

## V. SUMMARY AND CONCLUSION

Bone development starts from birth and continues to grow till the second decade of ones life when the bone density attains its peak. After this bone strength is maintained until onset of old age, but for women, due to menopause there is a decrease in bone mineral density due to lack of a hormone called oestrogen which contributes to bone health. This decrease in bone mineral density during menopause is much higher for women compared to men in the same age group. As the bone mineral density decreases the bone becomes weak and fragile which leads to non traumatic fracture at times. This condition where bones become weak and brittle is called as osteoporosis.

Osteoporosis is not only prevalent in female but also in male. Elderly people despite of gender are more prone to osteoporosis. Osteoporosis can be caused by few risk factors like physical inactivity, inadequate calcium intake, lack of sunlight exposure, decreased BMI, ageing, menopause, lack of knowledge on bone health and some improper lifestyle practices like consumption of alcohol, smoking and tobacco chewing. These risk factors pave the way for decrease in bone mineral density.

Osteoporosis is basically asymptomatic ie, there will not be symptoms initially, later on few symptoms like back pain caused by fracture, lack of height overtime, stooped posture, fractures due to fragile bone can be seen. As osteoporosis is mostly asymptomatic one should consider to do risk assessment of osteoporosis in order to diagnose osteoporosis in early stages. There are few online tools which can predict the risk of osteoporosis like ORAI (Osteoporosis Risk Assessment Instrument), OST (Osteoporosis self-assessment tool), SCORE (Simple Calculated Osteoporosis Risk Estimation). These tools can be used to assess the risk of osteoporosis at an early stage so that it can be prevented.

Osteoporosis is diagnosed through bone mineral density screening. It is done using dual-energy x-ray absorptiometry (DXA or DEXA) or bone densitometry. And the densitometry gives the value in Z Score. With that Z score bone density is defined as normal, osteopenic and osteoporotic. After the diagnosis of osteoporosis, usually it is suggested to take calcium supplements. Calcium supplements are available in various forms like calcium carbonate, calcium citrate, calcium lactate,

calcium gluconate etc. Chicken egg shell powder can be an alternate source of commercially available calcium supplements.

Some of the risk factors like age, gender and gene cannot be changed. But few risk factors are modifiable through which osteoporosis can be prevented. Regular exercising habit can prevent osteoporosis ie, mainly the weight bearing exercises are best to maintain bone health. Avoiding improper life style habits and regular consumption of healthy and balanced diet aids in the prevention of osteoporosis. Calcium is one of the most important nutrient to maintain proper bone health. Consuming adequate amount of calcium is necessary to maintain proper bone health. Vitamin D is essential for calcium absorption. Unlike calcium which is a dietary source, vitamin D must be obtained through exposure to sunlight. Hence adequate sun light exposure is essential to maintain bone health.

Chicken egg shell comprises of almost 40 percent of calcium. It contains calcium in form of calcium carbonate. Half an eggshell may provide enough calcium to meet the daily requirements for adults, which is 1,000 mg per day. The chicken egg shell powder have better absorption rate than pure calcium carbonate. Hence egg shell powder can be a good calcium supplement. Considering all these aspects, the current research was carried out with the following objectives to assess the risk factors associated with osteoporosis among selected adult women, to formulate egg shell calcite powder and determine its characteristics, to develop calcite incorporated recipes, to create awareness on calcite and its role in the prevention and management of osteoporosis

**In phase I of the study, collection of data on demographic profile, anthropometric measurements, physical activity, exposure to sunlight and dietary assessment** were done. Based on easy accessibility and availability of women subjects, the investigator chose areas in and around Coimbatore and Tiruppur districts (Tamil Nadu) as the areas of study. One thousand thirty six women in the age group of 40 to 60 years at various stages of menopause were selected for the study. Menopausal stage includes perimenopause, menopause and post menopause. Perimenopause begins about eight to ten years before menopause. Menopause is a period when women experience no menstrual periods for a year and post menopause

is when women experiences more than one year of no menstrual periods (WHO, 1996 and Cleveland, 2021).

