

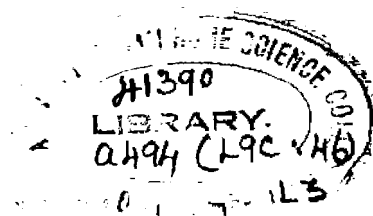
**EVALUATING THE SUPPLEMENTARY VALUE OF AN OPAQUE - 2  
MAIZE MIXTURE TO PRESCHOOL CHILDREN**

by

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## **A C K N O W L E D G E M E N T**

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## . INTRODUCTION

Children are the mirror of a nation. Good nutrition in childhood is of paramount importance in fostering the physical, mental and emotional health and growth of population (Nevadas et al, 1971)<sup>1</sup>. Health is ability to participate fully in all aspects of life. It is the result of good nutrition. Yet, even today a vast majority of the world's children are malnourished or undernourished. Malnutrition is primarily due to inadequacy of food of the right quality and quantity. In spite of significant increases in food production, the availability of food could not cope up with the enormous increase in population. As Pooma, (1971)<sup>2</sup> warns, malnutrition can wreak havoc with a country's growth potential.

From the nutritional stand point children below five years, are the most vulnerable group. They constitute over 15 per cent of the population in India. The prosperity of the nation will depend upon the well being and the optimum development of these human resources. It is the birth right of every child to have adequate health care, education and food for a happy future (Chandra, 1968 and United Nation Children's Fund, UNICEF, 1972)<sup>3,4</sup>.

At a given time, nearly one to two per cent of the

children in the economically poor communities of India manifest extreme signs of Protein Calorie Malnutrition (PCM). The major bottleneck in the diets of these children is calories and not protein (Gopalan, 1968)<sup>5</sup>. The extent of malnutrition among the vulnerable groups in a particular community needs to be assessed and suitable measures should be taken to overcome the malady.

Devadas and Radharukmani (1966)<sup>6</sup> and Jayaraman (1972)<sup>7</sup>, consider supplementary feeding programme as a most promising and effective measure to improve and maintain nutritional status. Special feeding programmes have been in existence for a number of years, but it is only in the Fourth Five Year Plan, that such feeding programmes have been recognised as part of the national programmes. This essential and urgent task must be implemented in the Fifth Five Year Plan. The methods of feeding pre-school children need improvement.

Diet and nutrition surveys carried out in India reveal that the diets consumed by a large majority of the population are based mainly on cereals such as Rice, wheat and maize (World Health Organisation, WHO, 1969 and Devadas et al., 1970)<sup>8,9</sup>. The maize varieties presently cultivated in India contain 10 to 12 per cent total protein. However, the quality of their protein is poor,

lacking in the essential amino acids, lysine, tryptophan and isoleucine. Hence production of a hybrid maize in which these amino acids are present in the required quantities will have a direct beneficial effect on human nutrition. Such an effort, made in Purdue University, USA, in 1966, resulted in the Opaque-2 strain of maize, rich in the amino acids, lysine and tryptophan. Furthermore the leucine and isoleucine ratio of Opaque-2 maize is more favourable than the ordinary maize (Abraham and Franz, 1971 and Pandya, 1971)<sup>10,11</sup>. Swaminathan (1973)<sup>12</sup> opines that the greatest impact on nutrition will come from the genetic upgrading of commonly consumed cereal.

The scientists of the Indian Agricultural Research Institute have succeeded in incorporating the Opaque-2 gene in some of the crop strains of maize adapted to Indian conditions. In yield trials conducted in our country, the Opaque-2 designated as 'Shakti', has given yield which approached Ganga-5 the best developed double cross hybrid available at present (Jain, 1971)<sup>13</sup>.

Thus "Green Revolution" has brought out also other new varieties of high yielding maize with greater resistance to drought and higher protein content (Davidson and Passmore 1971 and Kymal and Natarajan, 1972)<sup>14,15</sup>. How far these

promising new strains developed in India is nutritionally valuable in human dietaries needs to be studied.

This supplementary feeding programme was an effort in that direction. It was conducted on selected preschool children ranging from one to three years of age in the village, Poochiyur to evaluate the effect of an Opaque-2 maize mixture in terms of the growth of the children. The findings of this study will be of interest to administrators and nutritionists in their plans for supplementary feeding programme for preschool children in the coming years.

## II. REVIEW OF LITERATURE

The review of literature pertaining to this study is discussed under the following headings:

- A. Importance of good nutrition for preschool children
- B. Assessing the nutritional status of the preschool children
- C. Prevalence of Protein Calorie Malnutrition among preschool children in India
- D. Opaque-2 maize
- and E. Feeding trials with Opaque-2 maize in overcoming malnutrition.

### A. Importance of good nutrition for preschool children:

Children are the wealth of a nation. There are more than 200 million children in our country. Utmost care must be exercised to promote their health (Basu, 1971 and Raju and Sundaravalli, 1971)<sup>16,17</sup>. Devadas and Eswaran (1967)<sup>18</sup> and Devadas et al (1969)<sup>19</sup> opine that good nutrition is one of the major factors responsible for the maintenance of health and physical fitness of man. According to Sai (1966)<sup>20</sup>, Berg (1968)<sup>21</sup>, Peerud (1971)<sup>22</sup> and Swaminathan (1973)<sup>12</sup>, there is a close relationship between growth, nutrition and national development.

A child's entire future life is determined, to a great extent, by the food provided during his early years. Serious dietary deficiencies in this period, will damage his health in numerous ways - inhibit growth, sap physical strength and possibly rob him of the chance to attain full mental development (Sen, 1963; Simpson, 1963; Satyanarayana, 1971 and Jim, 1972)<sup>23,24,25,26</sup>.

Food practices, attitudes and intake of the early years affect food choices and consequently the nutritional status throughout life (Kerry et al, 1968)<sup>27</sup>.

The dimensions of malnutrition in our country are appalling. Malnutrition is rapidly becoming a crisis with most of the victims as than children. More than 100 million children in India are on the verge of nutritional disorder. Children who survive malnutrition bear subtle scars - mental and physical. When they become adults, they are frequently unable to attain normal working capacity even with adequate diet. So chronic malnutrition mocks the basic aim of national development and hinders its effective realisation (Anne and Dean, 1962; Ferg, 1970; Devadas, 1971 and Rose, 1971)<sup>28,29,30,31</sup>.

Persistence of high infant and child mortality - 40 per cent in India as against six to eight per cent of other

developing countries - due to malnutrition, is a serious obstruction<sup>to</sup> the family planning endeavour (Sinha, 1968; Prabha, 1971 and Jim, 1972)<sup>32,33,26</sup>. Malnutrition also causes stunted growth, increased susceptibility to infection and in some cases, permanently impaired learning and behaviour. It is thus a grave threat to the quality of the world's social fabric (Jelliffe, 1962; King 1963; Autret, 1964; Berg, 1968; Serimshaw, 1972 and Donald, 1972)<sup>34,35,36,37,38,39</sup>.

Thus, the food children receive determines their whole future. How strong, smart, successful and happy they will be is influenced by nutrition. There is great danger that all the laboriously wrought and firmly cherished development plans for India will be swept away in a tidal flood of human malnutrition (Krishnaswamy, 1967 and Cifrine, 1971)<sup>40,41</sup>.

#### B. Assessing the nutritional status of preschool children:

In many developed countries, lack of reliable data on the various aspects of child health and development have contributed to the misdirection of emphasis in some of the beneficiary programmes to overcome malnutrition. The need for baseline studies on the nutritional status of young

children is crucial (Antrobus, 1971)<sup>42</sup>. Nutritional surveys are intended to define nutritional problems in an area and to set baselines against which nutrition programmes can be carried out and their impact be measured (WHO, 1969)<sup>8</sup>. The baseline studies should include:

- a) Dietary surveys
- b) Anthropometry
- and c) Clinical examination.

a. Dietary surveys:

Diet surveys can be qualitative and quantitative in nature. The former is quickly carried out on large sample whereas the latter requires a great deal of time and work to assess the food intake of a limited number of persons. It is advisable that a qualitative survey is first made, so as to obtain knowledge of the food stuffs and the relative proportions in which they are commonly consumed by the community surveyed. This can be done by a systematic questionnaire. Thereafter, the quantitative survey can be made on selected sample (Nichols, 1965)<sup>43</sup>.

According to Aykroyd (1962)<sup>44</sup>, Food and Agricultural Organisation, FAO (1964)<sup>45</sup> and Perry (1968)<sup>46</sup>, studies of

dietary intake constitute an essential part of any complete nutrition survey, providing information on nutrient intake levels, sources of nutrients, food habits, food preparation practices and attitudes. Such information is needed for modifying the existing economic, agricultural and food management policy programmes.

The three day food weighing procedure consists of determining the amount of each food item consumed by a family, group or individual for three days. Each edible food used in the preparation of each meal is weighed (ICNND, 1963)<sup>47</sup>. A statistical study was carried out to compare the efficiencies of a random day, three day and seven day weighing in 566 families by Tasker *et al* (1967)<sup>48</sup>. The results indicated that a three day weighing would be as efficient as that of the seven day weighing, if the dietary variation in the day to day life is not large as in the case of low socio-economic groups in India. Sundararaj *et al* (1971)<sup>49</sup>, opine that when individual intake of a rural group are to be studied the food weighing is the best method of choice. According to ICNND (1963)<sup>47</sup>, and Thimayamma and Hanumantharao (1971)<sup>50</sup>, the diet survey questionnaire also has yielded information of essentially the same character as that obtained in the detailed direct measurement of food intake.

**b. Anthropometry:**

Anthropometry is concerned with the measurement of the variation of the physical dimension and the gross composition of the human body (Jelliffe, 1968)<sup>51</sup>. Cepalan and Somenvara Rao (1961)<sup>52</sup>, Sen (1963)<sup>23</sup> and Cripeen et al (1968)<sup>53</sup>, say that physical measurements were related to the nutrient intake. Anthropometry can assess physical measurements such as:

1. Body mass as judged by weight
2. Linear dimension as judged by height
- and 3. Certain circumferences like those of head, chest and arm circumference.

The circumference of the head is recognised as an important index of intra-uterine growth and development (Prasad et al, 1971)<sup>54</sup>. The weight chart is a tool with which existing knowledge of nutrition can be translated in terms of applicable at village level (Morlay, 1971)<sup>55</sup>.

The relative merits of various anthropometric measurements were assessed through comparison of their median values and correlation coefficient between the severity of Protein Calorie Malnutrition on one <sup>hand</sup> and weight on the other. (Rao and Singh, 1970)<sup>56</sup>.

**e. Clinical examination:**

Plough (1962)<sup>57</sup>, regards clinical examination as the simplest and basic part of the evaluation of human nutrition. It is based on the examination of changes believed to be related to inadequate nutrition, that can be seen or felt in superficial epithelial tissues, skin and musculature. Jelliffe (1968)<sup>51</sup> opines that the cheapness and relatively easy organization of nutritional assessment by means of clinical examination have sometimes led to the assumption that the method is simple, quickly mastered by the beginner and yields results that are easy to interpret.

**G. Prevalence of Protein Calorie Malnutrition among preschool children in India:**

If one examines the data available in India, there is no evidence to support the thesis that diets as eaten by the people lack minimum quantity of protein. On the contrary, the dietary lack lies in energy foods to avoid the body, catabolising the protein (Subramanian *et al.*, 1961; Narayanaswamy *et al.*, 1971; Palasubramanian, 1971; Sukhatme, 1972 and Prabha, 1972)<sup>58,59,60,61,62</sup>. Thus the major bottleneck in the diets of preschool children as far as India is concerned is caloric deficiency. Although the protein intake is seemingly satisfactory, since diets are deficient in calories,

a considerable proportion of the dietary protein may be expected to be diverted towards providing energy and may not be available for meeting the protein needs. As a result there is widespread Protein Calorie Malnutrition (Parpia, 1964)<sup>63</sup>.

The National Institute of Nutrition recently participated in a country-wide survey of the dietary pattern of 15,000 preschool children belonging to the poor socio-economic group in six different centres which practically represents all the regions of the country. Analysis of the data showed that while 92 per cent of the children surveyed had a calorie intake that was below their requirement level, only 35 per cent were on inadequate level of protein intake. Another study which included the analysis of the diets of preschool children in rural areas of South India showed that nearly 50 per cent of <sup>the</sup> children had diets deficient in calories. By comparison, the percentage of children with diets deficient in protein was only 13. What is of interest is that, there are no children with diets adequate in calories but deficient in protein. In short, the calorie intake of the children was deficient to an extent of about 30 per cent (Gopalan and Sainur, 1971)<sup>64,65</sup>.

