. Recipes were given scores from a minimum of 7.07 to a maximum of 8.59.

Sample 3 had best score among the three samples for the flavor characteristic. In terms of colour sample 1 stood high among 3 sample. Sample 1 had the best score for overall acceptance with a score of 8.61. Sample 2 of taste scored high.

Table LXIX depicts mean organoleptic evaluation of ready to eat products.

Table LXIX - Mean Organoleptic Evaluation of Ready to Eat Products

	Sample 1	Sample 2	Sample 3
Appearance	8.07±0.50	8.22±0.61	8.06±0.61
Flavour	8.32±0.34	8.32±0.32	8.06±0.43
Colour	8.02±0.54	8.04±0.71	8.12±0.32
Texture	8.27±0.50	7.32±0.61	8.56±0.17
Taste	8.23±0.32	8.36±0.31	8.72±0.19
Overall acceptance	8.04±0.71	8.12±0.24	8.26±0.53

Table LXIX shows the scores for the organoleptic property of all three samples of ready-to-eat products. All three samples of ready-to-eat products scored between 7.32 and 8.72. The taste of sample 3 was highly accepted among all organoleptic properties. Sample 2 and 3 scored high for the characteristic of appearance and flavor respectively. Sample 3 of colour scored higher than other 2 samples. Sample 2 of texture scored the best among all the samples.

Table LXX shows mean scores of all developed recipes.

Table LXX - Mean Scores of All Developed Recipes

	Sample 1	Sample 2	Sample 3
Appearance	7.97 ±0.68	8.02 ±0.65	8.06±0.65
Flavour	8.05±0.81	8.03±0.76	8.09±0.72
Colour	8.02±0.74	8.04±0.72	8.06±0.71
Texture	7.99±0.74	8.04±0.72	8.04±0.71
Taste	8.01±0.75	8.05±0.72	9.09±0.69
Overall acceptability	8.05±0.69	8.04±0.71	8.05±0.65

The mean scores of all the recipes prepared are depicted in the table LXX. Among all the 3 samples, appearance of sample 3, flavor of sample 3, the colour of sample 3, the texture of samples 2 and 3, the taste of sample 3, and overall acceptability of samples 1 and 3 scored best among other recipes.

Table LXXI brings out the association between three samples of formulated recipes.

Table LXXI - Association between Three Samples of Formulated Recipes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	68.996	7	9.857	15.112	.000
Within Groups	2873.004	4405	.652		
Total	2942.000	4412			

Table LXXI depicts the association between the three samples. There is no significant difference between the three samples, Sample 1 , Sample 2 and Sample 3 for which calcite powder was incorporated in three variations i . Though there are slight variations among the three samples there is no statistically significant difference between the samples.

Table LXXII - Most Preferred Recipes Regarding Sensory Characteristics

	Appearance	**Flavour**	**Colour**	**Texture**	**Taste**
Starters	Strawberry, cucumber salad	Strawberry, cucumber salad	Strawberry, cucumber salad	Strawberry, cucumber salad	Thoothuvalai soup
Main dishes	Cabbage ragi adai	Cabbage ragi adai	Cabbage ragi adai	Cabbage ragi adai Wheat garlic pasta	Mughlai paratha
Dessert recipes	Ragi semolina payasam	Carrot kheer	Almond rabdi	Almond rabdi	Ragi semolina payasam
Snacks	Sesame seed balls	Sesame seed balls	Ragi banana pancake	Wheat flour appam	Wheat flour appam
Ready to Eat Products	Groundnut chutney podi	Garlic rice podi	Groundnut chutney podi	Pumpkin seeds podi Amla murabba	Kollu podi

Table LXXII shows the most preferred recipes under each category. Strawberry, cucumber salad scored high on most of the sensory characters like appearance, flavour, colour and texture among the starter recipes. Similarly cabbage ragi adai have scored high among main dishes. Among the dessert recipes prepared ragi semolina payasam have been highly accepted in terms of appearance and taste. Almond rabdi have scored high in terms of colour and texture. Sesame seed balls and wheat flour appam scored high among two sensory characteristics (Appearance and flavour; texture and taste) among the prepared snacks recipes. Groundnut chutney podi scored high among ready to eat products for its appearance and colour.

Ageing increases dietary protein requirements because skeletal muscles reduce their capacity of activating protein synthesis in response to anabolic stimuli, possibly

due to insulin resistance. Several studies have shown the importance of adequate calcium and vitamin D intake for better BMD and prevention of osteoporosis and fractures in older adults. Complementing additional ways of characterizing carbohydrate foods such as fiber and whole grain content, Glycemic Index (GI) should also be considered particularly important in reducing total body fat mass and managing weight. Considering the importance of these nutrients, recipes were developed for menopausal women and their nutrient content of developed recipe are discussed below.

