SUMMARY AND CONCLUSION

This chapter deals with the consolidation of the various findings presented in the previous chapter and the conclusions arrived there from.

The objective of the study was to evaluate the nutraceutical impact of Garden Cress Seed and the role of breakfast on the memory and concentration of elementary school children.

The study was carried out in three steps. Step I was conducted to elicit information on the dietary pattern and on the prevalence of anemia in the elementary school children. This preliminary investigation formed the basis for the study in step II and step III.

Step II was to evaluate the nutraceutical impact of Garden Cress Seed through supplementation and to study the impact on biochemical parameters like hemoglobin, morphological structure of RBC, memory and concentration.

As it is a pioneer research it was decided before supplementation to test the feasibility of using Garden Cress Seed through toxicology study in wistar rats, and palatability test through subjective evaluation.

Step III was to study the role of existing breakfast pattern on memory and concentration of children belonging to three socioeconomic group and also to study the effect of controlled breakfast pattern on memory and concentration of elementary school children.

Preliminary study was conducted by interviewing 100 working and 100 nonworking mothers, who had elementary school children. The dietary pattern was collected through 24-hour recall method and food frequency
questionnaire. Height and weight of the children were measured. The hemoglobin content was assessed for a sub group of 60 children (30 working, 30 nonworking) by cyanmethemoglobin method. The children were chosen on the basis of their willingness to undergo biochemical examination.

Step II sub-acute toxicology test for Garden Cress Seed was carried out at the International Institute of Biotechnology and Toxicology, Paddapai.

Six recipes were standardized; three recipes (using the seed) namely porridge mix, roasted Bengal gram dhal balls and sweet mix. Sweet dishes were chosen because it was difficult to mask the slight bitter taste of the seed, which made it unpalatable to be incorporated with savoury items. Besides the seeds, an attempt was also made to prepare three savoury recipes using Garden cress sprouts. Through trial and error method the investigator succeeded in sprouting the seed, as it cannot be sprouted by normal method being mucilaginous. The three recipes standardized using the sprouts were sandwiches, noodles and salad.

Taste panel members tested the standardized recipes and evaluated the acceptability with the help of five-point scorecard.

The sweet mix standardized above with Ten percent incorporation was chosen for supplementation study, as it can be prepared in bulk and stored for a longer time.

The supplementation study was carried out in a boarding school in order to control the variation due to extraneous variables. Fifty children suffering from moderate anemia (hemoglobin7-9.9g/dl) were chosen. They were randomly allotted to two groups control and experimental. Care was taken to see that they were matched for BMI and age. Test food was given for a period of 30
days. The control group was given sweet mix for the same period. The following parameters were studied before and after supplementation.

a) Memory and concentration
b) Anthropometrical measurement
c) Clinical examination
d) Biochemical estimation

The tools used for testing memory and concentration were as follows: Digit span and coding test (WISC intelligent test), Letter cancellation test, picture recollection (PGI Scale). The height and weight of children were measured using standard procedure. A pediatrician clinically examined the children before and after supplementation. Hemoglobin estimated before and after supplementation. Peripheral smear was also done.

Step III was to study the impact of existing breakfast on concentration and memory of 9-11 year old. Total sample of 600 fourth, standard children (9-11 yrs) were chosen to represent, 200 children from each socioeconomic group. Open-ended questionnaire was used to study the breakfast consumption pattern. Concentration test was conducted for all the 600. Out of the 600 children, 150 children were randomly selected, so as to represent 50 children from each income group. The 150 children were administered the Digit span and picture recollection scales to test their memory. Latter half of Step III was to study the effect of three types of selected breakfast on the concentration and memory of 9-11 year old children. Thirty children between the age group of 9-11 years were chosen from nearby locality based on their willingness to participate in the study. They were randomly allotted to three groups of ten children each.
The first group was fed three iddiappam (spring hoppers) and one tablespoon of sugar (cho rich); the second group was given two boiled eggs, 200 ml milk and one medium sized bread slice (protein rich); the third group was fed two dosai with one cup of sambar (cho+protein+fat). They were fed for three consecutive days. The pre test was done on day one before feeding them breakfast, on an empty stomach; the post test was done on the third day one hour after breakfast. The children were given memory and concentration test using the same tool.

The results are as follows:

Step I

Dietary pattern of working and non-working women revealed no differences. Hence the data from the two categories was merged and discussed in general. The following are salient findings:

Energy drink like Boost/Complan was the popular morning feed given to the children. The children did not have sufficient breakfast on weekdays due to lack of time. Traditional breakfasts are still popular, 50% consume traditional breakfast like idly and dosai. Some communities consume mixed rice for breakfast. Not much importance is given on providing nutritious snacks. 40% of the children consume biscuits, 20% chips and 20% do not carry snacks to school.

Mixed rice was popular packed lunch preferred by mothers, 67% had rice preparation for dinner whereas 33% had tiffin items.
Generally the diet was lacking in iron and Vitamin C. Consumption of green leafy vegetables and fruits is inadequate. Weekend menu were more laborate and well balanced compared to weekday menu.

As far as BMI was concerned 30% of the boys and 20% of girls had BMI below normal; 50% had hemoglobin below normal level.

**Step II**

The toxicology study revealed normal architecture of liver, kidneys and gonads of the animals. The biochemical and hematological parameters did not differ significantly between the experimental and control group. The alkaline phosphatase value was significantly higher for the female experimental group. The difference was seen only in one animal. The histopathology of that particular animal was also normal. Hence it could be safely concluded that the Garden Cress Seed did not produce nephrotoxicity and hepatotoxicity.