#### D. Opaque - 2 maize:

Indian diet is one based on cereals. Cereal grain proteins are complex and heterogenous mixtures of a large number of completely different types of molecules. The identification of individual protein fractions responsible for the poor Biological Value of proteins is of immense practical value in research aimed at genetic improvement of the nutritive quality of the proteins. This has been amply demonstrated in the case of maize, where the ethanol soluble zein fraction was known to be extremely deficient in lysine and tryptophan. A search for low zein mutants led Hertz, Bates and Nelson at Purdue University in November, 1966, to the discovery of high lysine mutant gene designated as Opaque-2 maize. This gene changed the protein composition and increased the contents lysine and tryptophan contents in maize endosperm. The incorporation of Opaque - 2 gene involves crossing the source material of this gene with promising adapted local breeding material (Hansen, 1961; Venkatarao et al., 1964; Swaminathan et al., 1970; Anani and Gupta, 1970; Austin, 1972 and Singh et al., 1973)<sup>66,67,68,69,70,71</sup>.

Opaque - 2 maize varieties differs from other hybrid varieties, in several aspects. This hybrid maize was from

self pollinated back cross progeny, the mutant gene being recessive. The ratio of germ to endosperm is not increased but only the amino acid content of the endosperm is altered. The endosperm is floury instead of horny. It makes softer 'textillas' with a slightly sweeter taste. Zein, the nutritionally inferior protein is reduced to half the usual concentration and glutelin is doubled. Both lysine and tryptophan are approximately 50 per cent higher and leucine is lower than in other hybrids, thus improving the balance between leucine and isoleucine (Stewart and Prock 1962 and Clark, 1968)<sup>72,73</sup>. Normal corn contains 2.8 g. lysine per 100 g. of protein while Opaque - 2 contains 4.7 g. Other differences in amino acid composition are less striking. This increased lysine content can be attributed to:

- a. Increased lysine in the acid <sup>soluble</sup> amino acid fraction
- b. Increased lysine in the zein
- and c. a reduction in the ratio of zein to glutelin (Frederick, 1965)<sup>74</sup>.

According to Swaminathan et al (1970)<sup>68</sup>, the biochemical basis for the improvement in the amino acid was decreased synthesis of zein with a coincident increase in the non zein protein synthesis. Hertz et al (1964)<sup>75</sup>, Prasad (1966)<sup>76</sup> and Ahuja et al (1970)<sup>77</sup> opine that the

main effect of the Opaque - 2 gene is to reduce the quantum of the prolamia fraction in grain and to concomitantly increase the proportion of other protein fraction, namely albumin, globulin and glutelin. The analytical results of Opaque - 2 maize obtained at California University are given below:

| <u>Protein fraction</u> | <u>Ordinary Maize</u><br><u>Per cent</u> | <u>Opaque-2 maize</u><br><u>Per cent</u> |
|-------------------------|--|--|
| Albumin                 | 3.2                                      | 13.2                                     |
| Globulin                | 1.5                                      | 3.9                                      |
| Prolamin                | 47.2                                     | 28.8                                     |
| Glutelin                | 40.4                                     | 50.0                                     |

Abraham and Franse (1970)<sup>10</sup>, give the amino acid content (grams per 100 grams of protein) as follows:

| <u>Amino Acid</u> | <u>Ordinary</u> | <u>Opaque - 2</u> |
|-------------------|-----------------|-------------------|
| Isoleucine        | 3.0             | 3.6               |
| Leucine           | 16.1            | 8.0               |
| Lysine            | 2.8             | 4.0               |
| Methionine        | 3.0             | 4.5               |
| Phenylalanine     | 5.4             | 3.8               |
| Threonine         | 3.5             | 3.3               |
| Tryptophan        | 0.6             | 1.0               |
| Valine            | 7.2             | 5.6               |

The amino acid composition shows an increase in lysine and tryptophan contents in Opaque - 2 maize as compared to the ordinary maize from which it is derived and also an improvement in leucine/isoleucine ratio (Abraham, 1971)<sup>78</sup>. Karl (1966)<sup>78</sup> concluded that Opaque - 2 maize endosperm is lower in starch than normal varieties with consequent reduction in alcohol yielding capacity, although the fermentation characteristics are satisfactory.

The proteins of the endosperm of normal maize and its homogenous counterpart samples at intervals after pollination, were fractionated by a modified Osborne procedure by Murphy and Dalby (1971)<sup>79</sup>. Selected fractions were subjected to amino acid analysis and starch gel electrophoresis. The results showed that Opaque - 2 maize had a decreased content of I<sub>1</sub> and increased quantities in glutelin and lysine. Swaminathan, (1969)<sup>80</sup> also showed that Opaque - 2 maize endosperm contained twice as much as lysine and tryptophan, 50 per cent more arginine, aspartic acid and glycine and 30 per cent less alanine and leucine than ordinary maize. The cause of these changes is a marked reduction in the level of glutelin.

Careful investigation on the relative production of a<sub>1</sub> toxin content in different hybrid varieties of

maize was carried out by NagaraJan (1971)<sup>81</sup> by screening a large number of varieties in an attempt to identify the strains that may be resistant to *A. flavis*. Each variety was artificially infected under laboratory conditions by inoculating a known toxic strain of *A. flavis*. The experiment proved that Opaque - 2 maize was markedly less susceptible in terms of toxin production while Deccan hybrid and other varieties were more susceptible. Abraham (1971)<sup>16</sup> reported that Opaque - 2 flour when used at 20 to 30 per cent level is quite satisfactory for bread baking purposes from the technical, economic and nutrition view points.

Although good sources of protein of both animal and plant origin are available in India, lack of purchasing power makes animal sources largely unavailable to the economically handicapped sections of the population. Consequently, there is widespread protein Calorie Malnutrition (Pandya, 1971)<sup>11</sup>. To these group maize can be a major source of calories and protein (Clark, 1968)<sup>73</sup>.

Maize contributes about 20 million tonnes of protein annually to the human diet. An improvement of 25 per cent in the protein value of maize would add the equivalent of five million tonnes of protein to the world's total supply

of this vital nutrient. This would make a substantial contribution towards reducing the current estimated global protein deficit of 5 - 10 million tonnes. It is obvious therefore, why the discovery of Opaque - 2 maize has received world-wide attention (Wicks, 1972)<sup>82</sup>.

Over five million tonnes of maize are produced annually in India. Over 90 per cent of this production is used directly as human food. It is here, that the Opaque - 2 maize may play an important role as a rich and cheap source of calories and protein (Pandya, 1971)<sup>81</sup>. A major increase from 30 to 35 per cent in the protein level is obtainable even without an increase in yields, merely, through the improvement in protein quality of Opaque - 2 maize (Narayanan et al., 1965 and Laine, 1969)<sup>83,84</sup>

E. Feeding trials with Opaque - 2 maize in overcoming malnutrition:

The availability of Opaque - 2 strain, provided scientists with an opportunity of testing the role of leucine in the pathogenesis of nicotinic acid deficiency among maize eaters. Relavady (1970)<sup>85</sup> fed pups, diets based on Opaque - 2 maize which is low in leucine. They did not develop the disease, while black tongue could be induced easily with Decca hybrid which has a high leucine

concentration. Between these two varieties of maize, the amount of isoleucine and valine are not different.

Nelson de Souza and Dutra de Oliveira (1972)<sup>86</sup> evaluated the protein quality of Opaque - 2 maize in young and adult rats employing nitrogen balance technique. They showed that in both young and adult rats Opaque - 2 corn had a slightly lower absorption of nitrogen but its nitrogen retention was more and therefore the weight gain was higher.

Opaque - 2 maize as a valuable source of food for the preschool children was demonstrated also by Bressani at the Institute of Nutrition of Panama. Weight gain and nitrogen retention were as satisfactory as for skim milk, when both supplied 1.8 g. protein and 100 calories per kg. body weight per day, but the nitrogen retention resulting from skim milk was slightly higher when the protein was reduced to 1.5 g. per kg. body weight. Bressani concluded that the protein value of Opaque - 2 maize was nearly 90 per cent of that of milk and far superior to the ordinary maize (Clark, 1968)<sup>73</sup>.

At California University, six very undernourished children of 3 to 7 years without chronic ailments were fed with a diet with the protein coming only from the endospermic flour of Opaque - 2 maize. Their weight recovery was excellent - about 1.5 kg. per child in four months.

The nitrogen retention recorded throughout this period was in complete agreement with the weight gained, so that there was a real recovery of growth with the formation of healthy tissue, as confirmed by fat, calcium and phosphorus counts. In addition, the evaluation of plasmatc protein and the ratios between essential and non-essential free amino acids in the blood showed a recovery to nutritional normalcy. Under the same conditions, the apparent Biological Value was equal to 41, without taking account of endogenous nitrogen, whereas it was only 17 with ordinary maize. The efficiency of Opaque - 2 maize for rehabilitating undernourished children was thus proved (Abraham, 1971)<sup>10</sup>.

Harpstead et al. (1968)<sup>87</sup> have reported the recovery (gain in weight and restoration of bone growth) of children from advanced stages of malnutrition, when Opaque - 2 maize was fed as traditional Colombian dishes. Nitrogen balance studies with two subjects showed that a positive balance was achieved when 50 per cent of the total nitrogen intake (2.8 g/kg body weight per day) was provided by Opaque - 2 maize and the rest of the nitrogen as glycine and ammonium citrate.

Clarke et al. (1968), conducted a nitrogen balance study with six young adults (four males and two females)

in which it was shown that Opaque - 2 maize at a total intake of 300 grams per day proved adequate for nitrogen equilibrium for all subjects weighing less than 70 kg. The remaining subjects required 350 grams per day. (Quoted by Cucke, 1972)<sup>82</sup>.

Whole kernel Opaque - 2 maize was compared with the degenerated product and whole egg in a nitrogen balance study by Young et al (1971)<sup>88</sup>, on eight young adult male subjects. No supplementary nitrogen was added. They found that the Biological Value of Opaque - 2 maize protein was as good as that reported for cow's milk for adult men.

Another study by Bressani (1966)<sup>89</sup> has shown that the niacin level of Opaque - 2 maize is substantially higher than that of normal maize and that this niacin is physiologically available. Supplementation of the Opaque - 2 maize diet with 4 mg. of niacin per 100 g. of the diet did not improve the performance of the rats when compared with the experimental group who received only Opaque - 2 maize. This finding is of great interest in view of the incidence of pellagra. It would appear that niacin supplement may not be necessary with Opaque - 2 maize.

There is only one study reported in India on the use of Opaque - 2 maize in human feeding trials.

Swaminathan (1971)<sup>90</sup>, reports of a trial in a Jhuggi colony in the Nangloi village of Delhi State. Eighty children, 6 - 36 months age were given Opaque - 2 maize. Another group of 80 children belonging to a comparable socio-economic stratum were fed with skim milk. The results indicate that the children fed with Opaque - 2 maize have gained more weight than children who get their protein through skim milk. What is more interesting is that, the children fed on Opaque - 2 maize were less irritable according to their mothers than the other group. In this experiment it is not clear whether or not both groups received supplements which were identical in all aspects except the sources of protein.

### **III. EXPERIMENTAL PROCEDURE**

The procedure for evaluating Opaque - 2 maize mixture on preschool children consisted of the following steps:

- A. Selection of the village**
- B. Selection of the subjects**
- C. Evolving the supplement**
- D. Preparing <sup>the</sup> supplement**
- and E. Conducting the study.**

#### **A. Selection of the village:**

Peechiyur, a village situated at a distance of 15.2 km from Coimbatore city was chosen for conducting the study for the following reasons:

- 1. A survey conducted in the year 1971-72 had shown the prevalence of Protein Calorie Malnutrition among preschool children**
- 2. The interest and co-operation shown by the village leaders and people were great**
- and 3. Easy accessibility from the college with public transport facilities.**

**B. Selection of the subjects:**

Forty preschool children of age one to three years from families with income ranging from Rs. 100/- to 200/- per month were selected for the study. Fresh samples of stools of the children were collected and tested for hook worm and round worm infestations as these two common helminthic infestation among children precipitate malnutrition. After screening the children for infestations and making sure that none were infected, 20 preschool children (10 boys and 10 girls) were taken as the experimental group by random sampling and the remaining 20 (10 boys and 10 girls) served as the control. Care was taken to see that both the experimental group and the control group were of the same nutritional status before starting the feeding programme.

**C. Evolving the supplement:**

A dietary survey was conducted by the oral questionnaire method using the schedule given in Appendix I, to get the general background of the food habits of children. The information gathered through the general dietary survey helped to conduct an intensive food consumption study through a three day weightment survey. Following the oral questionnaire,

a three day weighment was conducted on all the 40 children to determine the existing nutritional gaps in their intakes.

Opaque - 2 strain of maize which has good quality protein with high lysine and tryptophan contents was selected to be the supplement for the preschool children. Snacks consumed by children in between meals offer a useful medium to provide the nutrients (Rao et al, 1969)<sup>91</sup>. Accordingly, Opaque - 2 maize mixture (Laddu) was selected to be a supplement, for it was not only a snack but also a sweet preparation which the children liked. Preliminary feeding trials were conducted on 20 preschool children *who were not included in this study* (of the same age and socio-economic status) with mixtures containing varying proportions of Opaque - 2 maize flour, jaggery and gingelly oil. Based on the acceptability of the Opaque - 2 maize mixture by the majority (15) of these children the supplement (laddu) was prepared.

