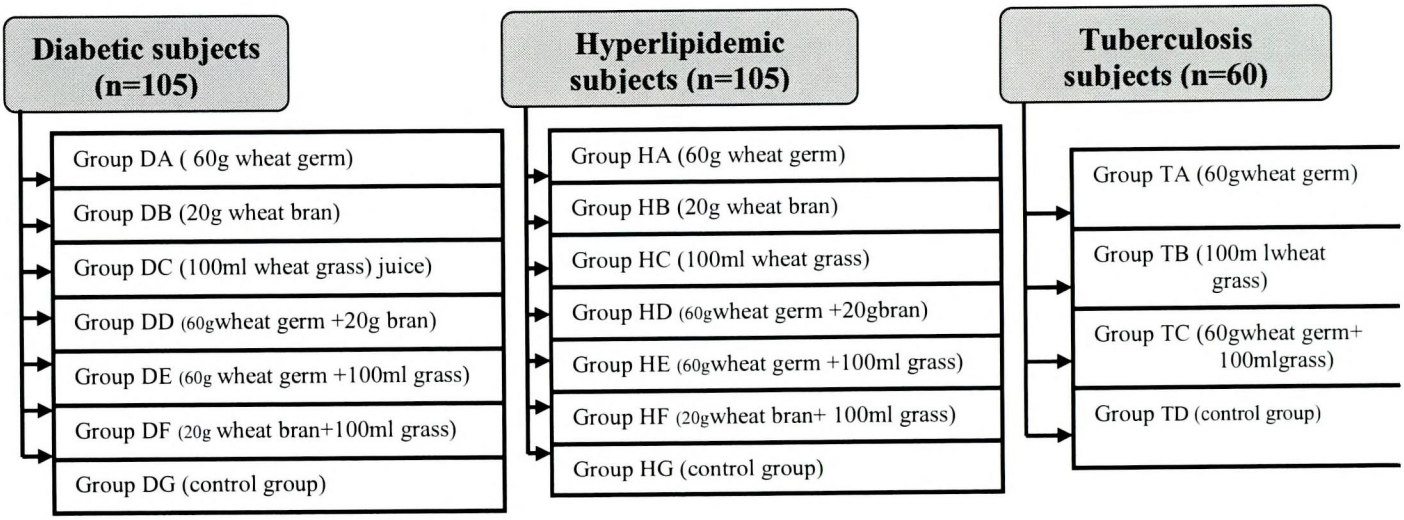
Summary and Conclusion

V. SUMMARY AND CONCLUSION

Health is a fundamental human right and a worldwide social goal. It encompasses all human disregard of age. Physical aspects of diabetes, hyperlipidemia and tuberculosis are now part of many people's lives and the border social dimensions affects all, even if this is not acknowledged by many. In India of the 400 people who are diagnosed with diabetes every day; of the 10.7 million deaths from cardiovascular disease every year and with over 1.8 million cases of tuberculosis, now, many have some of the symptoms and infections and some may have received clinical diagnosis too. Yet others enjoy good health and have every chance of continuing to do so for sometime, provided they have access to care and nutritional support. It is important that nutritional interventions should begin as soon as these diseases are diagnosed.

The present study entitled" **"Impact of supplementation of wheat germ, bran and grass on diabetic, hyperlipidemic and tuberculosis subjects"** is an attempt to find out the effect of nutritious food intervention in managing the conditions like diabetes, hyperlipidemia and tuberculosis and improving the nutritional status of the people with these problems. The locale selected for the study was the Districts of Chennai and Villupuram from the State of Tamil Nadu. Based on the physicians' opinion on the clinical and biochemical picture obtained from the hospital records and the criteria framed by the investigator,105 diabetics from the private diabetic clinics at Villupuram town ,60 tuberculosis subjects from the District Tuberculosis Centre, Villupuram and 105 hyperlipidemic subjects from Chepauk Government dispensary, Ezhilagam, Chennai were selected for the study. The ethical guidelines were followed and the study was approved by the Committee on Health Research Ethics, Avinashilingam University for Women, Coimbatore. As a first step in the study an interview schedule was formulated to elicit information from all the 105 diabetic, 60 tuberculosis and 105 hyperlipidemic subjects on their socioeconomic details including age, sex, education, family type, monthly income, food habits and

dietary pattern through interview cum observation method. Details on type and duration of disease and familial disposition of disease were also collected. The anthropometric measurements including height, weight, BMI and waist and hip circumferences were measured for all the diabetic, hyperlipidemic and tuberculosis subjects. MUAC and skin fold thickness were measured for the tuberculosis subjects. Precise information on food consumption pattern was collected through 24 hour recall method for one tenth of the selected subjects in all the three groups studied. The raw food equivalent of the cooked food was determined and the intake of macro nutrients was computed using the values given in the 'Nutritive Value of the Indian Foods. The 105 diabetics and 105 hyperlipidemics were divided randomly into seven groups of 15 each respectively.