Apart from organoleptic properties, nutrient contents of all the developed recipes were analysed based on the IFCT, further design of experiments were performed and the data were analysed and presented as following graphs:

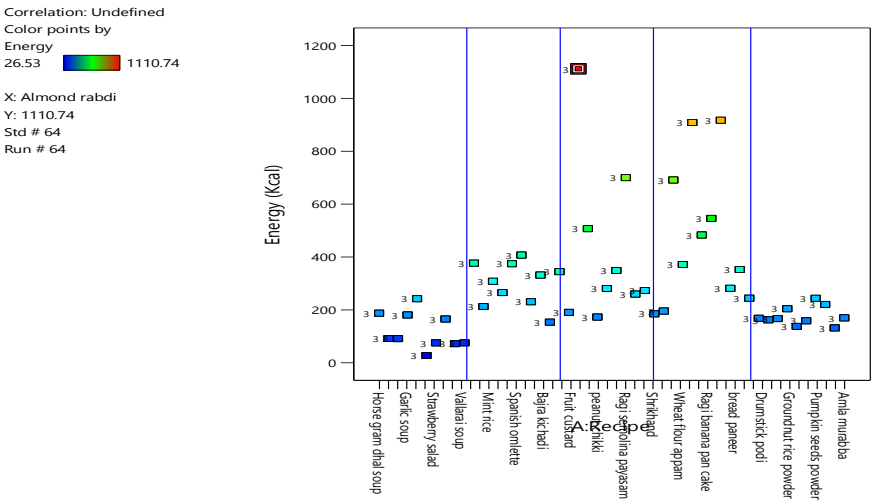


Figure XIV - Energy Content of all the Formulated Recipes

The figure depicts the energy content of all formulated recipes. Among all the recipes prepared Almond rabdi scored high which is followed by sesame seed balls. Strawberry salad had least energy content among all the prepared recipes and Vallarai soup had second least energy content among all other recipes**.**

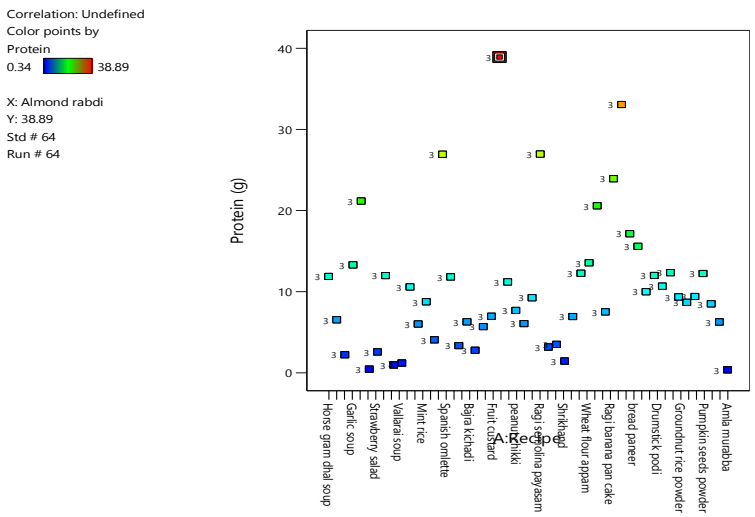


Figure XV - Protein Content of all the Formulated Recipes

The chart highlights the protein content of the formulated recipes. As per the protein content, here again Almond rabdi had the highest protein among all the recipes. The second and third highest recipes with protein content were flax seed ladoo and carrot kheer respectively. Strawberry, cucumber salad and Amla murabba were the two recipes which had low protein content among all other prepared recipes

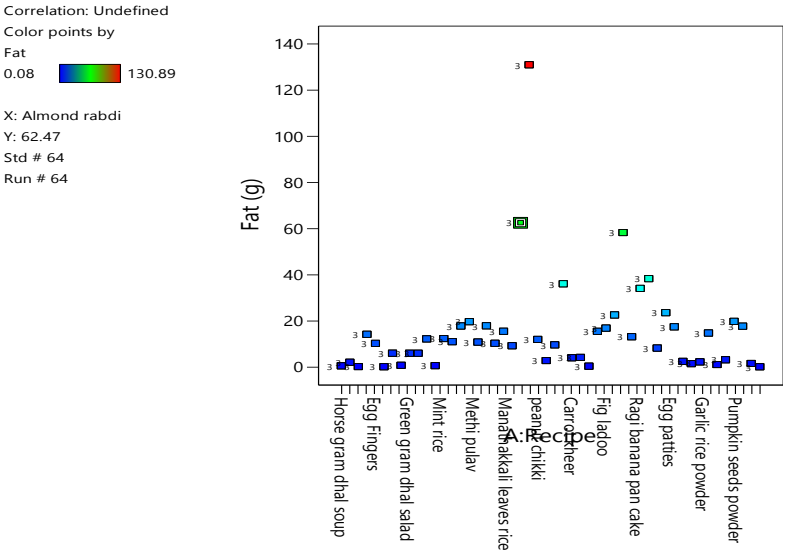


Figure XVI - Fat Content of all the Formulated Recipes

The above chart reveals the fat content of all the recipes prepared. Among the recipes prepared, Egg patties had the least fat content followed by Egg fingers and Fig ladoo which had second and third least fat content. However Dates and almond brownie were the recipe with high content of fat among all the other recipes prepared which was followed by Almond rabdi, which also had the second highest fat content.

