SUMMARY AND CONCLUSION
Germination is one of the most simple methods used in improving the nutritive value of cereals and pulses. Soil being a medium rich in nitrogen and all other minerals, it follows that the seeds germinated in soil may improve the protein and mineral contents of the seed in a greater proportion than the normal household process. Increase in vitamins and minerals are reported by many scientists and few have reported on the availability of certain nutrients but no reports are available on seeds germinated in soil. Therefore, the investigator chose to study commonly consumed seeds viz. wheat, greengram, bengalgram and fenugreek under different conditions of germination.

In the first experiment wheat and greengram were compared on soaking in distilled water for different lengths of time and on germination for 18 hrs by the muslin cloth technique in soil.

Wheat, due to a thicker seedcoat absorbed water slowly compared to greengram which showed rapid water uptake. Mineral leaching into seed-soak water was in negligibly minute quantities. Protein content of the seeds showed no variation due to germination. Iron content increased in both seeds during soil germination as a result of uptake from the soil, wheat showed a greater increase than greengram.
The first experiment revealed that the thickness of the seedcoat played an important role on the rate of germination therefore in the second experiment two legumes were selected, one with a thin seedcoat i.e. greengram and another with a thicker seed i.e. bengalgram for comparison. The legumes were germinated under three different conditions - soaking followed by muslin cloth germination, soaking followed by soil germination and soil-germination; greengram was germinated for 24 hours while bengalgram was germinated for 48 hours because it had a slower rate of germination.

Maximum shoot length was observed on soil germination in both the legumes. Soil-germinated legumes showed increased calcium and iron levels. In greengram, soaking followed by soil-germination produced higher calcium and phosphorus content compared to direct soil-germination. Iron content showed an equal increase under both conditions of soil-germination for both legumes.

Fresh seedling preparations of wheat and fenugreek are considered to be health tonics by the local population here. The nutrient changes in them compared to the ungerminated seeds could throw more light upon their effectiveness.

In the third experiment, wheat and fenugreek were soil-germinated for five and three days, respectively,
until the emergence of the first pair of leaves which indicates the stage of independent food manufacture in the seedling. The dry seedling powders were analysed and compared with the nutrient content of ungerminated seeds.

The fiber, lysine mineral and vitamin content of the seedling powders were greater than that of the respective ungerminated seeds. Wheat seedling powder showed an increase in protein content compared to ungerminated wheat while fenugreek seedling powder showed a slight decrease. Wheat seedling powder showed greater increases in mineral content (over raw) than fenugreek seedling powder while the latter showed greater increases in vitamin content than the former.

Since wheat seedling powder showed increased nutrient content, an animal experiment was planned to study its effect on growth, maintenance of protein status and bone mineralisation. Wheat seedling powder supplemented at 25, 50 and 75% level to raw wheat was fed to weanling animals for four weeks. One group was fed wheat seedling powder alone (100%) while raw wheat was fed as the control diet.

All the experimental groups showed the beneficial effect of feeding WSP i.e. higher weight gain, PER and tissue protein levels which was related to greater lysine intake. Bone calcium and phosphorus levels were higher in
the seedling powder fed groups because the dietary levels were also higher. Lower levels of supplementation showed better results than higher levels. Since the fiber content of the diet increased as the level of seedling supplementation increased, this could have led to interference in the availability of dietary protein and minerals at higher levels of supplementation with the seedling powder.

Since the lower levels of supplementation showed better results, wheat seedling powder was supplemented at these two levels i.e. 25 and 50% to a wheat plus bengalgram diet. The control group was fed wheat plus bengalgram (80 : 20). In the experimental groups, 5 and 10% of bengalgram were replaced by 25 and 50% of wheat seedling powder in order to observe whether the seedling powder could replace bengalgram effectively. The fourth group was fed the same 25% WSP supplemented diet as above but after fermentation overnight followed by steam cooking. This was done to observe whether the combination of germination and fermentation could further improve growth. Experimental feeding was carried out for a period of four weeks.

Control group fed raw wheat plus bengalgram showed greatest weight gain, PER and tissue protein levels. This is because the essential amino acid levels are greater in
bengalgram while wheat seedling powder contained low amounts of the same. Therefore, the protein quality of the control diet was superior due to the higher levels of bengalgram in the diet. Bone calcium levels were greater in the wheat seedling powder fed groups indicating that the seedling powder was effective in bone mineralisation due to its high calcium content. Fermentation of the diet did not produce any marked change on growth, protein status or bone mineralisation.

Greengram was selected for the next study as it is commonly consumed as a germinated legume. In the third animal experiment, greengram germinated under different conditions was supplemented to raw wheat and fed to weaning animals. The control group was fed raw wheat plus ungerminated greengram (80 : 20). The second and third groups were fed wheat supplemented with greengram germinated by the muslin cloth technique for one day and two days, respectively. Similarly, the next two groups were fed wheat supplemented with greengram germinated in soil for one day and two days, respectively. In the last two groups the diets fed were similar to the fourth and fifth groups but salt and vitamin mixture were omitted from these two groups. Feeding was carried out for a period of four weeks.
It was observed that the growth pattern was virtually the same in all the groups. Therefore, the experimental feeding period was extended for another four weeks.