Grouping of the subjects

Before starting the feeding trials, all the 225 subjects in the experimental groups were educated about the beneficial effect of the supplements in alleviating the disease conditions. Sixty grams of wheat germ and 20g of bran were supplied in sachets to the diabetic and hyperlipidemic groups every fortnight at the clinic premises. For the 45 subjects each in the diabetic and the hyperlipidemic group and 30 subjects in the tuberculosis group supplemented with wheat grass juice, 3000 ml of fresh juice was prepared daily and 100ml per selected subjects was supplemented. After supplementation for six months the impact of

supplementation of wheat germ, bran and grass on selected subjects was evaluated by clinical and biochemical methods. Further after three months of the withdrawal of supplementation five subjects were randomly selected from each subgroup and assessed for the biochemical parameters.

The findings of the study are summarized as follows

Nutrient content of wheat germ, bran and grass

- The moisture content of wheat germ, bran and grass were 11.1, 9.9 and 12.2g per 100g respectively. The carbohydrate content of wheat bran was 64.5g followed by 51.8g in wheat germ and 3.1g in wheat grass. The dietary fiber content was also found to be highest in wheat bran (42.8g) followed by wheatgrass with 17.3g and wheat germ with 13.2g. Wheat germ contained 23.1g of protein followed by 20.5g in wheat grass and 15.5g in wheat bran. The essential amino acid to non essential amino acid ratio of wheat germ, bran and grass were 0.52,0.43 and 0.56 respectively proving a higher ratio in wheat grass. Total fat content of wheat germ was 9.7g followed by 4. 3g in wheat bran. Wheat grass did not contain any fat. The thiamine(1.9mg), riboflavin(0.5mg), niacin(6.8 mg), vitamin B_6(1.3 mg) and folic aid(281mcg) contents were found to be highest in wheat germ. Vitamin B_{12}(103mcg) was found to be highest in wheat bran. Calcium (242mg)was found to be highest in wheat grass followed by 73mg in wheat bran and 39mg in wheat germ .Iron content was maximum in wheat bran (10.6mg), whereas the iron content of wheat germ was 6.3mg and of wheat grass was 0.61mg.Wheat bran provided highest content of magnesium (611mg).

Background details of the subjects

- Of all the diabetic subjects 35.2 per cent were in the age group of 40-45 years, 32.4 per cent in the age group of 46-50 years and 32.4 per cent were in the age group of 51-55 years. Of the selected hyperlipidemic subjects 26.7 per cent were in the age group of 40-45 years, 38.1 per cent in the age

group of 46-50 years and 35.2 per cent in the age group of 51-55 years. In the tuberculosis group 20 per cent were in the age group of 40-45 years, 36.67 per cent were in the age group of 46-50 years and 43.4 per cent were in the age group of 51-55 years.

- In the diabetic group there were 42.9 per cent women and 57.1 per cent men. In the hyperlipidemic group 70.5 and 63.3 per cent were male and female subjects respectively and in the tuberculosis group 63.3 per cent were male and only 36.7 per cent were women.
- Around 70 to 80 per cent of the families in the three groups studied belonged to nuclear family system and the remaining families belonged to joint families.
- Among the selected diabetics 40 per cent had primary education, 28.58 per cent had completed high school / higher secondary education and only 28.6 per cent were degree holders. In the hyperlipidemic group, 26.67 per cent had completed primary education, 34.3 per cent had completed high school /higher secondary education and only 5.71 per cent were degree holders. Among the tuberculosis subjects 15 per cent had primary school education, 26.70 per cent had high school/higher secondary education and none of them were degree holders. In the diabetic, hyperlipidemic and the tuberculosis groups 22.9, 33.3 and 58.3 per cent respectively were found to be illiterates.
- In the diabetic group, 40 per cent were agricultural landlords and only 1.9 per cent were doing business. Further 21.91 per cent were either in government or private jobs. In the hyperlipidemic group 85.7 per cent were government /private job holders and only 10.5 per cent constituted the agriculture group. In the tuberculosis group 58.33 per cent were agriculturists and only 13.3 per cent were either in government or private jobs