#### D. Preparing the Supplement

##### Ingredients for 43 laddus

|                             |       |
|-----------------------------|-------|
|                             | g.    |
| Jaggery .                   | 850   |
| Opaque - 2<br>maize flour - | 750   |
| Oil(gingelly)-              | 120   |
|                             | ----- |
|                             | 1720  |
|                             | ----- |

### Method:

The Opaque - 2 maize flour was roasted in the heated oil uniformly. The completion of the roasting was judged by the flavour and the colour. A syrup was made with jaggery up to the thread stage; and the roasted flour was added to the syrup stirring constantly to prevent formation of lumps. After adding all the flour, the syrup - maize mixture was made into laddus, each weighing 40 g.

Three aliquot samples of a laddu were analysed for calories, protein, calcium, iron, phosphorus and carotene using the procedures of Davidson and Passmore (1971)<sup>14</sup> and Oser (1965)<sup>92</sup>. Each laddu (40 g.) furnished 170 calories and 2 g. of protein. From these findings, it was concluded that a supply of two laddus (80 g) will bridge the Caloric gap of the preschool children.

The cost per serving per child per day (80g. of Opaque - 2 maize mixture) is 14 paise. This is the less than the cost (18 paise) which <sup>The</sup> Government has earmarked for a supplement (Rao, 1972)<sup>93</sup>.

### B. Conducting the study:

Two laddu's were given to each child in the experimental group, everyday for a period of six months. A

section of the experimental group taking the supplement is shown in figure I. A record of attendance was maintained throughout the study. In the middle of the study, the three day food weighment was done for the experimental group alone to find out whether or not the supplement had any effect on the home food consumption. The height, head, chest and arm circumference were measured at the beginning and every month to the nearest 0.1 cms. The weight of the children was taken at the beginning and fortnightly to the nearest 0.5 kg. The clinical examination was done before and after the study for all the 40 preschool children using the performas given in Appendix XI.



FIGURE - I

A SECTION OF THE SUPPLEMENTARY FEEDING PROGRAMME IN ACTION

#### IV. RESULTS AND DISCUSSION

The results of the study are discussed under the following headings:

- A. General background of the selected preschool children
- B. <sup>Calorie and</sup> nutrient intake of the selected preschool children
- C. <sup>calorie and</sup> The nutrients supplied by the Opaque - 2 maize mixture
- and D. Changes in the nutritional status of the preschool children.

##### A. General background of the selected preschool children:

Through a survey, the socio-economic status as well as the food habits of the families of the selected 40 preschool children were elucidated. They belonged to 33 families. Among the 33 families, 29 were nuclear and the remaining four were joint. The total number of members in the 33 families was 181 out of whom, 98 were males and 83 were females.

The occupational status of the members of the 33 families is given in Table I.

**TABLE I**  
**OCCUPATIONAL STATUS OF THE MEMBERS OF THE**  
**SELECTED FAMILIES**

| Sl. No. | Occupation  | Number of members |        |        |         |        |        |
|---------|-------------|-------------------|--------|--------|---------|--------|--------|
|         |             | Experimental      |        |        | Control |        |        |
|         |             |                   |        | Child- |         |        | Child- |
|         |             | Father            | Mother | ren    | Father  | Mother | ren    |
| 1.      | Agriculture | 11                | -      | -      | 13      | -      | 4      |
| 2.      | Workshop    | 2                 | -      | 1      | -       | -      | -      |
| 3.      | Mill worker | 3                 | -      | 1      | 1       | -      | -      |
| 4.      | Cooli       | -                 | 6      | -      | -       | 7      | -      |
| 5.      | Clerk       | 1                 | -      | 1      | -       | -      | 2      |
| 6.      | Business    | 1                 | -      | -      | -       | -      | -      |

The main occupation of the families surveyed was agriculture. This is in accordance with Dahana's (1968)<sup>94</sup> report, that in the Indian rural society, the main occupation is agriculture.

All the subjects belonged to the low income group with an income range of Rs. 100 - 200 per month. According to Pereira (1971)<sup>95</sup>, a family is considered to be poor when the total annual income is Rs. 2,400 or less.

The amount spent on food by the majority of the families (20) ranged from Rs. 91 - Rs. 110 (income range Rs. 150/- - 200/-). The remaining families food expenditure ranged from Rs. 60 - 90 (income range Rs. 100 - 150). This is in accordance with Ernest Engels law of food expenditure formulated in 1857 which states that the smaller the income the larger is the proportion of the income on food.

The frequency of consumption of selected feeds by these 33 families is given in Table II.

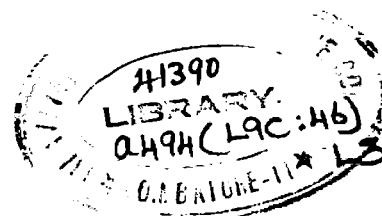


TABLE II

DETAILS OF FREQUENCY OF USE OF SELECTED FOODS  
(Total number of families - 33)

| Sl. No.                          | Foodstuff        | Frequency of use |              |             |         |
|----------------------------------|------------------|------------------|--------------|-------------|---------|
|                                  |                  | Daily            | Twice a week | Once a week | Monthly |
| <b>1. Cereals</b>                |                  |                  |              |             |         |
|                                  | Rice             | 31               | 2            | -           | -       |
|                                  | Cholam           | 32               | 1            | -           | -       |
|                                  | Wheat            | 4                | 8            | 7           | -       |
|                                  | Ragi             | 2                | 13           | 6           | -       |
| <b>2. Pulses</b>                 |                  |                  |              |             |         |
|                                  | Pongal gram dhal | -                | 6            | 8           | 8       |
|                                  | Red gram dhal    | 29               | 3            | 1           | -       |
|                                  | Horso gram dhal  | 2                | 11           | 11          | 4       |
| <b>3. Leafy Vegetables</b>       |                  |                  |              |             |         |
|                                  | Agathi           | 11               | 5            | 14          | -       |
|                                  | Amaranth         | 13               | 5            | 13          | -       |
|                                  | Murungai         | 2                | 5            | 11          | -       |
|                                  | Cabbage          | -                | 4            | 7           | -       |
| <b>4. Roots</b>                  |                  |                  |              |             |         |
|                                  | Potato           | -                | 6            | 7           | 7       |
|                                  | Yam              | 4                | 2            | -           | 3       |
| <b>5. Other vegetables</b>       |                  |                  |              |             |         |
|                                  | Brinjal          | 7                | 9            | 9           | 1       |
|                                  | Beans            | 8                | 5            | 4           | -       |
|                                  | Drumstick        | 5                | 6            | 7           | 2       |
| <b>6. Fruits</b>                 |                  |                  |              |             |         |
|                                  | Tomato           | 1                | 1            | 6           | 7       |
|                                  | Plantain         | -                | 1            | 1           | 5       |
|                                  | Guava            | 1                | -            | -           | 2       |
| <b>7. Fleishy foods</b>          |                  |                  |              |             |         |
|                                  |                  | -                | -            | 4           | 9       |
| <b>8. Eggs</b>                   |                  |                  |              |             |         |
|                                  |                  | -                | -            | 1           | 9       |
| <b>9. Milk and milk products</b> |                  |                  |              |             |         |
|                                  |                  | -                | -            | 10          | 8       |

Cereals were consumed by all the families daily and pulses by 31 families daily. Protective foods like fleshy foods and eggs were not included by 11 families. Milk and milk products were not taken by 13 families. This is in accordance with the information given by Rao (1967)<sup>96</sup> and Desai et al (1970)<sup>97</sup>, that, on the basis of the trends on food consumption, the diets consumed by a large majority of people in India are based mainly on cereals and are lacking in protective and protein rich foods such as eggs, meat and fish.

All the families surveyed had a three meal per day pattern. Chola kalli, ragi kalli, wheat uppama, rice, red gram dhal masial, iddli and coffee were the common items for breakfast. For lunch and dinner also the same items used for breakfast except iddli and coffee were used. The only extra item included for lunch and dinner was buttermilk or curd.

The likes and dislikes of the preschool children are presented in Table III.

TABLE XII

LIKES AND DISLIKES OF THE PRESCHOOL CHILDREN

(Number of Children: 40)

| S.No. | Likes    | Number of children stating it | Dislikes   | Number of children stating it |
|-------|----------|-------------------------------|------------|-------------------------------|
| 1.    | Sweets   | 31                            | Greens     | 17                            |
| 2.    | Biscuits | 15                            | Vegetables | 5                             |
| 3.    | Fruits   | 5                             | Meat       | 1                             |
| 4.    | Murukku  | 2                             | Groundnut  | 1                             |
| 5.    | Milk     | 2                             | Pulses     | 1                             |
| 6.    | -        | -                             | Fruits     | 1                             |

Sweets and biscuits were preferred by the majority (31 and 15 respectively) of the preschool children. Fourteen children liked both sweets and biscuits. Since the preschool children liked sweets, a sweet preparation, namely the laddu was chosen as a supplement in this study.

Green leafy vegetables were disliked by majority (17) of the preschool children and it was found that seven preschool children had no food dislikes.

Chulla was used as a cooking device by all families. Thirty two families used wood and one used charcoal. Out of this 32 families who used wood, nine pointed out that it is safe to use and 11 others opined that they were accustomed to using it and the remaining twelve felt that wood is cheap.

Boiling and steaming were the methods of cooking commonly used for cereals and pulses. In addition, frying was used by 19 families for cereals. While preparing the Opaque - 2 maize mixture (laddu), the maize flour was fried to improve the flavour.

A majority of the preschool children, (36), were weaned at one year. Only four were weaned at 18 months. For this study, children ranging from one to three years were selected to ensure that children had been completely weaned. After weaning, biscuits, rusk, sweets and cow's milk were given as special foods.

All the 33 families surveyed were in favour of supplementation of their children's food without any change in their meal pattern. They opined that supplementary preschool feeding programmes will certainly improve the health of the children.

Calorie and  
 B. nutrient intake of the selected preschool children:

Calorie and  
 The nutrient intake of the preschool children as determined through a three day food weighing survey, before starting the supplementary feeding programme is presented in Table IV.

TABLE IV  
 CALORIE AND  
 MEAN INTAKE OF NUTRIENTS AGAINST THE RECOMMENDED  
 ALLOWANCES

| Nutrients       | Recommended<br>Daily<br>Allowances<br>(I.C.N.R.) | Mean intake *         |                  |
|-----------------|--|-----------------------|------------------|
|                 |  | Experimental<br>Group | Control<br>Group |
| Calories        | 1200   | 889                   | 886              |
| Protein (g)     | 17 - 20  | 27                    | 25               |
| Calcium (mg)    | 400 - 500  | 309                   | 341              |
| Iron (mg)       | 15 - 20  | 17                    | 15               |
| Retinol (mcg)   | 250  | 236                   | 232              |
| Thiamine (mg)   | 0.60   | 0.77                  | 0.73             |
| Riboflavin (mg) | 0.70   | 0.42                  | 0.40             |
| Vitamin C (mg)  | 30 - 50  | 34                    | 38               |

\* The nutrient intake was calculated using the figures published by Gopalan *et al* (1971)<sup>97a</sup>.

There is a striking calorie gap in the preschool children in nutrient intake of this study. This proves the findings of Swaminathan (1968) and Cepalan and Vijayaraghavan (1971)<sup>98,99</sup>, who reported that the primary inadequacy in the dietaries of preschool children is not protein but calories. Hegsted<sup>d</sup> (1970)<sup>100</sup>, reported that mean intake of calories of the preschool children ranged from 600 to 950 in the various regions of India and the mean protein intake ranged from 19 to 28 grams daily. Another report by Pereira (1971)<sup>95</sup> also indicates that the diets of the preschool children of South India are poor in calories, Vitamin A and riboflavin. Appendix II and III give the <sup>calorie and</sup> nutrient intake of each child belonging to experimental group and control group along with their total and mean <sup>calorie and</sup> nutrient intake.

The calorie and nutrient intake of the 20 children in the supplemented group, in the middle of the study as compared with their initial intakes is shown in Table V, with details in Appendix IV.

**TABLE V**  
**CALORIE AND**  
**MEAN NUTRIENT INTAKE OF THE EXPERIMENTAL GROUP BEFORE**  
**AND DURING THE STUDY**

| Nutrient        | Mean nutrient intake in the home |                  |
|-----------------|----------------------------------|------------------|
|                 | Before the study                 | During the study |
| Calories        | 889                              | 887              |
| Protein (g)     | 27                               | 25               |
| Calcium (mg)    | 309                              | 318              |
| Iron (mg)       | 17                               | 18               |
| Retinol (mcg)   | 236                              | 231              |
| Thiamine (mg)   | 0.77                             | 0.84             |
| Riboflavin (mg) | 0.42                             | 0.38             |
| Vitamin C (mg)  | 34                               | 26               |

The caloric intake has remained the same, showing that the supplement given, did not affect the home food consumption, thus proving, that the supplement has been truly a supplement and not a substitute. It is of interest to refer to the recent field studies reported by Sukhatme (1972)<sup>101</sup>. According to Sukhatme, the normal food intake of the preschool children is least disturbed when the supplement is given in between meals in the form of a snack. Swaminathan *et al* (1970)<sup>102</sup>

also support the fact that except for the additional supplement consumed by the children there was no practical difference between the two groups namely, experimental and control in their study.