Sample size was determined using the formula by Vishwakarma (2017). The samples were selected using purposive random sampling method and considering the inclusion and exclusion criteria. Inclusion criteria includes female subjects of age above 40 years, those who are willing to participate in the study. Exclusion criteria included subjects without any chronic illness and disabilities and under regular calcium supplementation.

The study was approved by the Institutional Human Ethical Committee (IHEC/21-22/FSMD-28) of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. A well-structured interview schedule was developed to collect data on demographic profile which includes age, religion, marital status, education, occupation, monthly income and socio economic status, etc. The collected data were categorised based on Modified Kuppuswamy scale (Sheikh, 2018), data on physical activity were collected based on International Physical Activity Questionnaire (IPAQ) (Craig *et al.*, 2003), exposure to sunlight (Harinarayan, 2018), menopausal stage and symptoms, diet pattern using food frequency questionnaire, 24 hr recall method, diet diversity, family history, self history and BMI of the selected subjects were all gathered.

A pilot study was conducted among 60 selected subjects with the same inclusion and exclusion criteria to validate the interview schedule and osteoporosis risk assessment tool. The three osteoporosis risk assessment tools like OST (Osteoporosis Self-Assessment Tool), ORAI (Osteoporosis Risk Assessment Instrument) and SCORE (Simple Calculated Osteoporosis Risk Estimation) were used and compared statistically with the actual measured BMD of the selected subjects to identify most relevant tool for further conduct of the study. After orienting the subjects about the purpose and modality of the study, their consent was obtained and subsequently data were collected using the interview schedule.

**In phase II of the study, the association of risk factors of osteoporosis among selected subjects were analysed.** From 1036 subjects at phase I as the result,

678 at risk subjects were categorized based on age group into 40 to 45 years, 46 to 50 years, 51 to 55 years, and 56 to 60 years and their association with risk factors were compared statistically. Further 416 subsamples were selected from 678 at risk subjects for Bone Mineral Density (BMD) screening and their result were analysed.

About 416 sub samples were selected based on the inclusion criteria which includes subjects willing to undergo BMD assessment, subjects willing to participate in e-awareness session and subjects having smart phone. Data collected through the interview schedule was coded and was analysed using SPSS 21 (Statistical Package for Social Sciences).

**In Phase III development of calcite (egg shell) incorporated recipes and promotion of bone health through awareness**, the chicken egg shells were collected from the egg product industry and it was ensured that they were from the same batch of white leghorn hen. The underlying condition was that the hens were uniformly fed. The collected egg shells were washed properly and then dried. The egg shells were then powdered and stored in air tight container. The egg shell powder was washed thoroughly using purified water (less than 10 ppm) to ensure the removal of egg shell membrane and other impurities if any. The powdered and washed egg shell powder was heated in muffle furnace to 900°C in such a way that the temperature raise for every half an hour interval was 200°. Egg shell powder was maintained at 900°C for four hours and the final sample was taken out.

Characteristics like size, shape, nature of developed egg shell powder, ash, moisture and calcium content were analysed using various methods like FESEM (Field Emission Scanning Electron Microscope), heavy metal analysis, calcium analysis, moisture and ash content analysis. After formulation and characterisation of calcite powder, the calcite incorporated recipes were developed.

Recipes were developed with ingredients that are rich in protein, calcium, omega 3 fatty acid and phytoestrogens. Recipes were developed on five categories which includes, starter, main course, dessert, snacks and ready to eat products. Ten recipes were developed under each category. Totally 50 recipes were prepared by

incorporating the developed calcite powder in three different variations as 250mg, 350mg and 450mg. The developed recipes were evaluated by semi trained panel (15 members) with the help of 9 point hedonic scale for its sensory parameters. The sensory evaluation scores were analysed statistically and the nutritive value of each recipe was calculated using Indian Food Composition Tables (2017). After the nutritive value calculation of recipes, recipes were analysed based on design of experiments, which is a systematic way to analyse the data with multi input variables.