- It was found in the diabetic group 27.6 per cent belonged to low income group,17.1 per cent belonged to high income group and a majority of 55.2 per cent belonged to the middle income group . In the hyperlipidemic group 17.1 per cent of the subjects belonged to middle income group and 11.4 per cent belonged to the high income group. Only 0.95 per cent of the subjects belonged to the low income group. In the tuberculosis group 75 per cent belonged to the low income group, 18.3 per cent belonged to the middle income group and only 6.7 per cent belonged to the high income group.
- Among the diabetic subjects 58.6 per cent had the condition over the past four to six years,42.9 per cent of the subjects had diagnosed within the past 1-3 years and only 12.4 per cent of them had diagnosed the condition during the past one year. In the hyperlipidemic group 58.1 per cent had diagnosed the condition before four to six years while 33.3 per cent of the subjects had the condition over one to three years and only 8.6 per cent of the hyperlipidemic subjects had diagnosed the condition only during the past one year. All the 60 tuberculosis subjects had diagnosed the infection within one year.
- Among the selected 105 diabetic subjects 41 per cent of the mothers of the subjects were diabetic, 81 per cent of the fathers were diabetic. Also 12.4 and 11.4 per cent of the grand mothers and grand fathers respectively were found to be diabetic. In the hyperlipidemic group 61 and 91.4 per cent of the mothers and fathers respectively had heart disease, 21.9 and 33.3 per cent of the grand mothers and grand fathers respectively had heart disease.

Anthropometric measurements of the subjects

- The mean weight of the diabetic male and female subjects were 69.98 and 68.55kg respectively. In the hyperlipidemic group the mean weight of the male and female subjects were 71.25 and 65.99 kg respectively and in the tuberculosis group the male and female subjects weighed only 41.23 and 40.37kg respectively indicating muscle wasting .

- The mean Body Mass Index of male and female diabetic subjects were 24.81 and 26.21 respectively, of hyperlipidemic subjects were 25.35 and 26.85 respectively and tuberculosis subjects were 17.62 and 17.92 respectively. The diabetic and hyperlipidemic male and female subjects were in the Grade I obesity (25-30) and the tuberculosis male and female subjects were in mild Chronic Energy Deficiency (CED)-grade I.
- The Waist Hip Ratio (WHR) of the male and female diabetic subjects were 0.94 and 0.92 respectively, of hyperlipidemic subjects were 0.95 and 0.93 respectively and of tuberculosis group were 0.62 and 0.71 respectively.
- Mid Upper Arm Circumference and skin fold thickness were measured on tuberculosis subjects only. The MUAC of male and female subjects were 23.22 and 22.38 cm respectively and the skin fold thickness of the male and female subjects were 1.7 and 1.6 cm respectively.

Food and nutrient intake of subjects

- Consumption of cereals, milk and milk products and fats and oils in the diabetic group were found to be excess and the percentage adequacy of these foodstuffs included +132.9,+138.7 and +260 respectively. The consumption of pulses , green leafy vegetables and fruits were found to be deficient to the extent of 76.7, 80,39.5 and 48 per cent respectively.
- The mean energy intake of the diabetic subjects was 1688 kcal as against the suggested allowance of 1800kcal. The carbohydrate and fat intake of the diabetic subjects was 251 and 51g respectively. The protein intake of the diabetic subjects was 56.8g as against the suggested allowance of 59.5g and the dietary fiber content of their diet was 39.4g as against the suggested allowance of 34g.
- Consumption of cereals, milk and milk products, fats and oils were found to be 178.6,147.5,225 and 450 per cent of RDA respectively in the hyperlipidemic group. The consumption of green leafy vegetables(13.3%),

other vegetables(45%) and fruits(25%) were found to be deficit when compared with the suggested allowance. The mean energy intake of the hyperlipidemic subjects was 2153 kcal as against the suggested values of 1800 kcal. Similarly carbohydrate (65g) was also found to be in excess.

- In the tuberculosis group consumption of protein and dietary fiber was only 53.3 and 31.6g when compared with the suggested allowance of 59.5 and 34g. Consumption of all food stuffs including cereals, pulses, green leafy vegetables, other vegetables, fruits, milk and milk products and fats and oils were found to be deficient in their diets. The mean energy intake of the tuberculosis subjects was 1756 kcal. The low energy value of diets of tuberculosis was mainly due to low intake of fat and carbohydrate which was only 20 and 159g respectively.