C. <sup>Calorie and</sup> The nutrients supplied by the use of Opaque - 2 maize mixture:

Table VI presents the caloric and nutrient composition of 80 grams of the Opaque - 2 maize mixture (two laddus). The details of the calculation are given in Appendix - V.

TABLE VI

CALORIE AND NUTRIENT COMPOSITION OF 80g. OF OPAQUE - 2 MAIZE MIXTURE

| Nutrient        | Amount Present |
|-----------------|----------------|
| Calories        | 340            |
| Protein (g)     | 4              |
| Calcium (mg)    | 42             |
| Iron (mg)       | 5              |
| Phosphorus (mg) | 108            |
| Retinol (mcg)   | 25             |

Figure II, explains the caloric and nutrient gap as found by the three day weighment and the caloric and nutrients supplied by the Opaque - 2 maize mixture.

FIGURE - II

INITIAL MEAN NUTRIENT INTAKE AND NUTRIENTS SUPPLIED BY THE SUPPLEMENT

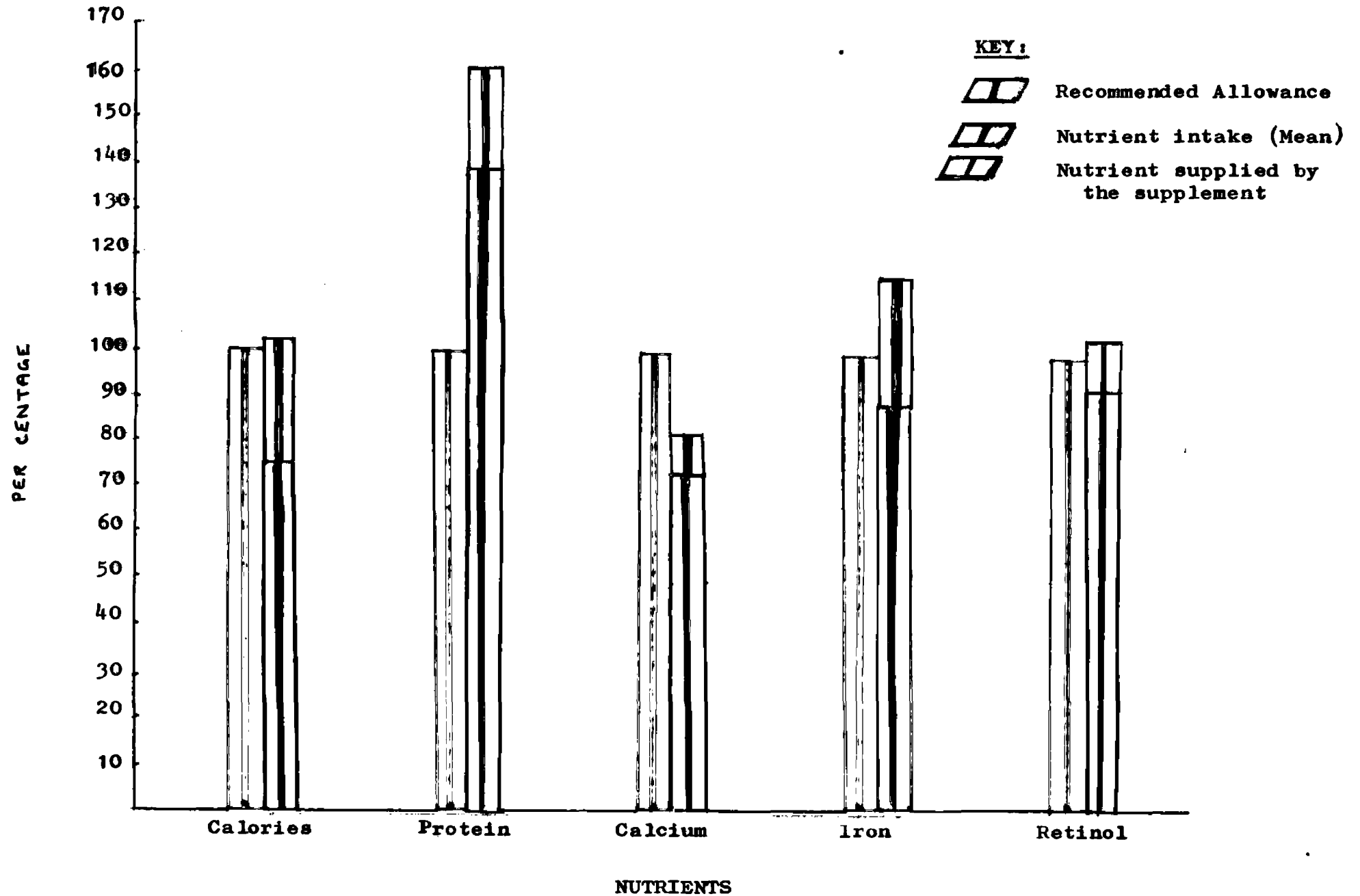


Figure II illustrates the initial mean nutrient intake of preschool children taken for the study (experimental and control) expressed in terms of percentage taking the recommended allowance as 100. How far does 80 g. of Opaque - 2 maize mixture bridges the nutritional gap is clearly seen. Except for calcium and iron, other requirements have been met with the help of the supplement 'laddu'.

**D. Changes in the nutritional status of preschool children:**

Care was taken to see that all the preschool children belonging to the experimental group received the Opaque - 2 maize mixture every day. But due to unavoidable reasons, 3 children could not receive the same for a period of 10 days in this study.

The changes in the nutritional status of the preschool children are discussed using anthropometry and clinical assessment as the media.

**a. Anthropometry:**

The mean increments in anthropometric measurements namely weight, height, head, chest and arm circumference due to the supplement in the case of the experimental group as compared with that of the control group are presented in Table VII. The monthly recorded anthropometric measurements are presented in Appendices VI to X.

TABLE VII  
INCREASE IN ANTHROPOMETRIC MEASUREMENTS

| Measurement                     | Mean initial  | Mean final    | Mean increase | Experimental versus Control |
|---------------------------------|---------------|---------------|---------------|-----------------------------|
| <u>Weight (g)</u>               |               |               |               |                             |
| Experimental                    | 10.02 ± 0.109 | 16.6 ± 0.943  | 6.58          | t = +8.956                  |
| Control                         | 10.00 ± 1.296 | 14.13 ± 1.368 | 4.13          |                             |
| <u>Height (cm)</u>              |               |               |               |                             |
| Experimental                    | 81.88 ± 5.445 | 95.6 ± 2.615  | 13.72         | t = +6.801                  |
| Control                         | 81.0 ± 8.132  | 92.1 ± 7.93   | 10.60         |                             |
| <u>Head Circumference (cm)</u>  |               |               |               |                             |
| Experimental                    | 46.51 ± 1.348 | 50.64 ± 1.113 | 4.13          | t = +7.808                  |
| Control                         | 46.60 ± 1.176 | 50.23 ± 1.059 | 3.63          |                             |
| <u>Chest Circumference (cm)</u> |               |               |               |                             |
| Experimental                    | 43.47 ± 1.588 | 48.62 ± 1.140 | 4.32          | t = +2.226                  |
| Control                         | 46.95 ± 0.990 | 51.27 ± 1.364 | 3.10          |                             |
| <u>Arm Circumference (cm)</u>   |               |               |               |                             |
| Experimental                    | 13.18 ± 0.949 | 16.28 ± 0.933 | 3.10          | t = +3.889                  |
| Control                         | 12.66 ± 1.081 | 14.97 ± 1.034 | 2.31          |                             |

\* Significant at 1 per cent level  
+ Significant at 5 per cent level

There was a significant increase in the anthropometric measurements of the supplemented preschool children. This finding correlates with that of Abraham (1971)<sup>91</sup> who recorded a mean weight gain of 1.5 kg. per child in four months with Opaque - 2 maize. Sukhatme (1972)<sup>101</sup> and Gopalan and Vijayaraghavan (1971)<sup>99</sup> support the fact that the supplementary feeding of preschool children for six months can bring about significant gains in weight.

The mean increase in the weight and height of the anthropometric measurements of experimental and control groups are represented in the figures III and IV.

FIGURE • III  
MEAN INCREASE IN WEIGHT

KEY:

- • Experimental Group
- • Control Group

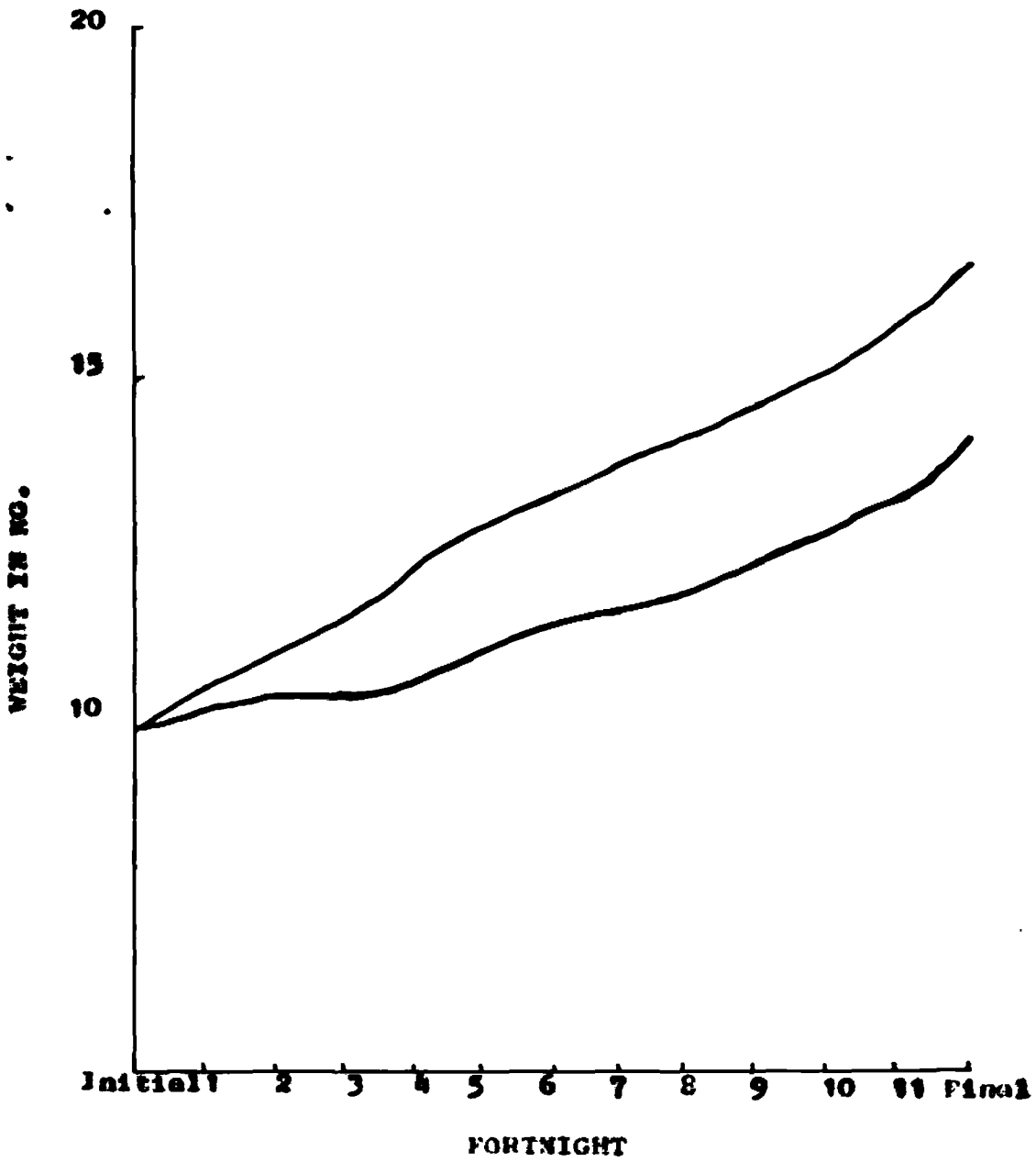
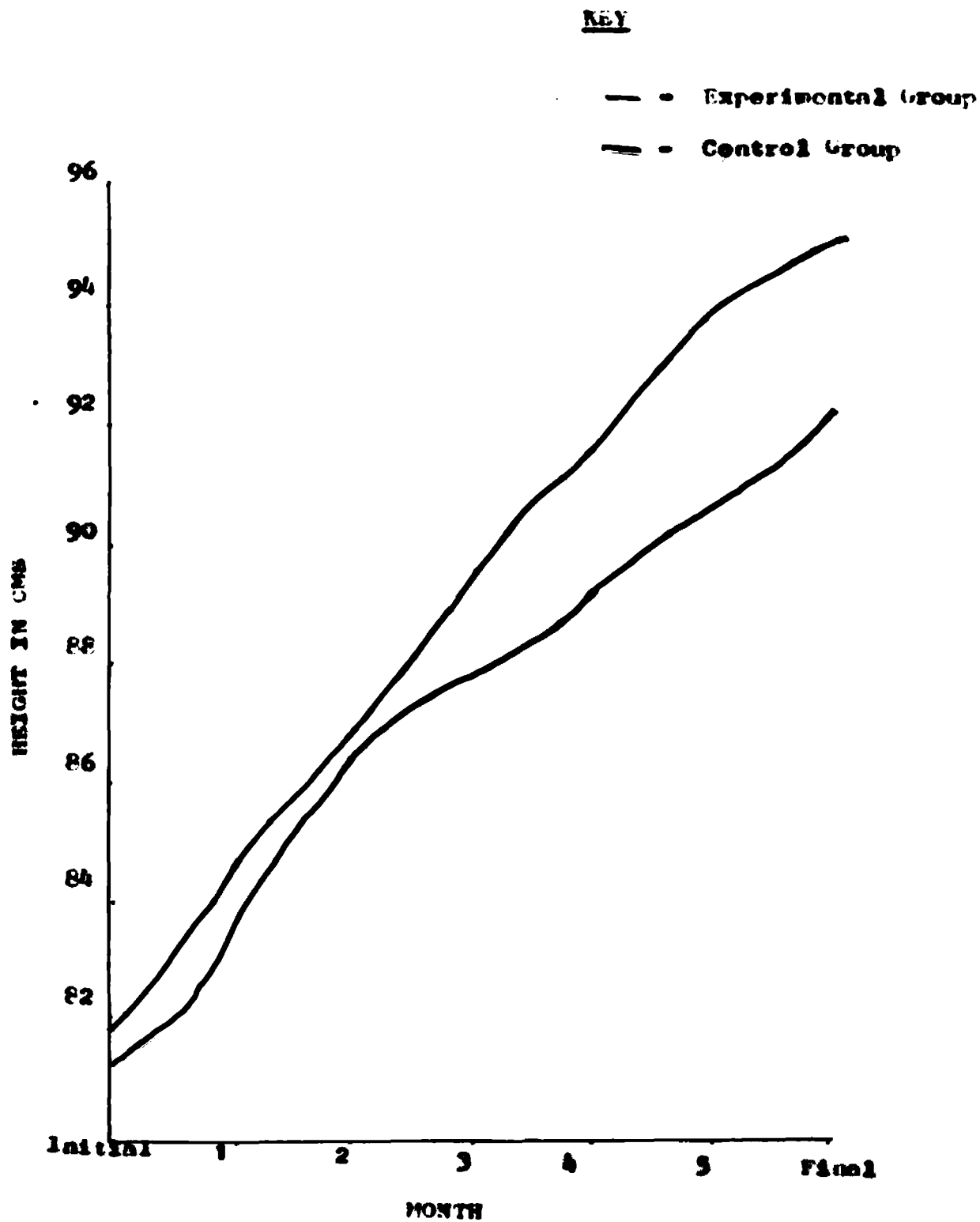