To carry out pre awareness knowledge, Osteoporosis Knowledge Assessment Tool (OKAT) (Winzenberg *et al.*, 2003) was used. OKAT is a reliable and frequently used tool to assess knowledge about osteoporosis. The total score of the participant was computed and categorized. After the initial assessment of knowledge of the subjects, awareness material containing information on osteoporosis, role of calcite in the prevention and management of osteoporosis, egg shell calcite powder incorporated recipes, causes and risk factors of osteoporosis and its prevention was prepared.

The e-awareness sessions were conducted for the selected subjects in different groups based on their locale. The sessions were interactive in nature. After the e-awareness session, the participants were provided soft-copy of the awareness material and e-booklet on calcite incorporated recipes for their future use in both English and Tamil. After the e-awareness session, the same OKAT was sent to the subjects for assessing their knowledge on osteoporosis and bone health. After receiving the answers, scoring was done based on the same criteria as pre-awareness knowledge assessment. Then pre awareness and post awareness knowledge scores on osteoporosis was compared and the effectiveness of awareness was assessed.

**The Salient Findings of the Study are Summarized below:**

**Demographic Profile:**

- Among the selected subjects, 84.5 percent were Hindus, 10.90 percent were Muslims and 4.16 percent were Christians. Nearly ninety nine percent of the subjects was married and one percent was unmarried.

- Considering the age of selected subjects, 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 percent) subjects. Further 118 subjects were under the age group of 56-60 followed by 111 (10.7 percent) subjects in 51-55.
- Among the 1036 subjects 71.5 percent belonged to the nuclear family and 22.8 percent of them living in joint family. Only 5.6 percent subjects lived with extended families.
- Regarding the educational qualification of the subjects, nearly sixty percent of subjects has attained middle school or high school. About twenty two percent of subjects were either graduates or postgraduates and 12.4 percent had primary education and 3.9 percent had diploma certificates. Only a minimum of 1.9 percent of the subjects were professional degree holders.
- With respect to the socio economic status, 28.6 percent of the subjects belonged to the upper middle class and 27.9 percent were under the category of upper lower. Another 26.0 percent belonged to the lower middle class followed by 9.1 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.

#### **Results of Pilot Study:**

- A smaller group of subjects (N=60) were selected to study the effectiveness of the risk assessment tools like OST (Osteoporosis Self Assessment Tool), ORAI (Osteoporosis Risk Assessment Instrument) and SCORE (Simple Calculated Osteoporosis Risk Estimation).The bone mineral density was measured for the selected subjects and it revealed that a majority of subjects (38 subjects) were osteoporotic or osteopenic which is classified as “at risk” followed by 22 subjects who were normal.
- 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 at no risk and further 44 subjects were at risk.

- Prediction using ORAI Scale was the closest to the directly measured BMD values. As there was a significant relationship between ORAI and BMD, compared to the other two risk assessment methods, the ORAI tool was chosen as the preferred method to conduct the study on the larger sample size

**Risk Assessment using ORAI tool:**

- The osteoporosis risk assessment performed by the ORAI tool revealed that sixty five percent of the subjects were at risk of osteoporosis and only thirty five percent of them are not at risk.
- Considering the menopausal stages, 47.9 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.
- About nineteen percent of the subjects reported irritability, followed by fourteen percent of the subjects experiencing mental and physical exhaustion. About twelve percent of them suffered from hot flushes, sweating, dryness of vagina, anxiety and depressive mood. About ten percent of the women had problem with their sleep and five percent of the women had sexual problems, joint and muscular discomfort, bladder discomfort, heart discomfort.
- With respect to physical activity performed by selected subjects, majority of 408 (39.4 percent) subjects did moderate physical activity followed by 380 (36.6 percent) subjects and 248 (23.9) subjects who had low and high quantum of physical activity.
- Four seventy four subjects had adequate exposure to sunlight of greater than 30 minutes and 54.2 percent had inadequate exposure. Nearly 749 (72.3 percent) subjects were exposed to sun light between 9 and 11 am. 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 3 pm. Among the 313 (30.2 percent), subjects 103 (9.9 percent) were exposed for over 30 minutes and 210 (20.2 percent) were exposed for less than 30 minutes.