The nutrient analysis of the seed was carried out for four nutrients and the findings are as follows; Iron-107mg/100g; Calcium –434mg/100g; Protein 31 g/100g and Fat 15g/100g.

Six dishes were standardized and tested for acceptability. Three sweet dishes with the seeds namely Breakfast porridge mix, Roasted Bengal gram dhal sweet balls and Sweet mix. Three dishes with the sprouts namely Salads, Sandwiches and noodles. Of the three sweet dishes, porridge and sweet balls were acceptable at Five percent level. There is significant difference in the acceptability scores of all the three dishes at seven and ten percent level. When the sweet items were served without the control they were well accepted. The items standardized with sprouts were acceptable only at Two
percent level. The items can easily be made palatable by adding salad
dressing or spread to the sandwiches.

Impact of supplementation

The hemoglobin content increased significantly in both the groups, but the
gain score for the experimental group was double that of control group. This
is attributed to the incorporation of Garden Cress Seed. The significant
increase in the hemoglobin content of the control group might be attributed to
the sweet mix. The iron content of the sweet mix was found to be
10.2mg/100g. 10g of the sweet mix were given to the control group. Secondly
the children in the control group were also anemic hence they responded well
to the sweet mix. There was significant increase in letter cancellation and
coding test for both the groups. This might be attributed to the increase in the
hemoglobin content. No significant increase was noted in digit span test in
both the groups. Significant increase was seen in picture recollection for
experimental group. Though there was an increase in picture recollection for
control group it was not statistically significant. There was a significant
increase in weight in both the groups not much difference was noted in the
height as the period of supplementation was only a month.

Clinical examination showed improvement in the paleness of the children for
both the groups, the paleness, which was noticed prior to the feeding, had
reduced considerably. The skin lesions in the experimental group had reduced
considerably. The experimental group children looked healthier after
supplementation.

The peripheral smear showed improvement in the RBC’s. The target cells,
which were present prior to feeding, had disappeared. The hypo chromic
RBC’s were replaced by normochromic RBC’s.
Step III

In the low-income group 25% of the children skipped breakfast, and only 5% skipped breakfast in the middle-income group whereas none of them skipped breakfast in the high-income group. Traditional breakfast item are still popular among all the income groups. The BMI of the children belonging to the HIG was the highest followed by MIG and then LIG. The concentration score was affected greatly by health status and the type of breakfast. Children belonging to HIG and MIG performed better than LIG children. Children who skipped breakfast scored the least and those who consumed a balanced breakfast like curd rice, sambar rice or other balanced breakfast scored the maximum. In traditional breakfast like idly and dosai, the performance of the children depended on the side dish they had with idly and dosai. Children who drank energy drink, coffee and porridge scored similarly. The coding score and picture recollection was moderately affected by the health status and type of breakfast, but they did not have much impact on the digit span score. From the breakfast study it could be concluded that the performance of the children is affected by their health status and quality of breakfast consumed by them. The results of intervention study showed that breakfast did improve the scores of the children. Balanced breakfast like dosai and sambar enhanced the performance compared to carbohydrate rich breakfast like Iddiappam. Animal protein like milk and egg also improved the performance greatly but inclusion of all the three macronutrients like CHO, protein and fat is better for children.
CONCLUSION

The following conclusions are drawn from the above study.

- No toxicity was found in Garden Cress Seed As evident from the study on Wistar rats.

- The sweet recipes with Garden Cress Seed incorporation and the savoury recipes with Garden Cress Sprouts incorporation were acceptable.

- The Garden Cress Seed used had high iron content, calcium, protein and fat as found from the nutrient analysis.

- The iron in Garden Cress Seed is highly bioavailable when the seeds are mixed with ingredients like red rice, coconut milk, egg and sugar and roasted in an iron pot.

- When one gram of Garden Cress Seed incorporated in sweet mix and given to moderately anemic children for thirty days, it increases their hemoglobin by 2.4 g/dl.

- Breakfast with milk, balanced breakfast (curd rice; Idli, sambar;)are better than idli and sugar or idly and chutney. Skipping breakfast or eating too much of carbohydrate one hour before testing showed poor cognition.

- Breakfast with same amount of calories showed variation in performance. The best breakfast is a combination of “protein, carbohydrate and fat” breakfast followed by “protein and fat” combination. The breakfast, which is only carbohydrate rich, gives immediate energy but is not sustained for long. and is the least for undernourished group of children.
• Children in LIG are worst hit. They have no breakfast or they have poor quality breakfast. Among children in the middle and high-income group some skip breakfast because of early school timings. For all these children it is ideal to have a quick nutritious snack like sweet mix with Garden Cress Seed.

• Dry sweet mix can be packed and taken to school and consumed during break time by those children who skip breakfast. Mothers can prepare this nutritious sweet mix in bulk as it has a long shelf life and make things easy for themselves and easy for the children.

• On the whole it can be summed up that Garden Cress Seed possess "Nutraceutical properties". It is a potential nutraceutical.

Limitations of the study

There are some potential limitations to this study

➢ Many factors other than iron status and breakfast influence the cognitive functioning of the children; all the factors cannot be controlled (genetic influences, health status and so on).

➢ Several studies have suggested that infants who had iron deficiency anemia continue to have lower cognitive scores years later. We cannot determine whether the iron deficient children in this sample had iron deficiency as infants.

➢ The investigator used open-ended questionnaire as one of the tools to elicit information on the breakfast consumed, which relied on students' responses rather than more objective data.
The investigator did not have a control over the different classes/subjects the children had attended prior to the administration of Concentration and Memory test. The classes attended by the children prior to the assessment had a lot of impact, for example children who had Physical Activity class performed better than children who had Mathematics class.