FIGURE - IV  
MEAN INCREASE IN HEIGHT



**b. Clinical assessment:**

Svaminathan (1968)<sup>103</sup>, says that clinical examination is an essential part of nutritional studies, since the ultimate objective is to assess levels of health of individuals as influenced by the diet. The findings of the clinical assessment in the study are given in Table VIII. Performa of clinical assessment is given in Appendix XI.

Table VIII represents the clinical picture of the preschool children before and after the supplementary feeding programmes.

**TABLE VIII**  
**CLINICAL PICTURE OF THE EXPERIMENTAL AND CONTROL**  
**GROUP**

| Sl. No.   | Criteria   | Number of children (Experimental) |                 | Number of children (Control) |                 |
|-----------|--|-----------------------------------|-----------------|------------------------------|-----------------|
|           |  | Before the study                  | After the study | Before the study             | After the study |
| <b>1.</b> | <b><u>General appearance:</u></b>                |                                   |                 |                              |                 |
|           | Good   | 8                                 | 16              | 7                            | 9               |
|           | Fair   | 12                                | 4               | 13                           | 11              |
| <b>2.</b> | <b><u>Eyes:</u></b>                              |                                   |                 |                              |                 |
|           | <b><u>Conjunctiva:</u></b>                       |                                   |                 |                              |                 |
|           | Slightly dry on exposure for half a minute       | 12                                | 4               | 15                           | 2               |
|           | Mittot's spot                                    | 1                                 | -               | 1                            | 4               |
|           | <b><u>Pigmentation:</u></b>                      |                                   |                 |                              |                 |
|           | Slight discolouration                            | 9                                 | -               | 11                           | 4               |
|           | Moderate browning in patches                     | 5                                 | -               | 3                            | 3               |
|           | <b><u>Xerosis of cornea:</u></b>                 |                                   |                 |                              |                 |
|           | Slight dryness                                   | 6                                 | -               | 8                            | 4               |
|           | Mild Vascularisation                             | 6                                 | 2               | 9                            | 4               |
|           | Moderate Vascularisation                         | -                                 | -               | -                            | 3               |
|           | Mild night blindness                             | 6                                 | -               | 8                            | 9               |
| <b>3.</b> | <b><u>Mouth:</u></b>                             |                                   |                 |                              |                 |
|           | Mild angular stomatitis                          | 8                                 | 3               | 11                           | 14              |
|           | Moderate angular stomatitis                      | 4                                 | 1               | 2                            | 2               |
| <b>4.</b> | <b><u>Hair:</u></b> Lack of lustre               | 8                                 | -               | 8                            | 6               |
| <b>5.</b> | <b><u>Oedema:</u></b> Present on dependant parts | 6                                 | -               | 7                            | 3               |
|           | General Oedema                                   | 1                                 | -               | -                            | -               |

The clinical picture points out that after the supplementary feeding programme signs of Protein Calorie Malnutrition namely lack of lustre of hair and edema disappeared in the experimental group unlike that of the control.

On the whole, this study is in accordance with Singh(1973)<sup>104</sup>, who reported that on the basis of available information the role of Opaque - 2 maize in child nutrition is very effective.

## V. SUMMARY AND CONCLUSION

Fifty preschool children of age 1 to 3 years belonging to low income families in the village, Poochiyur, Coimbatore District were selected for the study. After screening the children for worm infestation, 20 preschool children were taken as the experimental group, by random sampling and the remaining 20 served as the control. Information on their dietary patterns were collected through oral questionnaire and weightment surveys. There was a striking caloric gap of 392 calories. A supplement with Opaque - 2 maize was evolved to supply 340 calories per child per day. This supplement was given in the form of laddus for six consecutive months. The findings revealed that:

1. There was a significant increase (at 1 per cent level) in the mean weight, height, head and arm circumference of the experimental group when compared with that of the control. The chest circumference showed significant increase at 5 per cent level.
2. The signs of Protein Calorie Malnutrition such as lack of lustre of hair and oedema, disappeared in the supplemented group.

Further research is needed on:

1. Formulating similar supplementary foods with the recently evolved hybrid varieties at low cost to bridge the nutritional gaps of the needy masses.
2. Using supplementary feeding of preschool children as tools for nutrition education.
- and 3. Evaluating the impact of supplementary feeding programmes on the families.

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**A P P E N D I C E S**



8. Between which figures your monthly income falls?

- a. 1-50
- b. 51-100
- c. 101-150
- d. 151-200
- e. 201-250
- f. 251 - and above

9. Interviewee's opinion about the income?

Under estimate

Apperantly accurate

Accurate

10. Total family expenditure

11. Expenditure on food

12. Details of food frequency:

| S.No. | Foods    | Frequency of use |             |              |         |
|-------|----------|------------------|-------------|--------------|---------|
|       |          | Daily            | Once a week | Twice a week | Monthly |
| 1.    | Cereals: |                  |             |              |         |
|       | Rice     |                  |             |              |         |
|       | Cholan   |                  |             |              |         |
|       | Wheat    |                  |             |              |         |
|       | Ragi     |                  |             |              |         |
|       | Others   |                  |             |              |         |

contd...

| S.No. | Foods                         | Frequency of use |             |              |         |
|-------|-------------------------------|------------------|-------------|--------------|---------|
|       |                               | Daily            | Once a week | Twice a week | Monthly |
| 2.    | <b>Pulses:</b>                |                  |             |              |         |
|       | Red gram dhal                 |                  |             |              |         |
|       | Bengal gram dhal              |                  |             |              |         |
|       | Horse gram dhal               |                  |             |              |         |
|       | Black gram dhal               |                  |             |              |         |
|       | Others                        |                  |             |              |         |
| 3.    | <b>Leafy vegetables:</b>      |                  |             |              |         |
|       | Agathi                        |                  |             |              |         |
|       | Amaranth                      |                  |             |              |         |
|       | Drumstick leaves              |                  |             |              |         |
|       | Cabbage                       |                  |             |              |         |
|       | Others                        |                  |             |              |         |
| 4.    | <b>Roots and tubers:</b>      |                  |             |              |         |
|       | Potato                        |                  |             |              |         |
|       | Yam                           |                  |             |              |         |
|       | Others                        |                  |             |              |         |
| 5.    | <b>Other vegetables:</b>      |                  |             |              |         |
|       | Brinjal                       |                  |             |              |         |
|       | Beans                         |                  |             |              |         |
|       | Drumstick                     |                  |             |              |         |
|       | Others                        |                  |             |              |         |
| 6.    | <b>Fruits</b>                 |                  |             |              |         |
| 7.    | <b>Fleshy foods</b>           |                  |             |              |         |
| 8.    | <b>Eggs</b>                   |                  |             |              |         |
| 9.    | <b>Milk and milk products</b> |                  |             |              |         |

**13. Daily meal patterns:**

| Meal | Breakfast | Lunch | Dinner |
|------|-----------|-------|--------|
|------|-----------|-------|--------|

1st Day

2nd Day

3rd Day

**14. Likes and dislikes of the child:**

| Likes | Dislikes |
|-------|----------|
|-------|----------|

**15. Types of cooking devices:**

| Purpose | Device | Method |
|---------|--------|--------|
|---------|--------|--------|

## 16. Details of cooking:

| Items | Boiling | Steaming | Frying | Stewing | Others |
|-------|---------|----------|--------|---------|--------|
|-------|---------|----------|--------|---------|--------|

Cereals

Pulses

Greens

Other  
vegetables

Egg

Meat

Fish

Others

## 17. Age of the subject at weaning

## 18. Was any special food given to the child during/after weaning?

| During | After |
|--------|-------|
|--------|-------|

19. Attitudes towards change in food habits:

| Habit | Perferred | Not perferred |
|-------|-----------|---------------|
|-------|-----------|---------------|

Meal pattern

Alteration of food

Supplementation of food

20. What is your opinion about the preschool feeding programme?

21. Will you like to have a supplementary feeding programme in your village for the preschool children?

APPENDIX - II

INITIAL WEIGHMENT

Experimental Group

| Subject Number | Calories | Protein (g) | Calcium (mg) | Iron (mg) | Carotene (µg)                     | Thiamine (mg) | Riboflavin (mg) | Vitamin C (mg) |
|----------------|----------|-------------|--------------|-----------|-----------------------------------|---------------|-----------------|----------------|
| 1.             | 748      | 24.7        | 305          | 14.1      | 1075                              | 0.69          | 0.57            | 24             |
| 2.             | 807      | 30.5        | 338          | 20.7      | 1935                              | 0.81          | 0.50            | 35             |
| 3.             | 941      | 26.5        | 288          | 25.1      | 435                               | 0.87          | 0.51            | 34             |
| 4.             | 912      | 26.5        | 314          | 18.9      | 1489                              | 0.77          | 0.48            | 71             |
| 5.             | 873      | 23.0        | 150          | 12.0      | 132                               | 0.69          | 0.32            | 30             |
| 6.             | 853      | 25.0        | 253          | 13.0      | 230                               | 0.73          | 0.42            | 29             |
| 7.             | 859      | 27.2        | 295          | 15.4      | 268                               | 0.82          | 0.38            | 19             |
| 8.             | 1050     | 32.6        | 237          | 18.3      | 226                               | 0.81          | 0.39            | 20             |
| 9.             | 1032     | 33.1        | 296          | 20.6      | 1318                              | 0.84          | 0.44            | 30             |
| 10.            | 859      | 24.4        | 357          | 13.1      | 178                               | 0.80          | 0.34            | 2              |
| 11.            | 1016     | 35.8        | 751          | 16.5      | 2353                              | 1.02          | 0.48            | 94             |
| 12.            | 745      | 20.6        | 222          | 11.5      | 197                               | 0.53          | 0.28            | 12             |
| 13.            | 911      | 31.8        | 370          | 20.3      | 1375                              | 0.89          | 0.45            | 37             |
| 14.            | 955      | 18.9        | 255          | 11.0      | 136                               | 0.55          | 0.32            | 4              |
| 15.            | 923      | 29.8        | 272          | 21.4      | 2029                              | 0.84          | 0.51            | 55             |
| 16.            | 953      | 33.1        | 352          | 23.0      | 1884                              | 0.88          | 0.50            | 43             |
| 17.            | 828      | 28.3        | 298          | 18.3      | 1405                              | 0.79          | 0.44            | 33             |
| 18.            | 737      | 23.4        | 237          | 12.6      | 235                               | 0.53          | 0.30            | 8              |
| 19.            | 955      | 28.5        | 340          | 23.7      | 1843                              | 0.58          | 0.48            | 56             |
| 20.            | 735      | 23.7        | 223          | 10.2      | 159                               | 0.62          | 0.35            | 25             |
| Total          | 17,782   | 547.4       | 6,184        | 340.8     | 18,897                            | 15.36         | 8.42            | 578            |
| Mean           | 889      | 27.4        | 309          | 17.0      | 945                               | 0.77          | 0.42            | 29             |
|                |          |             |              |           | X 00.25<br>= 236 µg<br>of Retinol |               |                 |                |