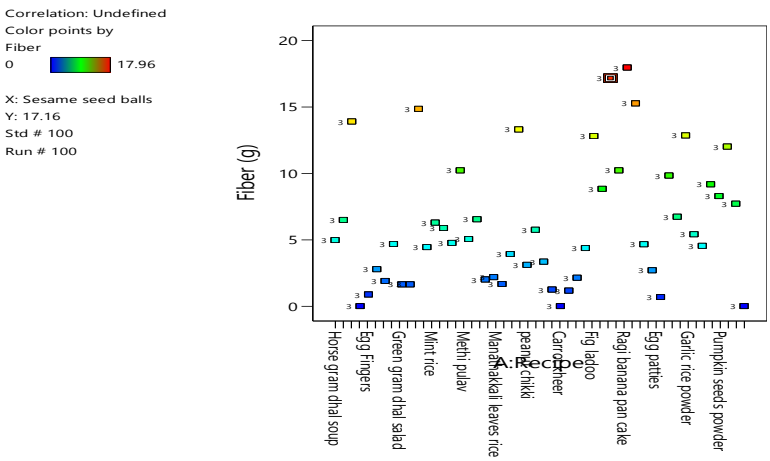


Figure XVII - Fibre Content of all the Formulated Recipes

From the above chart it is clear that Egg patties had the highest fibre content among all other recipes prepared. Soya been vada had the next highest fiber content to Egg patties. The recipe which had least fibre content was Egg finger and this was closely followed by Sweet yogurt and Amla murabba which were second and third recipe with low fibre content among all the prepared recipes.

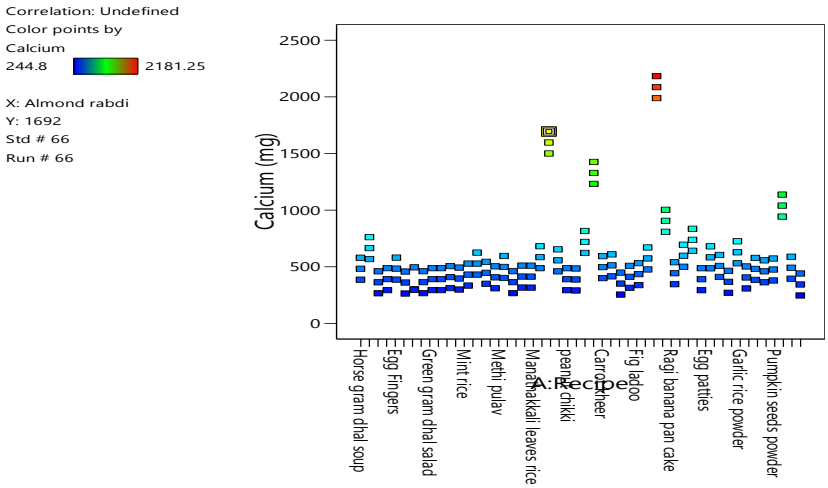


Figure XVIII - Calcium Content of all the Formulated Recipes

The above chart depicts the calcium content of all three samples of recipes developed. As the chart clearly states, sample 3 of all the recipes are higher in calcium than that of sample 2 and sample 1 of each recipe prepared. All three samples of Sesame seed balls had high calcium among all other recipes which was followed by all three samples of Almond rabdi and carrot kheer. Sample 1 of Amla murabba scored least in terms of calcium content among all other recipes prepared.

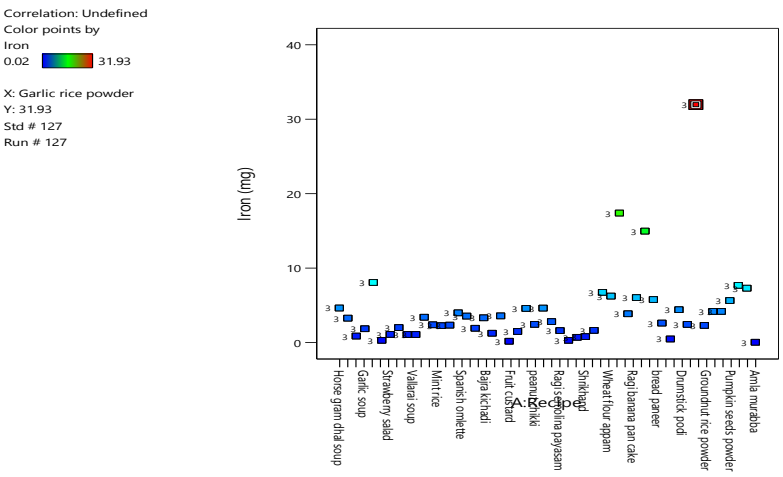


Figure XIX - Iron Content of all the Formulated Recipes

The above graph highlights the iron content of the recipes prepared. Among all the prepared recipes, Garlic rice powder had the highest iron content which was followed by Sesame seed balls and Flax seed ladoo. More over Amla murabba had the least iron content among other recipes prepared.

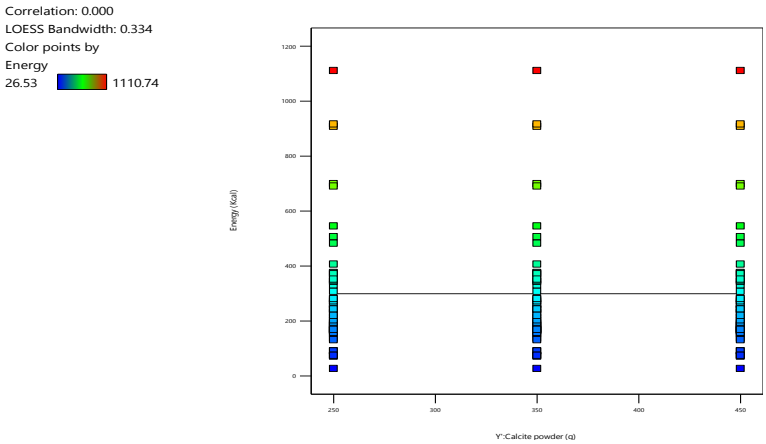


Figure XX - Effect of Calcite Powder Addition on Energy Content of Formulated Recipes

Graph depicts the effect of calcite powder on energy quotient of all the formulated recipes. As the graph reveals there was no variation between the energy of three samples which clearly denotes that there is no effect of calcite powder addition on energy. Average value of energy of all the recipes were between 200 and 400 K.Cals. Considering the colour plots only fewer recipes had energy more than 600 K.Cals.