**Diet Pattern:**

- Among 1036 selected subjects, majority (692) were non-vegetarians, 253 subjects were vegetarians and 91 of them were ova vegetarians.
- Mean energy consumed by sedentary and moderate lifestyle subjects are 1286 and 1950 K. calories respectively. Mean carbohydrate of the selected subjects were 220 g and 327 g for sedentary and moderate working subjects respectively. Similarly fat intake was at 21 and 37 g respectively. The protein intake was measured at 51 g and 70 g for the above subjects.
- Out of the total subjects 394 were found to be consuming more than 600 mg of calcium per day. Four hundred and twenty eight subjects had a lower intake between 301 to 599 mg /day. Further 214 subjects had a very low intake of less than 300 mg per day which makes them likely target for the onset of osteoporosis.
- As per the diet diversity, almost all subjects consume cereals followed by oils and fats. Organ meat was consumed by 451 subjects. Fish and sea food was consumed by 510 subjects. A total of 698 subjects consumed fruits rich in Vitamin A. There were about 725 subjects who consumed other fruits. A majority of 963 subjects consumed other vegetables and 837 of them consumed dark green leafy vegetables like amaranth, spinach etc.
- Based on the subjects consumption frequency of millets which are a good source of calcium, close to seventy percent of the respondents expressed that they consumed foxtail millet, kodo millet, banyard and little millet on an occasional basis. Less than five percent of the respondents only said that they have never had any type of millet. Among the millets, the foxtail millet, kodo millet, little millet and banyard millet seem to be the popular ones based on daily, weekly and monthly consumption .
- Among the frequency of consumption of greens and vegetables, curry leaves and corriander leaves were consumed by a majority of the subjects (99 and 97 percent) on a daily basis. Drumstick leaves were consumed by majority of subjects (42 percent) on monthly basis. Drumstick leaves, knoll khol, cauliflower greens and amaranth were not consumed on a daily basis by any of

the subjects. Curry leaves were consumed by a majority of the subjects on a daily and weekly basis.

- 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 family history of the selected subjects revealed that blood pressure was the most commonly experienced disorder with 502 subjects reporting the same. This was followed by diabetes and obesity with 327 and 263 subjects respectively. Around 221 subjects (just over twenty percent) experienced osteoporosis. Very less number of 41 subjects reported cardio vascular disease. Nearly 45 subjects had a history of epilepsy.
- Similar to the family history, the self history of the subjects also reveals blood pressure (with either high or low) as the most prevalent among the selected subjects. About 357 subjects were under medication for one disorder or the other. Osteoporosis, diabetes and thyroid function were reported by 246, 245 and 240 subjects respectively. Least number of 8 subjects reported fractures.
- A maximum of 288 subjects (twenty eight percent) had a normal BMI classified based on Asia Pacific Guidelines, 2017. This was followed by the over weight category which had 283 subjects (twenty seven percent subjects). About 262 subjects (twenty five percent) were under weight. A least number of 203 subjects (twenty percent) were obese.