Impact of supplementation on diabetic subjects

- Initially polyuria, polydypsia, polyphagia ,nocturia and constipation were found to be the most frequently occurring symptoms in all the diabetic subjects studied. After six months of supplementation with wheat germ, bran and grass individually and in combination there was a drastic reduction in the physiological symptoms expect for one or two subjects in whom symptoms like polyuria, polyphagia, nocturia and polydypsia did not reduce. Further it was found out that the subjects who expressed constipation as a problem expressed relief of constipation after taking the supplements.
- It is inferred that there was a gradual reduction in fasting glucose levels on supplementation with wheat germ, bran and grass individually and in combination. Group DA supplemented with wheat germ and group DC supplemented with wheat grass had a minimal decrease of 22.07mg/dl. Group DB supplemented with wheat bran had a reduction of serum fasting glucose of 22.80mg/dl while group DF supplemented with wheat bran and

grass had a reduction of 23.46mg/dl. Group DD supplemented with wheat germ and bran had a decrease of 23.27mg/dl while group DE supplemented with wheat germ and grass had a maximal decrease of 28.33mg/dl. The final values of the serum fasting glucose was significantly lower than the initial values ($P<0.01$) in all the experimental groups. The difference observed between the initial and final values of the control group DG was not found to be significant. Tukey test revealed that the reduction in the fasting blood glucose in all the experimental groups supplemented with wheat products proved significance over the control group. Further the mean difference in the fasting blood glucose levels of group DE supplemented with wheat germ and bran proved significance over groups DA, DC, DB, DD and DF proving the combined potential of wheat germ and bran over the other test groups.

- The serum postprandial glucose levels in the experimental groups after the supplementation ranged from 113.07 to 123.93 mg/dl. Among the supplemented groups, maximum reduction of 52.87mg/dl was noted in group DE supplemented with wheat germ and grass and the minimum reduction of 39.80mg/dl was noted in group DB supplemented with wheat bran. The decreases observed in serum postprandial glucose levels in all the experimental groups were found to be significant at one per cent level and also significantly greater than group DG proving the potential of supplementation. The mean decrease observed in groups DC, DD and DF supplemented with wheat grass, wheat germ and bran and wheat bran and grass were significantly higher than that of groups DB and DA supplemented with wheat bran and wheat germ respectively. Group DE supplemented with wheat germ and grass pictured increased reduction and was significant over groups DB, DC, DA and DD significantly.
- The HbA_1C had lowered by the individual as well as combined supplementation over a period of six months. Group DA supplemented with

wheat germ had a reduction of 2.07 per cent with the final values at 6.35 per cent which was considered as 'good control'. A similar effect was noted in groups DB and DC which had a reduction of 1.96 and 1.99 per cent respectively with the final values at 6.41 (good control). In all the three combined supplementation groups including groups DD,DE and DF the final values were 5.49,5.26 and 5.34 per cent respectively. Further maximum reduction of the HbA_1C was noted in group DE supplemented with wheat germ and grass. The reduction between the mean initial and final values of HbA_1C in the all the supplemented groups were significant at one per cent level and also all the reductions were found to be significant over that of the control group.

- Maximum increase (262.13 U/g Hb) of serum superoxide dismutase was observed in group DE supplemented with wheat germ and grass while the slightest increase of 97.83 U/g Hb was noted in group DB supplemented with wheat bran. The mean increments were found to be significant ($P<0.01$) in all the experimental groups. Further it could be noted that the mean incremental differences observed in group DA supplemented with wheat germ was significantly greater over groups DB and DF which were supplemented with wheat bran and wheat bran and grass respectively. Moreover the mean incremental differences in groups DC and DD supplemented with wheat grass and wheat germ and grass respectively was also significant over groups DB, DF and DA supplemented with wheat bran, wheat bran and grass and wheat germ respectively. The mean incremental difference in the serum superoxide dismutase of group DE supplemented with wheat germ and grass was significant over groups DB, DF, DA and DC which were supplemented with wheat bran, wheat bran and grass and wheat germ and wheat grass respectively proving the potential of combined supplementation of wheat germ and grass.

- The serum malondialdehyde had lowered by the individual as well as combinations of wheat germ , bran and grass supplementation. Among the groups treated with individual supplementation, group DC had the maximum reduction of 0.57 μM/L and among the groups treated with combined supplementation group, HE supplemented with wheat germ and grass had a maximum reduction of 1.09 μM/L. The reduction observed in the final values of mean serum malondialdehyde in all the supplemented groups were significant at one per cent level. Further it could be noted from the tukey table that group DD supplemented with wheat germ and bran showed a significant betterment in the reduction of serum malondialdehyde over groups DB supplemented with wheat bran. Group DC supplemented with wheat grass showed significant reduction when compared with groups DB and DA which were supplemented with wheat bran and wheat germ respectively. Group DF supplemented with wheat bran and grass also proved significant reduction in serum malondialdehyde when compared against groups DB,DA,DD and DC . Group DE supplemented with wheat germ and grass showed significant reduction of serum malondialdehyde over the groups DB,DA,DD,DC and DF.
- There was a significant increase ($P<0.01$) in the glutathione reduced levels on supplementation. Maximum increase of 18.78 μM/L was observed in group DE supplemented with wheat germ and grass while the least increase of 8.00 μM/L was noted in group DF supplemented with wheat bran and grass. All the mean differences of glutathione reduced recorded in the supplemented groups were significantly greater than that of the control group. Further it could be noted that the mean incremental differences observed in groups DB and DD supplemented with wheat bran and wheat germ and bran respectively were significant over group DF which was supplemented with wheat bran and grass and moreover the mean incremental difference in group DC also was significant over groups

DF,DB and DD. The mean incremental difference of the serum glutathione reduced of group DA was significant over groups DF, DB,DD and DC. The mean increment in glutathione reduced of group DE proved significance over the other supplemented groups.