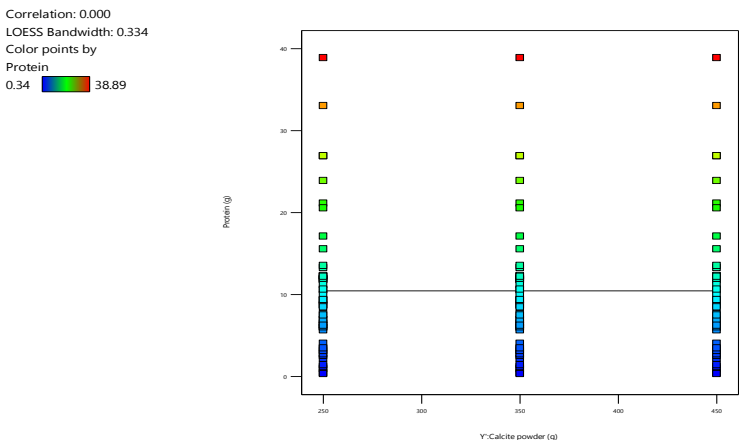


Figure XXI - Effect of Calcite Powder Incorporation on Protein Content of Formulated Recipes

Graph displays the effect of calcite powder addition on protein content of all three samples of prepared recipes. The average protein content of all the recipes were nearly 10g and moreover there was no difference between the protein content among three samples of prepared recipes upon addition of calcite powder. Since the blue plots are highly crowded compared with other colours, it clearly indicates that most of the recipes have protein content below 15g per serving.

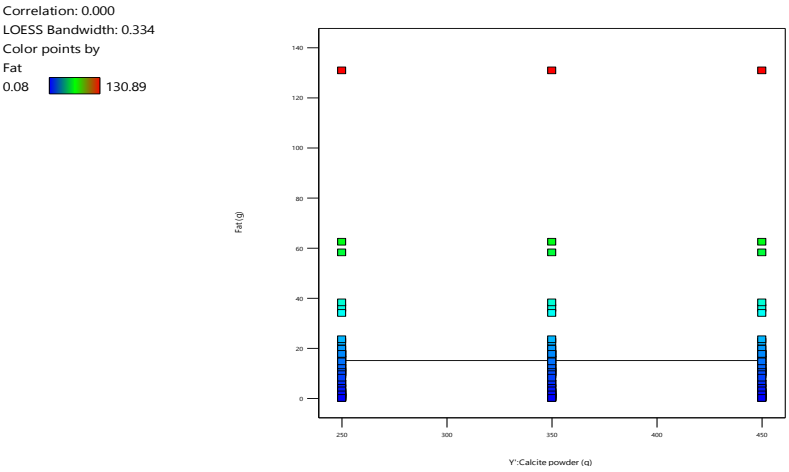


Figure XXII - Effect of Calcite Powder Addition on Fat Content of Formulated Recipes

The graph XXII denotes the effect of calcite powder addition on all three samples of prepared recipes. As there were no differences between the fat content of three samples of prepared recipes before and after addition we can conclude that calcite powder addition had no effect on fat content of prepared recipes. However the average value of fat content was between 20g and 10g. Similar to the protein content, fat content

of the recipes lies mostly within blue plots and with the further reference to the figure it is clear that most of the recipes had less than 30 g of fat.

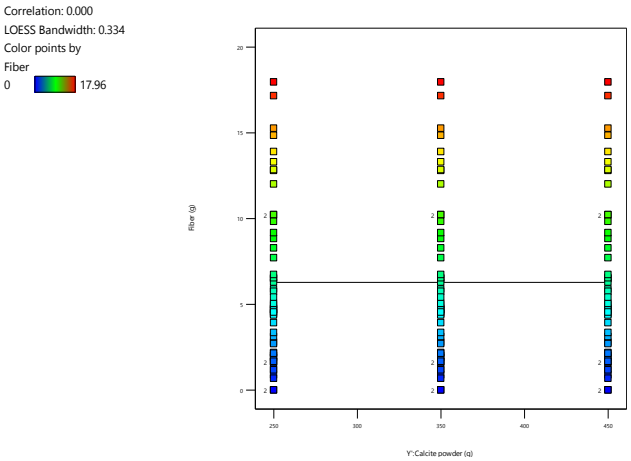


Figure XXIII - Effect of Calcite Powder Addition on Fiber Content of Formulated Recipes

The graph highlights the effect of calcite powder incorporation on fibre content of all three samples of prepared recipes. Clearly, there was no difference between the fibre content among all the three samples of prepared recipes due to the addition of calcite powder. The average value of fibre among the prepared recipes falls between 5 to 10 g. Unlike the previous nutrient discussed, fibre had a wide spread from 0 to 20g