#### **Association of Risk Factors of Osteoporosis among Selected Subjects**

- Risk assessment using ORAI method revealed that 678 subjects (sixty five percent) were at risk for the onset of Osteoporosis. The remaining thirty five percent were not at risk as per the assessment tool.
- A majority of 206 subjects were classified under the category of under weight. Ninety nine of the 206 under weight subjects were in the age group of 46-50. This was followed by 162 subjects who had a normal BMI. Seventy five

out of 162 subjects who had normal BMI were in the age group of 40-45. About 161 of at risk subjects fell under the overweight category. Sixty six out of 161 subjects were in the age groups of 40-45 years. And a total of 149 subjects were obese. Fifty nine out of 149 subjects who were obese were in the age groups of 46-50 years.

- A majority of 293 out of 678 at risk subjects had a very low calcium intake. Among the low intake group 106 subjects were in the age group of 40-45. A total of 218 subjects consumed very low level of calcium (<300mg). Among this group a majority of 81 subjects were again in the age group of 40-45s. 167 subjects had adequate intake of calcium. Among this 70 belonged to the age group of 46-50.
- With respect to physical activity of at risk subjects, 210 subjects had a low level of Physical activity. Among the 210 subjects a majority of 85 subjects were in the age group of 40-45 years. 226 subjects had a high level of Physical activity. Among this group 88 subjects belonged to the age group of 46-50 years. A maximum of 242 subjects had moderate physical activity. Within this group 112 subjects were in the age group of 46-50.
- Four hundred and twenty nine out of the 678 at risk subjects had inadequate exposure to sun light. A maximum of 177 within the inadequate exposure group were in the age group of 46-50 years. Two hundred and forty nine subjects had adequate exposure to sun light. Within this group 98 subjects were in the age group of 40-45 years.
- The analysis between Age with Calcium, BMI, Knowledge, Sun Exposure, and Physical Activities reveals that 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 had the most association with Risk and no risk subjects followed by physical activity, than age, calcium intake and finally exposure to sunlight.

### **Bone Mineral Density Assessment of Selected Sub Samples:**

- Seventy seven respondents at perimenopause stage had normal BMD. Around 76 subjects in the perimenopause stage were found to be osteopenic. Forty four subjects in the same perimenopause stage were found to be osteoporotic. About 52 women in the menopause stage were found to be osteopenic. This was followed by 40 women who had a normal BMD in the Menopausal stage. A maximum of 50 post menopausal women were found to be osteoporotic. This was followed by 40 subjects of the same group, who were osteopenic. A least number of 9 subjects in the post menopause stage had the normal Bone Mineral Density.
- Among the osteopenic subjects, a majority of subjects (52) again belonged to upper middle class category. Around 38 subjects who were osteoporotic belonged to the upper lower category. Among the 3 categories of normal, osteopenic and osteoporotic, a maximum of 169 subjects were found to be osteopenic.
- Considering the physical activity performed by selected sub samples, maximum number of 65 subjects who were performing low physical activity were osteopenic. Furthermore 64 subjects performing moderate physical activity were also identified as osteopenic. A maximum of 40 subjects who had the high physical activity had a normal BMD. A least number of 18 subjects who had high physical activity were prone to osteoporosis.
- From the selected sub sample, maximum number of subjects (100) with inadequate sun exposure were osteopenic. This was followed by 86 subjects who had inadequate sun light were found under the category of osteoporotic. Small number of 41 subjects with inadequate sun light exposure had normal BMD. In contrast a majority of 85 subjects with adequate sun exposure had normal BMD. This was followed by 68 subjects with adequate sunlight being osteopenic. Only a least number of 36 subjects with adequate sun exposure were reported to be osteoporotic.
- Regarding the nutrient intake and bone mineral density of selected sub samples, energy, carbohydrate, protein and fibre have a significant relationship with bone mineral density, unlike those of fat which do not have significant

relation with bone mineral density. Among the nutrients protein had most direct association with bone mineral density as its correlation value is higher than other nutrients.