- Supplementation of wheat products brought about a marked increase in the serum glutathione peroxidase values in all the supplemented groups ($P<0.01$). Among the individual supplementations group DA supplemented with wheat germ had an increase of 24.72 U/g Hb in the serum glutathione peroxidase levels while group DB supplemented with wheat bran resulted in a minimal increase of 27.24 U/g Hb. Group DE supplemented with wheat germ and grass had a maximum increase of 29.76 U/g Hb followed by group DF supplemented with wheat bran and grass which had an increase of only 8.68 U/g Hb in the serum glutathione peroxidase levels. The control group DG had an increase of 0.65 U/g Hb over a period of six months without any supplementation. It was observed that the mean incremental difference of serum glutathione peroxidase in all experimental groups were found to be significantly greater than that of control group HG.
- Groups DA, DB and DC recorded an increase of 0.16, 0.11 and 0.38 mg /dl of vitamin C respectively. Groups DD and DF had an increment of 0.10 and 0.36 mg /dl respectively. Group DE supplemented with wheat germ and grass had the maximum increase of 0.45 mg /dl. The final values of the serum vitamin C were significantly ($P<0.01$) greater than the initial values in all the experimental groups. Tukey test exhibited significance in the serum vitamin C levels in the supplemented groups over the control group.
- Groups DA, DB and DC with individual supplementation recorded an increase of 83.54, 30.54 and 5.80 µg /l of serum zinc respectively. Group DD supplemented with wheat germ and bran had a maximal increase of 56.88 µg /l of serum zinc while group DF supplemented with wheat bran and grass had a minimal increment of 31.24 µg /l. The final values of the

serum zinc was significantly greater than the initial values ($P<0.01$) in all the experimental groups. Through tukey test the serum zinc levels in all the supplemented groups proved significance over the control group.

- It is inferred that on supplementation with wheat germ, bran and grass individually and in combinations resulted in an increase in serum selenium levels. Group DA supplemented with wheat germ had an increase of 13.96 µg /dl, group DB supplemented with wheat bran had an increase of 13.20 µg /dl and group DC supplemented with wheat grass had a minimal increase of 5.14 µg /dl. Group DD supplemented with wheat germ and bran had an increase of serum selenium of 17.80 µg /dl while group DF supplemented with wheat germ and grass had an increment of 12.60 µg /dl. Group DE supplemented with wheat germ and bran had a maximal increase of 18.20 µg /dl. The final values of the serum selenium was significantly greater than the initial values ($P<0.01$) in all the experimental groups. No significant difference was observed between the initial and final levels of the control group DG.
- There was a decrease in serum copper levels with supplementation with wheat products. Group DA supplemented with wheat germ had a decrease of 2.86µg /dl, group DB supplemented with wheat bran had a reduction of 2.20µg /dl and group DC supplemented with wheat grass had a minimal decrease of 3.27 µg /dl. Group DD supplemented with wheat germ and bran had a decrease of serum copper by 3.93µg /dl while group DF supplemented with wheat germ and grass had a reduction of 3.67 µg /dl. Group DE supplemented with wheat germ and bran had a maximal reduction of 5.74 µg /dl. The final values of the serum copper were significantly lesser than the initial values ($P<0.01$) in all the experimental groups. The reduction in the serum copper levels in the groups DB,DF,DA,DD and DE supplemented with wheat products proved significance over the group DG which served as the control group.The

group DE supplemented with wheat germ and grass proved its efficiency in maintaining the blood parameters which were altered in diabetes except in the case of vitamin C and vitamin E levels which were best improved in group DD which was supplemented with wheat germ and bran.

- Three months after the withdrawal of the supplementation the fasting blood glucose , postprandial blood glucose and glycosylated hemoglobin levels of the subjects were foun to be significantly ($P<0.01$) increased in all the sub group studied.