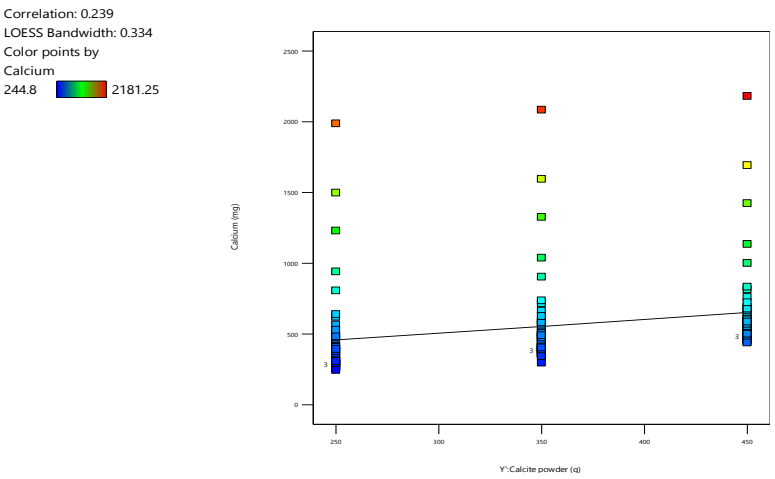


Figure XXIV- Effect of Calcite Powder Addition on Calcium Content of Formulated Recipes

The graph shows the effect of calcite addition on powder on calcium content of prepared recipes. As the graph denotes, there was a significant positive effect of calcite

powder addition on three samples of prepared recipes. Increase in amount of calcite powder addition increased the calcium content of the prepared recipes. The average calcium content of sample 1 was 450 mg, and the calcium content of all formulated sample 2 recipes increased higher than sample 1 and calcium content of sample 3 recipes increased more than sample 1 and sample 2 of formulated recipes.

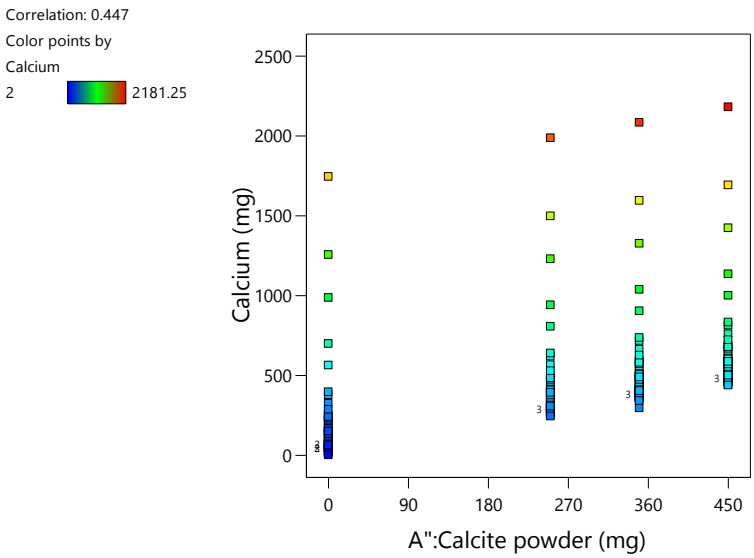


Figure XXV - Calcium Content of Formulated Recipes

The above graph denotes the calcium content of prepared recipes. X axis depicts the quantity of calcite powder incorporated in the recipes. First column of colored plots denotes the recipes without calcite powder incorporation. The average value of calcium content was 250 mg for recipes which were not incorporated with egg shell calcite powder. These are seen as blue dots in the graph. Upon addition of calcite powder, the calcium content of all three samples increased significantly as seen in the above columns 2, 3, and 4.

Table LXXII depicts the relationship of ingredients with the energy content among formulated recipes.

Table LXXIII - Relationship of Ingredients with the Energy Content among Formulated Recipes

Source	F-value	p-value
Model	52.24	< 0.0001
F-Bengal gram dhal	149.73	< 0.0001
G-Bread	31.31	< 0.0001
H-Pista	14.76	0.0002
O-Raisins	10.70	0.0014
P-Milk	101.37	< 0.0001
Q-Cardamom powder	18.84	< 0.0001
R-Jaggery	269.75	< 0.0001
S-Walnut	4.47	0.0368
U-Almond	262.04	< 0.0001
Y-Banana	117.91	< 0.0001
E'-Oil	41.74	< 0.0001
G'-Garlic	4.52	0.0356
H'-Lemon	11.76	0.0008
K'-Toor dhal	17.80	< 0.0001
L'-Corriander seeds	7.78	0.0062
N'-Cumin seeds	7.83	0.0060
P'-Mint leaves	5.54	0.0203
U'-Wheat flour	7.30	0.0079

The table LXXIII indicates the ingredients which had the significant relationship with the energy content of all prepared recipes. Among all the ingredients used, jaggery was most significant ingredient with maximum contribution to energy content of all fifty recipes as F-value was 269.75. Following jaggery, almond was the second most significant contributor of energy content. Walnut had the least contribution to the energy content among all ingredients.

Table LXXIV indicates the relationship of ingredients with the protein content among formulated recipes.