APPENDIX - III  
INITIAL WEIGHMENT

Control Group

| Subject Number | Calories | Protein (g) | Calcium (mg) | Iron (mg) | Carotene (mcg)                       | Thiamine (mg) | Riboflavin (mg) | Vitamin C (mg) |
|----------------|----------|-------------|--------------|-----------|--------------------------------------|---------------|-----------------|----------------|
| 1.             | 925      | 25.8        | 257          | 9.8       | 138                                  | 0.68          | 0.45            | 1              |
| 2.             | 873      | 31.6        | 271          | 19.8      | 380                                  | 0.84          | 0.43            | 25             |
| 3.             | 911      | 19.5        | 251          | 10.8      | 183                                  | 0.52          | 0.35            | 9              |
| 4.             | 886      | 26.5        | 229          | 13.5      | 392                                  | 0.83          | 0.49            | 23             |
| 5.             | 935      | 29.9        | 375          | 21.8      | 2074                                 | 0.80          | 0.49            | 54             |
| 6.             | 921      | 35.7        | 607          | 25.0      | 1511                                 | 0.93          | 0.40            | 95             |
| 7.             | 853      | 22.2        | 359          | 13.4      | 1558                                 | 0.60          | 0.35            | 50             |
| 8.             | 941      | 26.6        | 382          | 16.0      | 1849                                 | 0.58          | 0.30            | 90             |
| 9.             | 764      | 24.3        | 235          | 15.0      | 1509                                 | 0.59          | 0.33            | 55             |
| 10.            | 977      | 27.8        | 443          | 15.5      | 1318                                 | 0.74          | 0.41            | 39             |
| 11.            | 859      | 20.8        | 292          | 15.5      | 733                                  | 0.70          | 0.35            | 17             |
| 12.            | 849      | 24.4        | 458          | 13.2      | 1391                                 | 0.74          | 0.37            | 57             |
| 13.            | 858      | 21.2        | 355          | 13.9      | 722                                  | 0.83          | 0.41            | 4              |
| 14.            | 793      | 20.9        | 310          | 11.8      | 174                                  | 0.70          | 0.45            | 8              |
| 15.            | 1155     | 34.2        | 530          | 21.4      | 1520                                 | 1.12          | 0.55            | 52             |
| 16.            | 921      | 27.9        | 213          | 17.4      | 184                                  | 0.61          | 0.77            | 9              |
| 17.            | 730      | 17.1        | 296          | 11.3      | 177                                  | 0.58          | 0.29            | 7              |
| 18.            | 875      | 21.4        | 110          | 10.9      | 435                                  | 0.64          | 0.67            | 21             |
| 19.            | 853      | 17.2        | 494          | 22.9      | 1488                                 | 0.85          | 0.51            | 53             |
| 20.            | 813      | 21.5        | 345          | 10.0      | 1214                                 | 0.67          | 0.25            | 67             |
| Total          | 17,715   | 498.5       | 6,829        | 305.2     | 18,560                               | 14.67         | 8.11            | 758            |
| Mean           | 886      | 24.9        | 341          | 15.3      | 928                                  | 0.73          | 0.40            | 38             |
|                |          |             |              |           | X 0.25<br>= 232 mcg<br>of<br>retinol |               |                 |                |

APPENDIX - IV  
EXPERIMENTAL GROUP

Second Weighment:

| Subject Number | Calo-ries    | Protein (g)  | Calcium (mg) | Iron (mg)    | Carotene (mcg) | Thiomine (mg) | Riboflavin (mg) | VitaminC (mg) |
|----------------|--------------|--------------|--------------|--------------|----------------|---------------|-----------------|---------------|
| 1.             | 853          | 25.6         | 329          | 15.3         | 922            | 0.75          | 0.34            | 29            |
| 2.             | 942          | 23.7         | 334          | 15.7         | 1363           | 0.75          | 0.47            | 48            |
| 3.             | 1011         | 30.5         | 343          | 22.6         | 1517           | 0.95          | 0.55            | 33            |
| 4.             | 841          | 24.1         | 339          | 19.1         | 1283           | 0.75          | 0.39            | 24            |
| 5.             | 942          | 27.0         | 239          | 33.4         | 175            | 0.89          | 0.34            | 2             |
| 6.             | 927          | 22.2         | 258          | 31.0         | 196            | 0.55          | 0.35            | 15            |
| 7.             | 957          | 25.7         | 195          | 12.2         | 108            | 0.59          | 0.34            | 10            |
| 8.             | 774          | 23.0         | 481          | 11.8         | 1337           | 0.77          | 0.30            | 75            |
| 9.             | 951          | 20.9         | 210          | 14.5         | 194            | 0.72          | 0.28            | 14            |
| 10.            | 825          | 29.6         | 382          | 23.3         | 1750           | 0.85          | 0.50            | 62            |
| 11.            | 1025         | 27.6         | 373          | 23.9         | 1750           | 0.83          | 0.47            | 42            |
| 12.            | 787          | 24.8         | 279          | 16.5         | 1225           | 0.72          | 0.38            | 29            |
| 13.            | 840          | 20.3         | 395          | 12.0         | 1001           | 0.72          | 0.30            | 20            |
| 14.            | 745          | 25.7         | 333          | 19.7         | 1108           | 0.78          | 0.47            | 38            |
| 15.            | 807          | 18.4         | 201          | 9.8          | 84             | 0.87          | 0.32            | 8             |
| 16.            | 1035         | 30.5         | 558          | 17.0         | 1579           | 0.95          | 0.54            | 48            |
| 17.            | 925          | 24.8         | 247          | 18.7         | 1255           | 0.77          | 0.40            | 35            |
| 18.            | 945          | 24.2         | 245          | 12.0         | 133            | 0.75          | 0.35            | 11            |
| 19.            | 853          | 19.2         | 218          | 10.3         | 122            | 1.71          | 0.15            | 5             |
| 20.            | 851          | 23.5         | 394          | 19.9         | 1258           | 0.78          | 0.44            | 27            |
| <b>Total</b>   | <b>17752</b> | <b>491.3</b> | <b>5359</b>  | <b>259.7</b> | <b>18482</b>   | <b>15.80</b>  | <b>7.50</b>     | <b>530</b>    |
| <b>Mean</b>    | <b>887</b>   | <b>24.6</b>  | <b>318</b>   | <b>17.9</b>  | <b>924</b>     | <b>0.84</b>   | <b>0.38</b>     | <b>25</b>     |

OR  
924X 0.25  
= 231 mcg. or  
Retinol

## APPENDIX V

ANALYSIS OF THE OPAQUE - 2 MAIZE MIXTURE (80 GRAMS)A. Determination of the energy value:

|  |   |                          |
|--|---|--------------------------|
| Initial temperature of water                                       | = | 79.7°F                   |
| Final temperature of water   | = | 82.86°F                  |
| Therefore rise in temperature                                      | = | 82.86-79.7               |
|  | = | 3.16°F                   |
| Energy equivalent of the calorimeter<br>in calories per degree (F) | = | 1348 Calories            |
| Calories for rise in temperature                                   | = | 3.16 x 1348              |
|  | = | 4259.68 Calories         |
| Length of fuse wire used   | = | 10-3.3                   |
|  | = | 6.5 cms                  |
| Therefore Calories for the wire used                               | = | 6.5 x 2.3                |
|  | = | 14.95 Calories           |
| Fuse wire correction   | = | 4259.68-14.95            |
|  | = | 4244.73                  |
| 1g. of the dry sample contain                                      | = | 4244.73 Calories         |
| Therefore 80g of the dry sample will<br>contain                    | = | 4244.73 x 80             |
|  | = | 339578.40 Calories       |
|  |   | (or)                     |
|  |   | 339.578 K.Cals.          |
| Therefore 80g of the supplement supply =                           |   | <u>340 Kilo Calories</u> |

**B. Estimation of Protein:****Observation:**

|                            | Initial reading | Final reading | Volume of N/70 $H_2SO_4$ (ml) | Volume of the sample (ml) |
|----------------------------|-----------------|---------------|-------------------------------|---------------------------|
| Flank                      | 0               | 0.7           | 0.7                           | 20                        |
| Test Sample S <sub>1</sub> | 0               | 16.7          | 16.7                          | 20                        |
| S <sub>2</sub>             | 0               | 16.6          | 16.7                          | 20                        |
| S <sub>3</sub>             | 0               | 16.7          | 16.7                          | 20                        |

**Calculation:**

|   |   |                              |
|---|---|------------------------------|
| Volume of N/70 sulphuric acid used to titrate the ammonia evolved | = | 16.7 ml.                     |
| Flank titre value   | = | 0.7 ml.                      |
| Therefore 16.7 - 0.7  | = | 16 ml.                       |
| 1 ml. of N/70 sulphuric acid corresponds to                       | = | 0.2 mg. of nitrogen          |
| Therefore 16 ml. of N/70 sulphuric acid corresponds to            | = | 16 x 0.2                     |
|   | = | 3.2 mg of nitrogen           |
| 20 ml. of the test solution contain                               | = | 3.2 mg of nitrogen           |
| Therefore 100 ml of the test solution contain                     | = | 100 x 3.2/20                 |
|   | = | 16.0 mg. of nitrogen         |
| 2 g. of the sample (supplement) contain                           | = | 16 mg of nitrogen            |
| Therefore 80 g of the sample contain                              | = | 80 x 16/2                    |
|   | = | 640 mg or 0.64 g of nitrogen |
| Therefore the amount of protein present                           | = | 0.64 x 6.25                  |
|   | = | <u>4 g.</u>                  |

C. Estimation of CalciumObservations:Blank:0.01N  $\text{KMnO}_4$  against 2N  $\text{H}_2\text{SO}_4$ 

| Trial | Initial reading | Final reading | Volume of $\text{KMnO}_4$ |
|-------|-----------------|---------------|---------------------------|
| 1     | 0               | 0.1           | 0.1                       |
| 2     | 0               | 0.1           | 0.1                       |
| 3     | 0               | 0.1           | 0.1                       |

Sample:

| Trial | Initial reading | Final reading | Volume of $\text{KMnO}_4$ |
|-------|-----------------|---------------|---------------------------|
| 1     | 0               | 0.75          | 0.75                      |
| 2     | 0               | 0.75          | 0.75                      |
| 3     | 0               | 0.75          | 0.75                      |

Calculations:

|   |   |                           |
|---|---|---------------------------|
| Titre value for blank                               | = | 0.1 ml.                   |
| Titre value for the test solution                   | = | 0.75 ml.                  |
| Therefore volume of $\text{KMnO}_4$ used            | = | 0.75-0.1                  |
|   | = | 0.65 ml.                  |
| 1 ml of 0.01N $\text{KMnO}_4$ contain               | = | 0.2 mg of calcium         |
| Therefore 0.65 ml. of 0.01N $\text{KMnO}_4$ contain | = | 0.65 x 0.2                |
|   | = | 0.130 mg of Calcium       |
| 5 ml. of ash solution contain                       | = | 0.13 mg of Calcium        |
| Therefore 100 ml. of ash solution contain           | = | 0.13 x 100/5              |
|   | = | 2.6 mg of Calcium         |
| 5 g. of the sample contain                          | = | 2.6 mg of Calcium         |
| Therefore 80 g. of the sample contain               | = | 80 x 2.6/5                |
|   | = | <u>41.6 mg of Calcium</u> |