- Considering the calcium intake, maximum number of 66 subjects who had very less intake of calcium were osteoporotic in nature. A least number of 18 subjects in the same category (Less calcium intake) had the normal BMD. A majority of 72 subjects who had low intake (300-600 mg) were osteopenic. Forty one subjects under the same category were found to be osteoporotic. Among the subjects with adequate calcium intake, a majority of 60 subjects had the normal BMD. Only a very minimum of 15 subjects with adequate calcium intake were osteoporotic. There was a statistically significant association between calcium intake and BMD.
- The knowledge assessment on sub samples revealed that majority of subjects (thirty nine percent) who had low knowledge levels were found to be osteopenic. This was followed by 106 subjects (thirty five percent) with low knowledge levels and they were classified under the osteoporotic category. With respect to people with high awareness levels 48 subjects each fell under the category of normal BMD and osteopenic. The table shows that there was a statistically significant association between the knowledge of women about osteoporosis before awareness and BMD.

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

#### **Development and Characterization of Eggshell Calcite Powder:**

- The Eggshell powder was taken out at different temperatures for observation. At different temperatures, the colour of egg shell varied. During the final stage, the Eggshell calcite was white in colour. The eggshell calcite powder was like fine crystalline powder.
- The particles of eggshell calcite powder measured between 157-81nanometer in size. The eggshell powder was roughly crystalline in structure and spherical in nature.

- It was estimated that ninety seven percent of calcium is present in the eggshell calcite powder. 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.
- Moisture content was determined by the AOAC method. It was found that the eggshell calcite powder does not contain any moisture. The ash content of eggshell powder was determined with the AOAC method and it was found that eggshell contains 53.93 percent ash.

#### **Formulation of Recipes and their Sensory Evaluation:**

- A total of fifty calcite incorporated recipes were formulated under five categories namely starters, main dish, desserts, snacks, and Ready to Eat products. Under each of the above 5 categories 10 calcite incorporated recipes each were developed. Each recipe was developed as three samples with incorporation of 250, 350 and 450 mg of calcite powder. After development of recipes, organoleptic evaluation was carried out with semi-trained panel members and the results were discussed.
- Regarding the mean organoleptic evaluation of prepared starter recipes, they had an average value around 8. The highest among them is overall acceptance of sample 3 followed by sample 3 recipes of taste. Though there is no much difference sample 1 of flavor scored least among all other organoleptic properties of all the starters developed.
- The mean organoleptic properties of all 10 main dishes prepared revealed that 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.
- With respect to the dessert recipes developed, average scores of all dessert recipe falls between 7.32 and 8.32. Among these organoleptic properties, the overall acceptance of sample 3 scored high among other dessert recipe. Sample 3 of appearance scored least compared with other organoleptic factors.
- Considering the organoleptic scores of all 10 snacks recipes prepared under the snacks category, the scores were 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 over all acceptance with a score of 8.61. Sample 2 of taste scored high.

- 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.
- There was no significant difference between the three samples. Though there are slight variations among the three samples there is no statistically significant difference between the samples.

#### **Effect of Calcite Powder on Formulated Recipes:**

- Considering the effect of calcite powder on energy of prepared recipes, there was no variation between the energy of three samples. This clearly denotes that there is no effect of calcite powder on energy. Average value of energy of all the recipes falls between 200 and 400 K.Cals. Considering the colour plots as recipes, in the graph, most of the recipes developed falls below 600 K.Cals and only fewer recipes had energy more than 600 K.Cals.
- Regarding the average protein content of all the recipes, the average protein content were nearly 10g moreover there was no difference between the protein content among three samples of prepared recipes as calcite powder addition did not have any effect on protein. Since the blue coloured plots are highly crowded compared with other colours, it clearly indicates that most of the recipes have protein content below 15g.
- With respect to the fat content, there were no difference between the fat content of three samples of prepared recipes as calcite powder had no effect on fat content of prepared recipes. However the average value of fat content was between 20g and 10g. Similarly, the protein content fat content of the recipes lies mostly within the blue plots and with the further reference with the figure it is clear that most of the recipes had less than 30 g of fat.