Table LXXIV - Relationship of Ingredients with the Protein Content among Formulated Recipes

Source	F-value	p-value
Model	25.81	< 0.0001
E-Channa dhal	5.17	0.0248
F-Bengal gram dhal	131.32	< 0.0001
G-Bread	29.21	< 0.0001
H-Pista	32.37	< 0.0001
M-White sesame seeds	3.93	0.0499
O-Raisins	4.22	0.0423
P-Milk	81.06	< 0.0001
Q-Cardamom powder	9.39	0.0027
R-Jaggery	12.11	0.0007
S-Walnut	41.81	< 0.0001
U-Almond	202.28	< 0.0001
Y-Banana	4.10	0.0452
A'-Cabbage	3.94	0.0495
C'-Rice	5.25	0.0238
E'-Oil	5.32	0.0229
G'-Garlic	6.27	0.0137
H'-Lemon	17.90	< 0.0001
J'-Green chilli	15.93	0.0001
K'-Toor dhal	20.75	< 0.0001
M'-Onion	10.60	0.0015
O'-Potato	6.65	0.0112
U'-Wheat flour	21.00	< 0.0001
V'-Corn flour	4.69	0.0324
W'-Cucumber	6.37	0.0130

The table LXXIV displays the ingredients which had significant relationship with the protein content of prepared recipe. According to the F Value which is mentioned in the table, almond was the most significant ingredient with maximum protein contribution which was followed by Bengal gram dhal where the F value were 202.28 and 131.32 respectively. And milk was found to serves as third most significant ingredient contributing to the protein content of prepared recipes.

Table LXXV depicts the relationship of ingredients with the fat content among formulated recipes.

Table LXXV - Relationship of Ingredients with the Fat Content among Formulated Recipes

Source	F-value	p-value
Model	50.95	< 0.0001
C-Moong dhal	1.17	0.2823
E-Channa dhal	1.44	0.2333
F-Bengal gram dhal	47.48	< 0.0001
G-Bread	11.90	0.0008
M-White sesame seeds	5.18	0.0247
O-Raisins	2.20	0.1411
P-Milk	41.47	< 0.0001
Q-Cardamom powder	19.76	< 0.0001
S-Walnut	526.65	< 0.0001
U-Almond	115.10	< 0.0001
X-Papaya	8.20	0.0050
Y-Banana	12.62	0.0006
E'-Oil	56.14	< 0.0001
G'-Garlic	6.40	0.0128
H'-Lemon	3.15	0.0788
J'-Green chilli	5.34	0.0227
K'-Toor dhal	4.46	0.0368
L'-Corriander seeds	9.85	0.0022
N'-Cumin seeds	15.42	0.0001
P'-Mint leaves	6.38	0.0129
U'-Wheat flour	7.85	0.0060
W'-Cucumber	2.03	0.1571

The table LXXV reveals the ingredients that contribute significantly to fat content among the recipes developed. As per the F - Value it is clear that walnut is the most significant ingredient and the second most significant ingredient to the fat is almond, which is followed by oil. Considering the food groups, nuts and oil seeds contributes more to the fat content of the recipes which is evident from the above table.

Table LXXVI discuss the relationship of ingredients with the fibre content among formulated recipes.

Table LXXVI - Relationship of Ingredients with the Fibre Content among Formulated Recipes

Source	F-value	p-value
Model	20.23	< 0.0001
E-Channa dhal	20.31	< 0.0001
F-Bengal gram dhal	78.47	< 0.0001
G-Bread	10.90	0.0013
H-Pista	16.19	0.0001
M-White sesame seeds	5.91	0.0166
P-Milk	7.52	0.0071
Q-Cardamom powder	19.50	< 0.0001
S-Walnut	79.17	< 0.0001
U-Almond	7.77	0.0062
Y-Banana	82.57	< 0.0001
Z-Manathakkali leaves	4.32	0.0400
D'-Urad dhal	17.71	< 0.0001
G'-Garlic	12.49	0.0006
L'-Corriander seeds	51.54	< 0.0001
M'-Onion	35.15	< 0.0001
N'-Cumin seeds	8.45	0.0044
Q'-Paneer	8.91	0.0035
R'-Methi leaves	12.26	0.0007
V'-Corn flour	11.90	0.0008

The table LXXVI highlights the significance of ingredients to the fibre content, among the ingredients used to develop all the fifty recipes. Within the ingredients used to develop all the fifty recipes, banana was the most significant ingredient to fibre contribution with an F-Value is 82.57. However with a least difference in the f-value, walnut and Bengal gram dhal stood second most and third most significant ingredients to the fiber content of recipes prepared.

Table LXXVII shows the relationship of ingredients with the calcium content among formulated recipes

Table LXXVII - Relationship of Ingredients with the Calcium Content among Formulated Recipes

Source	F-value	p-value
Model	7.95	< 0.0001
E-Channa dhal	1.39	0.2405
G-Bread	19.68	< 0.0001
P-Milk	32.46	< 0.0001
Q-Cardamom powder	11.00	0.0012
R-Jaggery	88.52	< 0.0001
U-Almond	26.70	< 0.0001
X-Papaya	7.22	0.0083
Y-Banana	7.09	0.0089
E'-Oil	10.45	0.0016
G'-Garlic	3.21	0.0757
L'-Corriander seeds	9.89	0.0021
N'-Cumin seeds	5.98	0.0160
O'-Potato	2.55	0.1134
P'-Mint leaves	3.49	0.0641
W'-Cucumber	2.82	0.0961
Y'-Calcite powder	92.34	< 0.0001

The table LXXVII displays the ingredients which had significant relationship with the calcium content of prepared recipe. According to the F Value which is mentioned in the table, calcite powder was the most significant ingredient which was followed by jaggery which had their F values at 92.34 and 88.52 respectively. And milk served as third most significant ingredient contributing to the calcium content of the developed recipes.