**D. Estimation of Phosphorus:****Observation:**

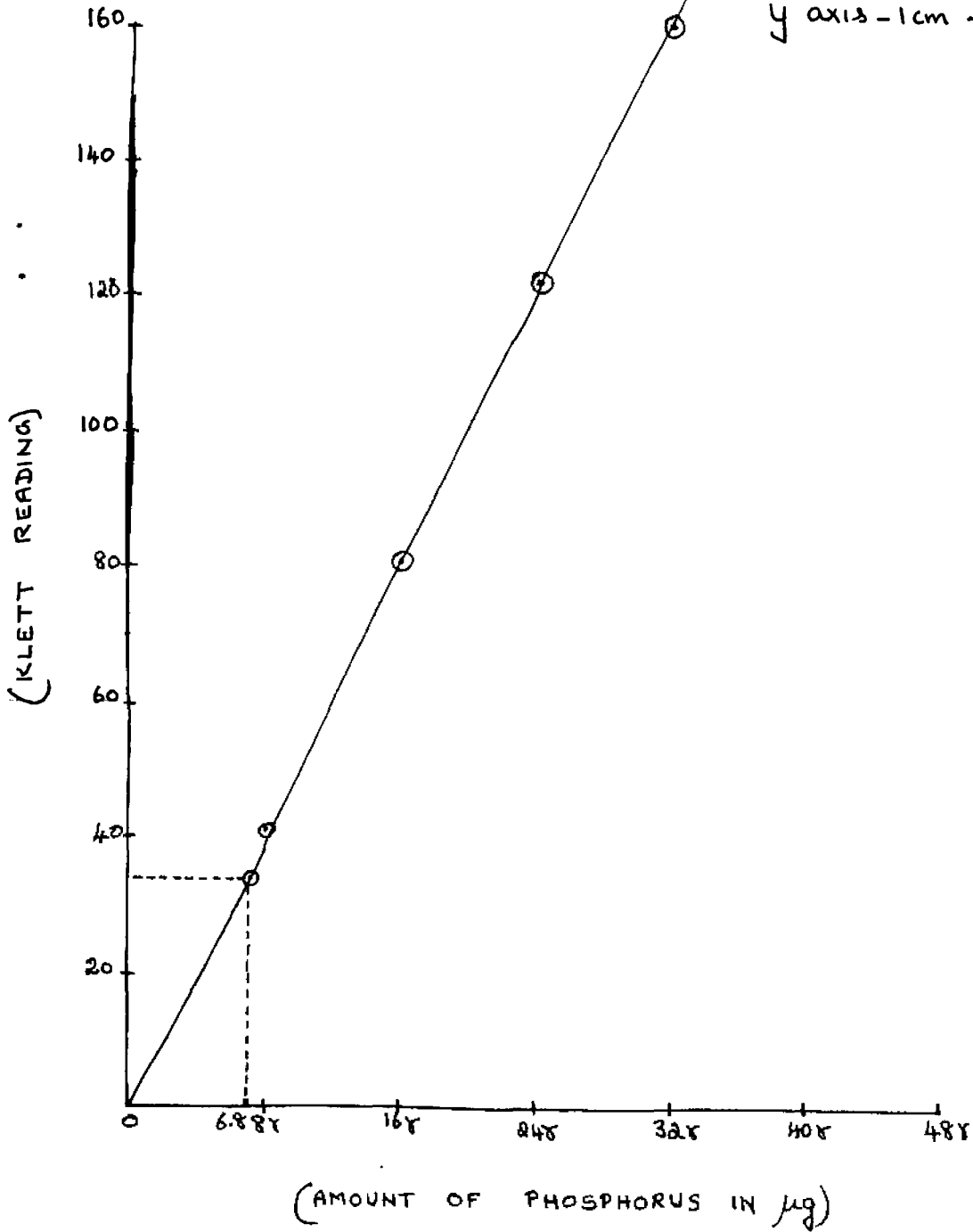
| *****                  |                |               |           |            |              |                           |                  |
|------------------------|----------------|---------------|-----------|------------|--------------|---------------------------|------------------|
|                        | Volume<br>(ml) | Water<br>(ml) | Molybdate |            | ANBA<br>(ml) | Concen-<br>tration<br>(%) | Klett<br>reading |
|                        |                |               | I<br>(ml) | II<br>(ml) |              |                           |                  |
| -----                  |                |               |           |            |              |                           |                  |
| Blank                  | -              | 8.6           | 1         | -          | 0.4          | -                         | -                |
| Standard               |                |               |           |            |              |                           |                  |
| S <sub>1</sub>         | 1              | 7.6           | 1         | -          | 0.4          | 8                         | 49               |
| S <sub>2</sub>         | 2              | 6.6           | 1         | -          | 0.4          | 16                        | 89               |
| S <sub>3</sub>         | 3              | 5.6           | 1         | -          | 0.4          | 24                        | 124              |
| S <sub>4</sub>         | 4              | 4.6           | 1         | -          | 0.4          | 32                        | 169              |
| Test                   |                |               |           |            |              |                           |                  |
| Sample TS <sub>1</sub> | 0.1            | 8.5           | -         | 1          | 0.4          | -                         | 34               |
| TS <sub>2</sub>        | 0.1            | 8.5           | -         | 1          | 0.4          | -                         | 34               |
| TS <sub>3</sub>        | 0.1            | 8.5           | -         | 1          | 0.4          | -                         | 34               |
| *****                  |                |               |           |            |              |                           |                  |

FIGURE - V

ESTIMATION OF PHOSPHORUS

SCALE:

X axis - 1 cm - 48 of phosphorus  
Y axis - 1 cm - 10 klett units



Calculations:

From the graph,  
0.1 ml. of ash solution contain   • 6.8% of phosphorus  
Therefore 100 ml. of ash solution  
contain                                   •  $100 \times 6.8/0.1 \times 1000$   
   • 6.8 mg of phosphorus

5 g. of the test sample contain       • 6.8 mg of phosphorus

Therefore 80 g. of the test  
sample will contain                   •  $80 \times 6.8/5$   
   • 108.8 mg of  
   phosphorus

**E. Estimation of Iron****Observations**

|             |                 | Volume<br>(ml) | Potas-<br>sium per<br>sulphate | Potas-<br>sium this<br>sulphate | Water<br>(ml) | Concen-<br>tration<br>(%) | Klett<br>read-<br>ing |
|-------------|-----------------|----------------|--------------------------------|---------------------------------|---------------|---------------------------|-----------------------|
| Blank       |                 | -              | 0.5                            | 2                               | 7.5           | -                         | -                     |
| Standard    | S <sub>1</sub>  | 1              | 0.5                            | 2                               | 6.5           | 10                        | 60                    |
|             | S <sub>2</sub>  | 2              | 0.5                            | 2                               | 5.5           | 20                        | 124                   |
|             | S <sub>3</sub>  | 3              | 0.5                            | 2                               | 4.5           | 30                        | 186                   |
|             | S <sub>4</sub>  | 4              | 0.5                            | 2                               | 3.5           | 40                        | 256                   |
| Test sample | TS <sub>1</sub> | 2              | 0.5                            | 2                               | 5.5           | -                         | 40                    |
|             | TS <sub>2</sub> | 2              | 0.5                            | 2                               | 5.5           | -                         | 40                    |
|             | TS <sub>3</sub> | 2              | 0.5                            | 2                               | 5.5           | -                         | 40                    |

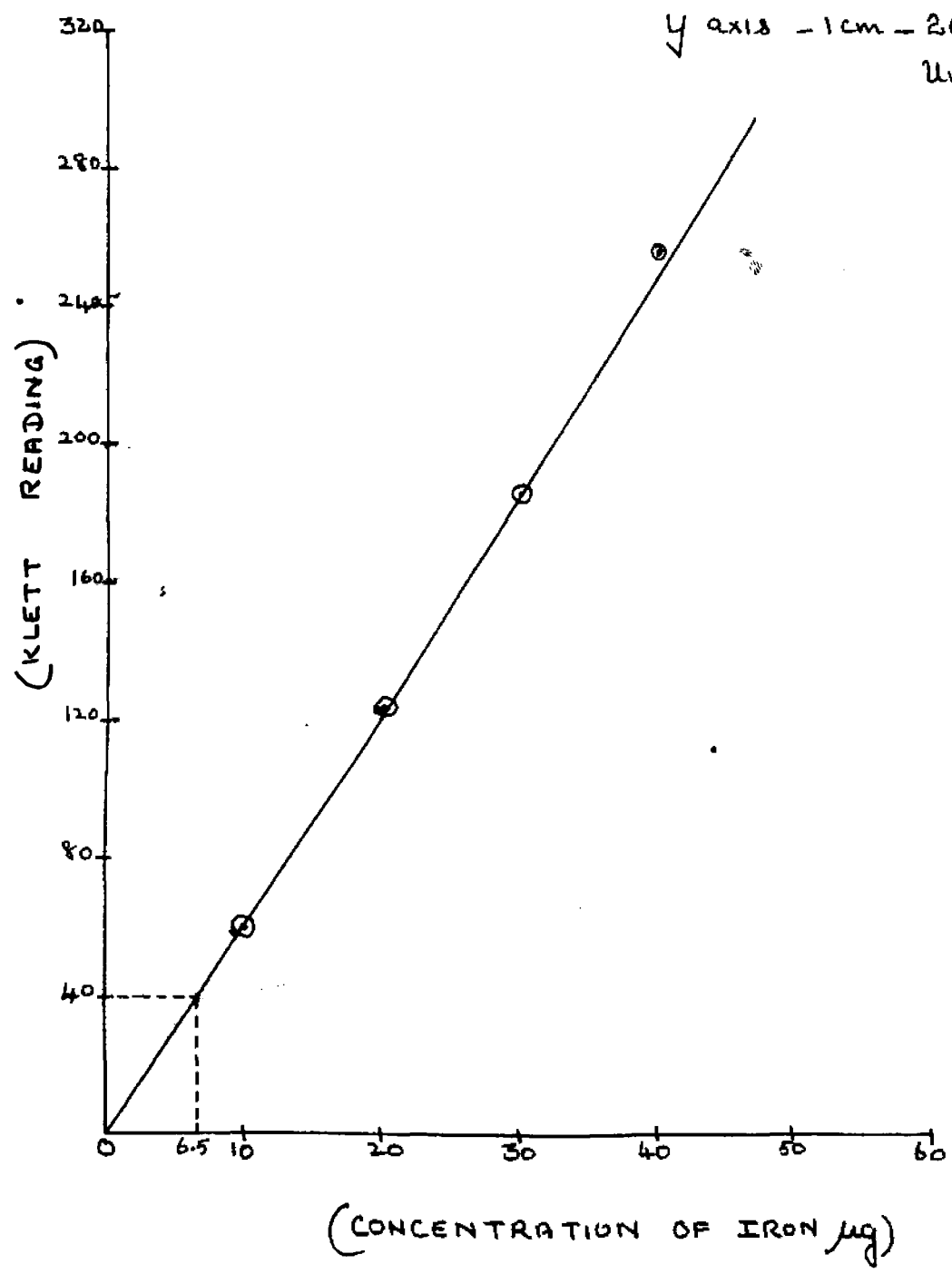
FIGURE - VI

ESTIMATION OF IRON

SCALE

X axis - 1cm - 5  $\mu$ g of iron

Y axis - 1cm - 20 klett Units



Calculations:

|   |  |
|---|--|
| From the graph,<br>2 ml. of the ash solution<br>contain | • 6.5% of Iron   |
| Therefore 100 ml. of the ash<br>solution contain        | • $100 \times 6.5/2 \times 1000$<br>• 0.325 mg of Iron |
| 5 g. of the sample contain                              | • 0.325 mg of Iron                                     |
| Therefore 80 g. of the sample<br>contain                | • $80 \times 0.325/5$<br>• <u>5.2 mg of iron</u>       |

F. Estimation of carotene:

Observation:

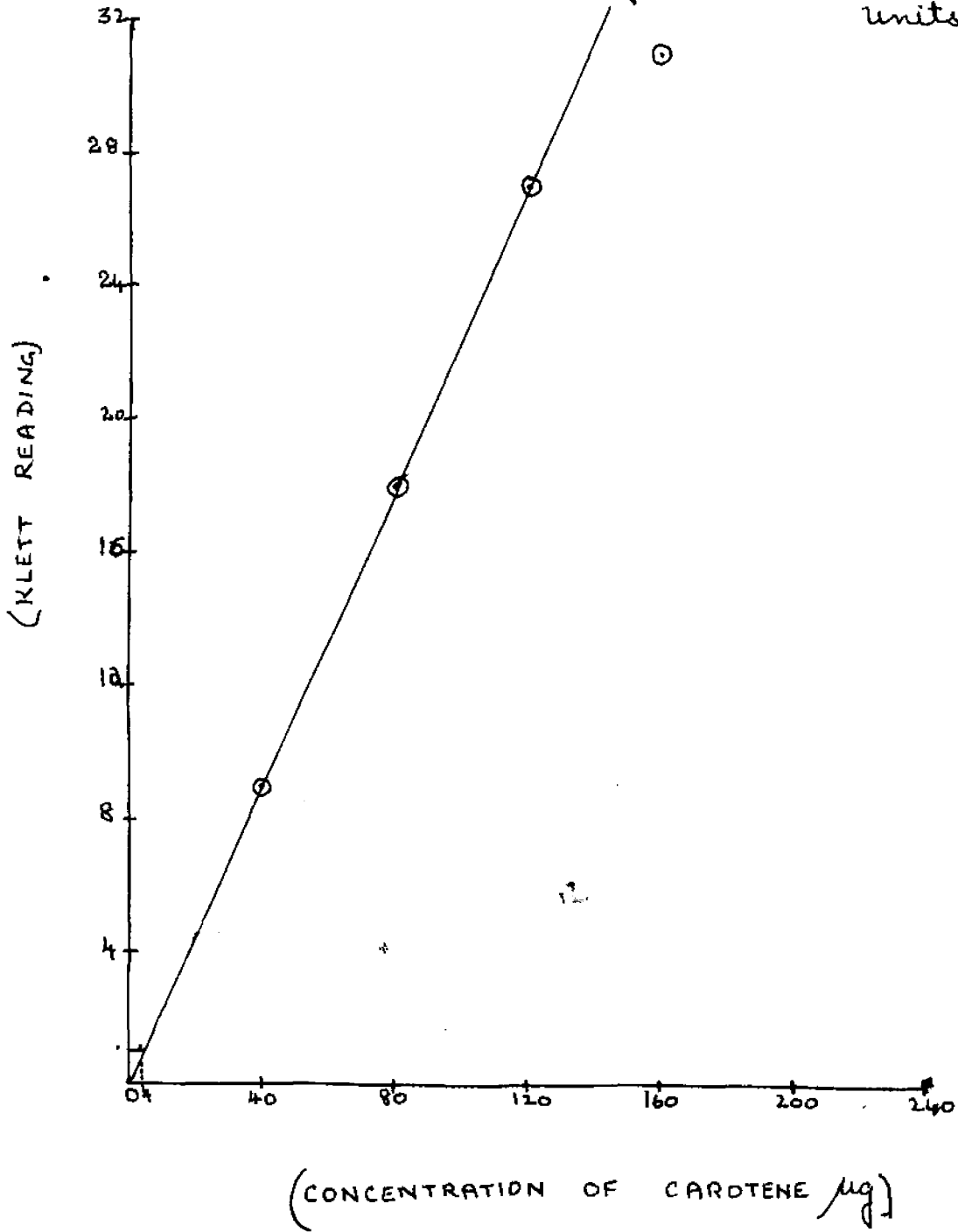
|             |                 | Volume of<br>standard<br>(ml) | Petroleum<br>ether<br>(ml) | Amount of<br>carotene<br>( $\gamma$ ) | Klett<br>reading |
|-------------|-----------------|-------------------------------|----------------------------|---------------------------------------|------------------|
| Blank       |                 | -                             | 8                          | -                                     | -                |
| Standard    | S <sub>1</sub>  | 2                             | 6                          | 40                                    | 9                |
|             | S <sub>2</sub>  | 4                             | 4                          | 80                                    | 18               |
|             | S <sub>3</sub>  | 6                             | 2                          | 120                                   | 27               |
|             | S <sub>4</sub>  | 8                             | -                          | 160                                   | 31               |
| Test sample | TS <sub>1</sub> | 8                             | -                          | -                                     | 1                |
|             | TS <sub>2</sub> | 8                             | -                          | -                                     | 1                |
|             | TS <sub>3</sub> | 8                             | -                          | -                                     | 1                |