Impact of supplementation on hyperlipidemic subjects

- Six months of supplementation of wheat products brought about a marked reduction in the serum total cholesterol values in all the supplemented groups. While group HB supplemented with wheat bran had a maximum reduction of 44mg/dl, group HC supplemented with wheat germ and grass had a minimal decrease of 22.47mg/dl among the individual supplements. Group HD supplemented with wheat germ and bran had the maximum reduction of 48.87mg/dl among the combination of supplements and group HE supplemented with wheat germ and grass had a minimum decrease of 28.26mg/dl. Group HG which served as the control group had an increase of 0.73mg/dl over a period of six months. The final values of the serum total cholesterol were found to be significantly lower than the initial values ($P<0.01$) in all the experimental groups. The mean difference in the serum total cholesterol of the experimental groups registered significance over the control group. Groups HB and HD supplemented with wheat bran and wheat germ and bran respectively had shown a statistically significant decrease in the mean total cholesterol when compared against the groups HC and HE which were supplemented with wheat grass and wheat germ and grass respectively.
- The serum triglyceride and combined levels reduced after individual supplementation with wheat germ, bran and grass. The final values of the

mean serum triglyceride levels in the experimental groups ranged from 132.60 to 155.33mg/dl. Maximum reduction of 52.07mg/dl was noted in group HD and the minimum reduction of 32.80mg/dl was noted in group HC. Decrease in serum triglyceride levels in the experimental groups were found to be significant at one per cent level whereas the change observed in the control group was not statistically significant. The mean differences of serum triglyceride in all the supplemented groups were significantly greater than that of the control group.

- The serum LDL – cholesterol had lowered by the individual as well as combined supplementation of wheat germ, bran and grass. Among the individual supplementation groups registered a maximum reduction of 40.53mg/dl was recorded by group HA while group HC supplemented with wheat grass had a minimal decrease of 16.87mg/dl. In the group HD supplemented with wheat germ and bran had a maximum reduction of 41.40mg/dl followed by groups HF and HE with a decrease of 36.67mg/dl and 27.47mg/dl respectively. The reduction in the serum LDL-cholesterol level of all the experimental groups except the control group were significant at one per cent level. In all the supplemented groups the mean serum LDL-cholesterol reduced significantly than the control group. Group HE supplemented with wheat germ and grass showed a significant betterment in the reduction of LDL- cholesterol over group HC supplemented with wheat grass. Group HF supplemented with wheat bran and grass showed a significant reduction over the groups HC and HE which were supplemented groups with wheat grass and wheat germ and grass respectively.
- There was an increase in the HDL-cholesterol levels on supplementation. Maximum increase of 9.53 mg/dl was observed in group HD while the least increase of 5.53mg/dl was noted in group HF. The increments in the HDL-cholesterol were found to be significant ($P<0.01$) in the experimental

groups. It was noted that the mean differences of serum HDL- cholesterol of the supplemented were significantly greater than the control group.

- There was a reduction in VLDL-cholesterol levels in all the experimental groups. Groups HA,HB and HC treated with individual supplements had a reduction of 6.64mg/dl. Maximum reduction of 10.35mg/dl was observed in group HD supplemented with wheat germ and bran followed by groups HE and HF with mean reduction of 8.67 and 8.26 mg/dl respectively. One per cent level of significance in the reduction was observed in all the experimental groups. The mean difference of serum LDL cholesterol in all the experimental groups registered significance over the control group.
- Six months of supplementation of wheat products brought about a marked increase in the serum apoenzyme A_1 levels in all the supplemented groups. Group HA supplemented with wheat germ had an increase of 28.61mg/dl in the serum apoenzyme A_1 levels while group HB supplemented with wheat bran had a minimal increase of 11.89 mg/dl. Among the groups receiving combined supplements group HD supplemented with wheat germ and bran had the maximum increase of 34.75mg/dl and group HF supplemented with wheat bran and grass had the minimum increase of 9.65mg/dl of serum apoenzyme A_1 levels. Group HG which served as the control group had an increase of 0.29mg/dl over a period of six months. The final values were significantly higher than the initial values ($P<0.01$) in all the experimental groups except the control group. The mean incremental difference of serum apoenzyme A1 in the experimental groups was significant over the control group HG .
- The serum apoenzyme B levels reduced after individual as well as combined supplementation with wheat germ, bran and grass. The final values of the mean serum apoenzyme B levels in the experimental groups ranged from 85.20 to 120.77 mg/dl. Among the supplemented groups, maximum reduction of 83.09mg/dl was noted in group HD supplemented

with wheat germ and bran and the minimum reduction of 8.23mg/dl was noted in group HC supplemented with wheat grass. Decreases in serum apoenzyme B levels in all the experimental groups were found to be significant at one per cent level whereas the change observed in the control group was not statistically significant.