- Clearly, there was no difference between the fibre content among all the three samples of prepared recipes upon calcite addition. The average value of fibre among the prepared recipes falls between 5 to 10 g. Unlike to the previous nutrients discussed, fibre content was widely spread from 0 to 20g.
- With respect to the calcium content of the recipes, there was positive effect of calcite powder addition on three samples of prepared recipes indicating clearly that an increase in amount of calcite powder increases the calcium content of the prepared recipes. The average calcium content of sample 1 was 450 mg upon calcite powder incorporation and the calcium content of sample 2 and sample 3 also increased proportionately.

**Effect of Ingredients on the Nutrient Content of Formulated Recipes:**

- Among all the ingredients used for the preparation of recipes, jaggery was most significant ingredient contributing to energy content of all fifty recipe as F value was 269.75. Following jaggery, almond was the second most significant ingredient contributing to the energy content of all developed recipe.
- Among the ingredients which contributes to the protein content of prepared recipes, the most significant ingredient was which is followed by Bengal gram dhal were the F value is 202.28 and 131.32 respectively. And the milk serves as third most significant ingredient contributing to the protein content of prepared recipes.
- As per the F Value it is clear that walnut has the most significant contribution with respect to the fat content and the second most significant ingredient contributing 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 also evident.
- Among all the ingredients used to develop all the fifty recipe, banana was the most significant ingredient with the fibre as the F-Value is 82.57. However in just one value difference walnut and Bengal gram dhal are the second most and third most significant ingredients contributing to the fibre content of recipes prepared.

- According to the F Value, calcite powder is the most significant ingredient contributing calcium which is followed by jaggery were the F values were 92.34 and 88.52 respectively. Milk serves as third most significant ingredient contributing to the calcium content for the developed recipes.

#### **Awareness on Osteoporosis and Bone Health:**

- The pre knowledge assessment revealed that maximum of 66 subjects has scored 5 on a scale of 20. And the maximum score of 17 was obtained by just 1 subject. And a minimum score of 2 was obtained by 14 subjects.
- 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 eggshell calcium.
- Knowledge assessment was done after the e-awareness session wherein a maximum of 57 subjects scored 12. The highest mark of 18 was obtained by 17 subjects and the least mark was obtained by 9 subjects. Totally 310 subjects scored more than 50 percent after the awareness.
- The comparison of knowledge of pre and post awareness results reveal that, majority of the subjects (304) scored less than 50 percent before awareness. But after awareness majority of the subjects (310) scored above 50 percent score. And only 106 subjects scored below 50 percent of the actual score after awareness. Statistical comparison between pre-knowledge and post-knowledge of the respondents shows that they were statistically significant which means the knowledge of the study respondents after awareness about osteoporosis increased compared to the knowledge of the respondents before awareness about osteoporosis.

#### **Conclusion:**

Women at menopausal stages especially at post menopause, are most likely to experience lower bone mineral density. As osteoporosis is mostly asymptomatic it is better to assess the risk of osteoporosis in order to prevent it. Hence standardized online tools can be used as they are user friendly and cost effective. Knowledge on bone health and calcium intake, adequate sun light exposure, proper physical activity,

intake of balanced and calcium rich diet can prevent osteoporosis to a large extent. So, basic knowledge about bone health, osteoporosis and preventive methods aids in the maintenance of bone health. Moreover knowledge is not enough to prevent a disease. Implementation of the knowledge plays a major role. Exercising regularly mainly weight bearing exercises, getting exposed to the sunlight especially between 10 am to 3 pm daily, consuming balanced and calcium rich foods and good life style habits should be practiced to maintain bone health. If the bone mineral density is low, it is most important to improve it through supplementations of calcium so that one can attain proper bone mineral density. Egg shell calcite powder being a rich source of calcium which contains 97 percent of calcium and better absorption can be a natural supplement to maintain the bone mineral density.