Table LXXVIII indicates relationship of ingredients with the iron content among formulated recipes.

Table LXXVIII - Relationship of Ingredients with the Iron Content among Formulated Recipes

Source	F-value	p-value
Model	19.85	< 0.0001
C-Moong dhal	30.20	< 0.0001
E-Channa dhal	7.23	0.0082
F-Bengal gram dhal	47.80	< 0.0001
G-Bread	19.36	< 0.0001
H-Pista	10.12	0.0019
M-White sesame seeds	9.85	0.0022
Q-Cardamom powder	14.44	0.0002
R-Jaggery	74.50	< 0.0001
S-Walnut	16.88	< 0.0001
U-Almond	15.61	0.0001
Y-Banana	9.49	0.0026
C'-Rice	6.23	0.0140
D'-Urad dhal	58.07	< 0.0001
E'-Oil	14.25	0.0003
G'-Garlic	12.63	<0.0003
J'-Green chilli	7.29	0.0080
L'-Corriander seeds	38.53	< 0.0001
M'-Onion	16.73	< 0.0001
P'-Mint leaves	16.41	< 0.0001
Q'-Paneer	9.31	0.0028
U'-Wheat flour	7.90	0.0058
V'-Corn flour	6.15	0.0146

The table LXXVIII indicates the ingredients which had significant relationship with the iron content of all prepared recipes. Among all the ingredients used jaggery had the most significant contribution to iron content of all fifty recipes with an F-value as74.50. Following jaggery, uradh dhal and bengal gram dhal were the second and third most significant ingredients contributing to the iron content of all developed recipe.

Awareness on Bone Health and Osteoporosis:

The objective of the study was to create awareness among the selected subjects. Accordingly efforts were taken to create awareness among the subjects. Before creating awareness, knowledge assessments were done and the scores were categorized as less than 50 percent and more than 50 percent using the OKAT tool. After the e-awareness

session again the knowledge of selected subjects was assessed. And the result of pre awareness and post awareness score is presented below:

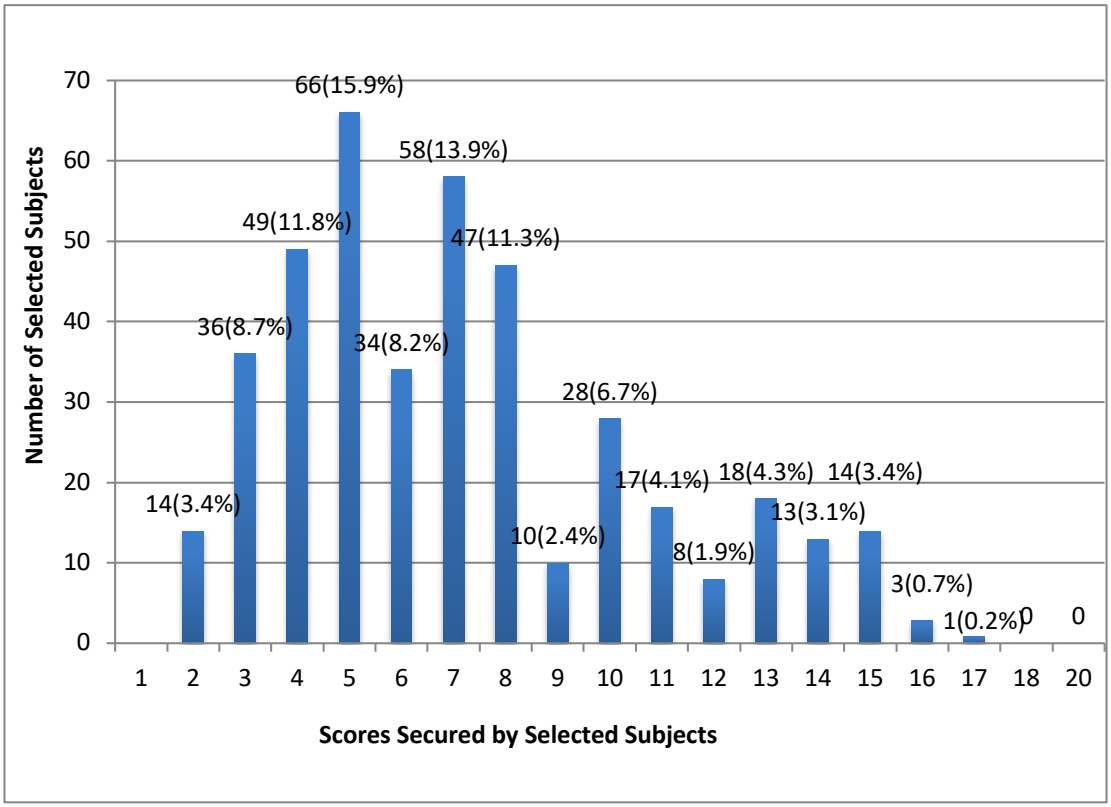


Figure XXVI - Pre Awareness Knowledge Assessment

The above graph shows the various scores obtained by selected subsamples. Here a maximum of 66 (15.9 percent) subjects has scored 5 which is 25 percent awareness level. And the highest score of 17 was scored by just 1(0.2 percent) subject. And a lowest score of 2 marks was scored by 13.4 percent of the subjects.