The study indicated that the first and second phases of feeding showed no great variation. Similar patterns of diet intake and weight gain were observed in both periods. The group fed two day lab-germinated greengram and the group fed two day soil-germinated greengram omitting the salt and vitamin mixture showed a slightly lower growth rate.

Haemoglobin levels were greater on feeding soil-germinated greengram rather than lab-germinated greengram. Feeding germinated legumes decreased the plasma protein levels while liver protein levels did not show any change. Feeding soil-germinated greengram increased the bone calcium levels favourably.

It was observed that germination under different conditions for different lengths of time did not alter the protein quality of greengram markedly but feeding soil germinated greengram led to better bone mineralisation in weanling animals. When salt and vitamin mixture were omitted, soil germinated greengram, especially for the shorter period i.e. one-day, was able to produce equal weight gain as the animals fed the same diet with the
inclusion of salt and vitamin mixture but bone calcium and phosphorus levels were lowered without the addition of salt and vitamin mixture, the increased mineral content in the soil germinated greengram could not satisfy this deficit.

Since the wheat seedling powder showed an increased fiber content the next experiment was planned to study the cholesterol-lowering effect of the same, if any. Adult animals were made hypercholesteremic and then they were fed raw wheat supplemented with wheat seedling powder at 25 and 50% levels. The first group was fed raw wheat and continued on the cholesterol. The second group was fed raw wheat and cholesterol was withdrawn from this group. Similarly, groups III and V were fed 25 and 50% WSP diets with cholesterol while groups IV and VI were fed 25 and 50% WSP diets omitting cholesterol. Cholesterol-omitted control groups were included to observe how much of the decrease in cholesterol levels occurred due to cholesterol withdrawal alone. Feeding was carried out for a period of four weeks.

Continuous cholesterol-feeding increased the plasma cholesterol, triglyceride and phospholipid levels. Feeding wheat seedling powder did not show any lipid-lowering effect in the plasma. Liver lipid and cholesterol levels increased on feeding cholesterol. Liver free and total cholesterol as well as liver triglyceride levels decreased on feeding WSP. Adipose tissue also showed a decrease in
cholesterol levels on feeding the wheat seedling powder. The soluble and insoluble fractions of the fiber were not estimated and the distribution of cholesterol among the different lipoprotein fractions of the plasma could not be estimated, these were drawbacks of the study.

Since the wheat seedling powder showed a cholesterol-lowering effect on adult animals, it was decided to observe the effect on weanling animals, to see whether feeding different proportions of WSP from the weanling stage could lower cholesterol levels. In the next animal experiment the control groups were fed raw wheat without cholesterol (Group I) and raw wheat with 1% cholesterol (group II). Groups III and V were fed 25 and 50% WSP supplemented to raw wheat omitting cholesterol. Groups IV and VI were fed the same diets with 1% cholesterol. In the VII group the 25% WSP was fed along with 25% greengram seedling powder (3 days old) to observe their combined hypocholesteremic effect. Group VIII was fed the same diet i.e. 25% WSP and 25% GCSP supplemented to raw wheat along with 1% cholesterol. Experimental feeding was carried out for a period of four weeks.

Plasma cholesterol levels did not show any lowering tendency on feeding the germinated diets. Plasma triglyceride and total lipid levels decreased on feeding
WSP. Liver cholesterol and triglyceride levels did not show any change on feeding the seedling powder, although adult animals had shown a lowering effect.

The organ cholesterol levels failed to show any consistent trend on feeding the seedling powders.

The increased fiber observed in soil-grown seeds indicated that seedlings may be effective not only in lowering cholesterol levels but also in lowering blood glucose levels. The next animal experiment was planned based on the local practice observed in the diabetic population of the community residing here. Fenugreek seedlings are pulped and consumed fresh as supportive therapy in the diabetic condition. Therefore, in the last animal experiment, adult male animals were made diabetic and fed raw and seedlings (3 days old) of fenugreek in order to observe any hypoglycaemic effect.

Both forms of fenugreek, raw and seedlings lowered blood glucose levels, the former produced a 33% decrease while the latter produced a 97% decrease indicating that feeding germinated fenugreek led to a greater hypoglycaemic effect. The increased fiber content of fenugreek could be the hypoglycaemic factor responsible for this greater decrease. Fenugreek seedling also enhanced glycogen deposition in the liver. Feeding fenugreek lowered the plasma triglyceride levels while cholesterol levels did not show any change.
Studies presented here indicate that seedling powders can enhance growth by improving the protein quality of the diet but their supplementary effect is still inferior to that of the pulse protein. The increased calcium and phosphorus content of these powders lead to improved bone mineralisation in weanling animals. Seedlings can also be included as palatable sources of fiber in the diet which lowers the cholesterol level in the body. Fenugreek seedling in particular is of use in lowering blood glucose levels.

Seedlings in the fresh form can be used in preparations of soups, custards and as fillings in various items like kachories, cutlets, parathas etc. The dry seedling powder has greater versatility since it will have an increased shelf life and can be incorporated into any kind of preparations from the simple home made items like chappathis, puris etc. to the more sophisticated, bread, biscuits and pasta preparations where they can effectively improve the nutrient content of the foodstuff.