- The mean initial LDL-C to HDL-C ratios of the experimental and the control groups ranged from 4.09 to 4.37 as against the desired range of 0.5 to 3.0. Group HA supplemented with wheat germ had a decrease of 1.24 followed by group HB by 1.25 among the groups receiving individual supplements. Maximum reduction in the ratio of 1.29 was noted in group HD supplemented with wheat germ and bran and minimal reduction was noted in group HC supplemented with wheat grass. The HDL to total cholesterol ratio ranged from 0.15 to 0.16 initially and after the supplementation period the final values ranged from 0.16 to 0.21 whereas the ideal value is $\geq$0.24. Similarly the apoB to $ApoA_1$ ratio ranged from 0.84 to 0.86 initially and after six months of supplementation the ratio ranged between 0.53 and 0.72 which was found to be well within the normal range of reference i.e <0.75.
- It could be depicted that group HD supplemented with wheat germ and bran proved to decrease total cholesterol, serum triglyceride, LDL-cholesterol, VLDL-cholesterol and Apoenzyme A_1 and increased HDL-cholesterol and Apoenzyme B levels. Further group HB supplemented with wheat bran was ranked second in reducing total cholesterol, serum triglyceride and LDL-cholesterol levels.
- The results after three months of the withdrawal of the study revealed that the total cholesterol, triglycerides, LDL-cholesterol and VLDL-cholesterol were increased significantly ($P<0.01$). Further the mean HDL-cholesterol was decreased among the subjects.

Impact of supplementation on tuberculosis subjects

- Of the various clinical parameters indicative of tuberculosis, cough with sputum was present initially in 13 subjects in group TA supplemented with wheat germ and 15 subjects each in groups TB, TC and TD. After the supplementation, groups TA , TB and TC had only two, five and three subjects with cough and sputum respectively. Dry cough was prevalent among 12,13 and 15 subjects in groups TA,TB and TC initially whereas after the supplementation period it was noted that only among five, three and five subjects respectively at the end of the study. Loss of weight greatly reduced at the end of the study among all the experimental subjects.
- On supplementation with wheat products there was an improvement in the serum albumin levels after six months. Group TC supplemented with wheat germ and grass had a maximum increase of 4.74g/l and group TB supplemented with wheat grass had a mean increase of 2.60g/l. The changes observed in the mean serum albumin levels in the experimental and the control groups were found to be significant at one per cent level. The tukey test revealed that the mean difference in group TC supplemented with wheat germ and grass was significantly greater over the control group.
- There was an increase in the serum total protein levels on supplementation. Maximum increase of 10.74 g/l was observed in group TC supplemented with wheat germ and grass while an increase of 7.6g/l was noted in group TA supplemented with wheat germ only. Group TB supplemented with wheat bran had registered an increase of 6.42g/l. The final values of the serum total protein when compared with the initial values were found to be significantly greater ($P<0.01$) in the experimental and control groups. Only the mean difference of serum total protein of group TC supplemented with wheat germ and grass was significantly greater than that of the control group.

- There was a marked reduction in the serum TLC values in all the supplemented groups.. Group TC supplemented with wheat germ and grass had a maximal decrease of 1088.60 cells/m^3 while group TB supplemented with wheat grass had a reduction of 565.07 cells/m^3. Group TD which served as the control group had a decrease of 224.20 cells/m^3 over a period of six months. The final values of the serum TLC was significantly lower than the initial values ($P<0.01$) in the experimental and control groups. Tukey test undercoverd that groups TB, TA and TC registered significantly lower reduction than the control group.
- The CD_4 levels increased after individual as well as combined supplementation with wheat germ and grass. The final values of the mean CD_4 levels in the experimental groups ranged from 441.40 to 573.93 cells/m^3. Among the supplemented groups, maximum increase of 251 cells/m^3 was noted in group TC supplemented with wheat germ and grass and the minimum increase of 143.33 cells/m^3 was noted in group TB supplemented with wheat grass. Increase in the final values of CD_4 count in the experimental and control groups were found to be significant at one per cent level . The mean difference of CD_4 levels of the groups TB, TA and TC were significantly higher than the control group TD.
- There was an increase in the serum superoxide dismutase levels on supplementation. Maximum increase of 295.93 U/g Hb was noted in group TC supplemented with wheat germ and grass while a minimum increase of 277.67 U/g Hb was registered in group TB supplemented with wheat grass. The final values were found to be significantly greater than the initial values in all the groups studied ($P<0.01$). Further the mean differences of serum superoxide dismutase of the supplemented groups were significantly greater than the control group. Further it could be noted that the mean incremental differences observed in group TC supplemented with wheat germ and grass was significantly greater over group TB which was

supplemented with wheat grass proving that potential of combined supplementation of wheat germ and grass.