Subsequently awareness of osteoporosis and bone health was created virtually for the subsamples through a PowerPoint presentation. Awareness material explained what is Osteoporosis its Causes and Risk factors, prevention of osteoporosis, treatment, dietary habits, and importance of eggshell calcium.

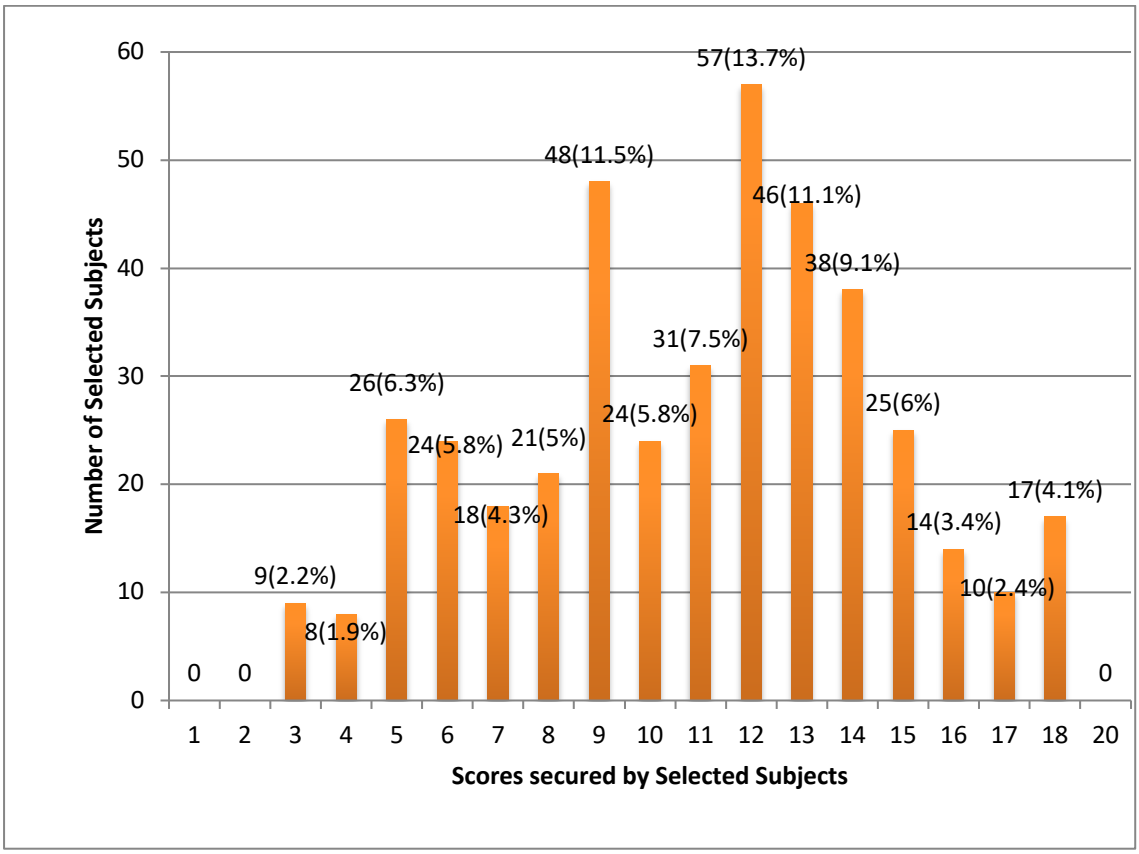


Figure XXVII - Post Awareness Knowledge Assessment

Knowledge assessment was done after the e-awareness session wherein a maximum of 57 (13.7 percent) subjects scored 12 i.e., 60 percent awareness level. The highest mark of 18 was scored by 17 (4.1 percent) subjects and the least mark was scored by 9 (2.2 percent) subjects. Totally 310 subjects scored more than 50 percent after the awareness.

Tables LXXIX shows the comparison on knowledge assessment of selected sub samples pre and post awareness.

Table LXXIX - Comparison on Knowledge Assessment of Selected Sub samples Pre and Post Awareness

(N=416)

Score	Pre-knowledge assessment		Post - knowledge assessment		t value	p-value
	N	%	N	%		
Less than 50 % score	304	73.1	106	25.5	19.05	0.000
More than 50% score	112	26.9	310	74.5		

The table LXXIX depicts the pre and post-knowledge assessment of selected subjects. As shown by the table, the majority of the subjects (73.1 percent) scored less than 50 percent before awareness. But after awareness majority of the subjects (14.5 percent) scored above 50 percent. And only 106 (25.5 percent) subjects scored below 50 percent of the actual score. Statistical comparison between pre-knowledge and post-knowledge of the respondents showed that the difference is statistically significant ($p<0.01$) which means that the awareness of the respondents about osteoporosis was much more increased than the knowledge they had before creating their awareness, hence null hypothesis (H0) is rejected.