- The serum malondialdehyde levels had lowered by the individual and combined supplementation of wheat germ, bran and grass over a period of six months. Groups TA,TB and TC had a reduction of 2.25,1.97 and 2.29 μM/L respectively. Further it was noted that group TC supplemented with wheat germ and bran had a significantly greater reduction of serum malondialdehyde over groups TB and TD.
- Maximum increase of glutathione reduced levels (11.23 μmol/l) was observed in group TC supplemented with wheat germ and grass while the increase of 55.23 μmol/l was noted in group TB supplemented with wheat grass.The final values of the glutathione reduced were found to be significantly greater ($P<0.01$) than the initial values in the experimental and control groups. The mean differences of glutathione reduced of the three supplemented groups were significantly greater than the control group TD.
- A marked increase in the serum glutathione peroxidase values was recorded in all the supplemented groups. Group TC supplemented with wheat germ and grass had a maximum increase of 29.60 U/ gHb among the supplemented groups. The control group had an increase of 5.26 μgm/Hb over a period of six months. The final values of the serum glutathione peroxidase was significantly lower than the initial values ($P<0.01$) in all the experimental and the control group. The mean incremental difference of serum glutathione peroxidase in the groups TA,TB and TC registered significance over the control group.
- Group TA supplemented with wheat germ had an increase of 0.45mmol/l in the serum total antioxidant levels followed by group TB supplemented with wheat grass registering an increase of 0.35mmol/l. Group TC supplemented with wheat germ and grass registered an increase of 0.49mmol/l. The control group TD had an increase of 0.03mmol/l over a period of six

months without any supplementation. The final values of the serum total antioxidant activity was significantly lower than the initial values P<0.01) in all the experimental and control groups.

- It is inferred that there was a gradual increase in serum zinc levels on supplementation with wheat germ and grass individually and in combination. Groups TA and TB had registered increase of 72.27 μg /l, and 48.33 μg /l respectively. Group TC had a maximal increase of 88.07 μg /l . The final values of the serum zinc was significantly lower than the initial values (P<0.01) in all the experimental and control groups. The increment in the serum zinc levels in the groups TC,TB and TA supplemented with wheat products proved significance over the group TD which served as the control group.
- There was an increase in serum selenium levels on supplementation with wheat germ and grass individually and in combination followed by groups TA and TB with mean increases of 87.20 μg /l. Group TC supplemented with wheat germ and wheat grass had a maximal increase of 89.53 μg /l. The final values of the serum selenium was significantly lower than the initial values (P<0.01) in all the experimental and control groups. There was a decrease in serum copper levels on supplementation with wheat germ and grass individually and in combination. Group TA supplemented with wheat germ had a decrease of 27.11 μg /l, group TB supplemented with wheat grass had a reduction of 23.21 μg /l and group TC supplemented with wheat germ and wheat grass had a maximal decrease of 29.68 μg /l. The final values of the serum selenium were significantly lower than the initial values (P<0.01) in all the experimental and control groups. The reduction in the serum copper levels in the groups TB,TA and TC supplemented with wheat products were significantly lower than the control group TD.

From the foregoing discussions, it could be concluded that wheat germ, bran and grass are effective contrivance in fight against degenerative and infectious diseases like tuberculosis and could be used as an adjunct intervention in ensuring better heath for diabetic, hyperlipidemic and tuberculosis subjects ; if not completely cure them of the disease. It would be a boon to the diabetic, hyperlipidemic and tuberculosis population, if all the hidden , health promoting properties of wheat like alleviation of co-morbidities are explored for the fullest use of this nature's gift.

It could be concluded from the study that wheat germ, bran and grass are reported to have beneficial effect in alleviating specific health issues like diabetes hyperlipidemia and could be used as an immune booster in tuberculosis. In this ever changing scenario of emerging varieties of disease, existence of medical assistance without any side effect is much sought after remedy. In this context, the result of the present investigation assumes significance and a small step in such innovative findings on the hitherto –**"Wheat – A treasure to treasure".**

Recommendations

The study emerged with the following recommendations

- The utility of wheat apart from the form in which it is consumed generally has been unraveled empirically, it becomes necessary that the findings of the study move to another level whereby the information is disseminated to the community at large, for which a nutrition education campaign may be conducted .
- The dietary departments of hospitals may be encouraged to use wheat byproducts namely wheat germ, bran and grass in the preparation of therapeutic diets wherever it is applicable.
- Further studies should be conducted to improve the shelf life of wheat germ and bran.
- Ways of incorporating wheat products in the recipes in most acceptable forms need to be explored.

- A comparative study on the efficacy of fresh wheat grass juice and wheat grass juice will throw light on the regular consumption.
- Above all , a state sponsored campaign; subsidized harnessing of the bran, germ and wheat grass juice can do a remarkable impact to the nutritional status of the nation as a whole , because every findings at ivory towered laboratories, especially as the present study, get their fullest meaning only if they are pointed towards the benefit of the common man.