FIGURE - VII

ESTIMATION OF CAROTENE

SCALE :

X axis - 1cm - 20  $\mu$ g of  
carotene  
Y axis - 1cm - 2 klett  
units



Calculation:

From the graph,

8 ml. of the test solution  
contain

= 4% of Carotene

Therefore 50 ml. of the test  
solution contain

= 50 x 4/8

= 25% of Carotene

20 g. of the sample contain

= 25% of Carotene

Therefore 80 g of the sample  
contain

= 80 x 25/20

= 100% (mg) of Carotene

1 mg of carotene

= 0.25 mg of Retinol

Therefore 100 mg of carotene

= 100 x 0.25

= 25 mg of Retinol

APPENDIX VI  
A. MONTHLY WEIGHT (IN KG) OF EXPERIMENTAL GROUP

| Sub-<br>ject<br>No. | Age<br>Yrs. | Sex | Initial      | 1            | 2            | 3            | 4            | 5            | 6            | 7            | 8            | 9            | 10           | 11           | Final        |
|---------------------|-------------|-----|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1.                  | 2 1/2       | M   | 9.0          | 9.5          | 10.0         | 10.5         | 11.0         | 12.00        | 12.5         | 13.0         | 14.0         | 14.5         | 14.5         | 15.0         | 16.0         |
| 2.                  | 3           | F   | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.5         |
| 3.                  | 2           | F   | 10.0         | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.0         |
| 4.                  | 2           | M   | 9.0          | 9.5          | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.5         | 15.0         | 15.5         |
| 5.                  | 1 1/2       | M   | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 13.0         | 13.5         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.5         |
| 6.                  | 3           | M   | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 16.0         |
| 7.                  | 2           | M   | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.0         | 15.5         | 16.0         | 16.5         | 17.0         | 17.5         |
| 8.                  | 2 1/2       | F   | 10.0         | 10.5         | 11.0         | 11.5         | 12.5         | 13.0         | 13.5         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.0         |
| 9.                  | 3           | M   | 7.5          | 8.0          | 8.5          | 9.0          | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 15.0         | 14.0         | 15.0         |
| 10.                 | 2 1/2       | F   | 11.0         | 11.5         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 13.5         | 14.0         | 14.5         | 15.5         | 16.0         | 17.0         |
| 11.                 | 2 1/2       | F   | 12.0         | 12.0         | 12.5         | 12.5         | 13.0         | 13.5         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.5         | 17.5         |
| 12.                 | 2           | M   | 9.0          | 9.5          | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.5         |
| 13.                 | 2 1/2       | M   | 10.0         | 10.5         | 11.0         | 11.5         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.0         | 17.0         |
| 14.                 | 2 1/2       | M   | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.5         |
| 15.                 | 3           | F   | 10.0         | 10.5         | 11.0         | 11.5         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.0         | 17.0         |
| 16.                 | 1 1/2       | F   | 10.5         | 11.0         | 12.5         | 13.5         | 14.5         | 15.0         | 15.5         | 16.0         | 16.0         | 16.5         | 17.0         | 17.5         | 18.5         |
| 17.                 | 3           | M   | 11.0         | 12.0         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 15.5         | 16.0         | 16.5         | 17.0         | 18.0         |
| 18.                 | 1 1/2       | F   | 9.0          | 10.0         | 10.5         | 11.0         | 11.5         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 15.0         | 15.5         | 16.5         |
| 19.                 | 1 1/2       | F   | 9.0          | 9.5          | 10.0         | 10.5         | 11.0         | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 15.0         | 16.0         |
| 20.                 | 2           | F   | 11.5         | 12.0         | 12.5         | 13.0         | 13.5         | 14.0         | 14.5         | 14.0         | 15.5         | 16.0         | 16.5         | 17.0         | 18.0         |
| <b>Total</b>        |             |     | <b>200.5</b> | <b>210.5</b> | <b>221.5</b> | <b>231.5</b> | <b>244.0</b> | <b>255.5</b> | <b>264.5</b> | <b>275.5</b> | <b>282.0</b> | <b>292.0</b> | <b>302.5</b> | <b>314.0</b> | <b>332.5</b> |
| <b>Mean</b>         |             |     | <b>10.0</b>  | <b>10.5</b>  | <b>11.0</b>  | <b>11.3</b>  | <b>12.2</b>  | <b>12.8</b>  | <b>13.2</b>  | <b>13.7</b>  | <b>14.1</b>  | <b>14.6</b>  | <b>15.1</b>  | <b>15.7</b>  | <b>16.6</b>  |

APPENDIX VI  
B. MONTHLY WEIGHT (IN KG) OF CONTROL GROUP

| Sub-<br>ject<br>No. | Age<br>yrs. | Sex | Initial | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | Final |
|---------------------|-------------|-----|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1.                  | 1           | F   | 10.0    | 9.5   | 9.0   | 10.0  | 10.5  | 11.0  | 11.5  | 11.5  | 10.5  | 11.5  | 12.0  | 12.5  | 13.5  |
| 2.                  | 2 1/2       | F   | 8.0     | 8.0   | 8.5   | 8.0   | 8.5   | 9.0   | 9.5   | 10.0  | 10.5  | 10.5  | 11.0  | 11.5  | 12.0  |
| 3.                  | 1 1/2       | M   | 14.0    | 14.0  | 14.5  | 15.0  | 16.0  | 15.0  | 15.5  | 16.0  | 16.5  | 17.0  | 17.0  | 16.5  | 17.5  |
| 4.                  | 2 3/4       | M   | 9.0     | 9.0   | 9.5   | 10.0  | 10.5  | 11.0  | 11.5  | 12.5  | 13.0  | 13.5  | 14.0  | 14.0  | 15.0  |
| 5.                  | 3           | F   | 10.0    | 10.5  | 11.0  | 11.5  | 11.5  | 11.5  | 12.0  | 12.0  | 12.5  | 13.0  | 13.0  | 13.5  | 14.5  |
| 6.                  | 1           | M   | 10.0    | 10.5  | 11.0  | 11.5  | 12.0  | 12.5  | 12.0  | 12.5  | 13.0  | 13.5  | 13.5  | 14.0  | 15.0  |
| 7.                  | 3           | M   | 9.0     | 9.5   | 10.0  | 9.5   | 9.0   | 9.0   | 10.0  | 10.5  | 10.5  | 11.0  | 11.5  | 12.5  | 13.5  |
| 8.                  | 2 1/2       | F   | 10.0    | 10.5  | 10.5  | 10.5  | 10.0  | 10.5  | 11.0  | 11.5  | 11.5  | 12.0  | 12.5  | 13.0  | 13.5  |
| 9.                  | 2 1/2       | M   | 12.0    | 12.0  | 12.5  | 13.0  | 13.5  | 14.0  | 14.0  | 14.5  | 14.5  | 15.0  | 15.5  | 16.0  | 17.0  |
| 10.                 | 2           | F   | 9.5     | 9.5   | 10.0  | 9.5   | 9.0   | 10.0  | 10.5  | 10.0  | 10.5  | 11.0  | 11.5  | 12.0  | 13.0  |
| 11.                 | 2           | F   | 11.5    | 12.0  | 12.5  | 12.0  | 12.5  | 13.0  | 13.5  | 13.0  | 12.5  | 13.0  | 13.5  | 13.0  | 14.5  |
| 12.                 | 2           | F   | 9.0     | 9.5   | 10.0  | 8.5   | 9.5   | 10.0  | 10.5  | 10.0  | 10.5  | 11.0  | 11.5  | 12.5  | 13.5  |
| 13.                 | 2 1/2       | F   | 10.0    | 10.5  | 10.0  | 9.5   | 9.5   | 10.0  | 10.5  | 9.5   | 10.0  | 10.5  | 11.0  | 11.5  | 12.5  |
| 14.                 | 2           | M   | 9.0     | 9.5   | 9.0   | 8.5   | 9.0   | 9.5   | 10.0  | 10.0  | 10.5  | 11.0  | 11.5  | 12.0  | 13.0  |
| 15.                 | 2 1/2       | F   | 10.0    | 9.5   | 9.0   | 8.5   | 7.5   | 9.5   | 10.0  | 10.5  | 10.5  | 11.0  | 11.5  | 12.0  | 12.5  |
| 16.                 | 1           | F   | 10.0    | 10.5  | 10.5  | 11.0  | 11.0  | 11.5  | 11.5  | 12.0  | 12.0  | 12.5  | 12.5  | 13.0  | 13.5  |
| 17.                 | 3           | M   | 9.0     | 9.0   | 9.5   | 10.0  | 10.5  | 11.0  | 11.5  | 12.0  | 12.0  | 12.5  | 13.0  | 13.5  | 14.5  |
| 18.                 | 2           | M   | 11.0    | 11.0  | 10.5  | 10.5  | 11.0  | 11.0  | 11.5  | 12.0  | 12.5  | 13.0  | 13.5  | 14.0  | 14.5  |
| 19.                 | 2 1/2       | M   | 10.0    | 10.0  | 9.5   | 9.0   | 9.5   | 10.0  | 10.5  | 11.0  | 11.5  | 12.0  | 12.5  | 13.5  | 14.5  |
| 20.                 | 1 1/2       | M   | 9.0     | 9.5   | 10.0  | 10.0  | 10.5  | 10.5  | 11.0  | 11.5  | 12.0  | 12.5  | 13.0  | 13.5  | 14.0  |
| Total               |             |     | 200.0   | 204.0 | 207.0 | 205.0 | 212.5 | 219.5 | 228.0 | 232.5 | 237.0 | 247.0 | 255.0 | 264.0 | 281.5 |
| Mean                |             |     | 10.0    | 10.2  | 10.4  | 10.3  | 10.6  | 11.0  | 11.4  | 11.6  | 11.9  | 12.4  | 12.8  | 13.2  | 14.1  |

**APPENDIX VII**  
**A. MONTHLY HEIGHT (IN CMS) OF EXPERIMENTAL**  
**GROUP**

| Subject Number | Age Yrs. | Sex | Initial       | 1             | 2             | 3             | 4             | 5             | Final         |
|----------------|----------|-----|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1.             | 2½       | M   | 78.1          | 82.0          | 84.0          | 87.0          | 90.4          | 94.5          | 96.5          |
| 2.             | 3        | F   | 81.6          | 84.0          | 86.0          | 89.5          | 92.5          | 95.4          | 97.1          |
| 3.             | 2        | F   | 85.8          | 87.5          | 88.5          | 91.0          | 93.0          | 95.0          | 96.5          |
| 4.             | 2        | M   | 75.0          | 76.5          | 79.2          | 81.4          | 84.1          | 87.0          | 89.5          |
| 5.             | 1½       | M   | 70.0          | 73.4          | 75.8          | 78.2          | 80.0          | 82.5          | 85.0          |
| 6.             | 3        | M   | 81.5          | 84.8          | 87.5          | 89.6          | 90.4          | 92.6          | 93.5          |
| 7.             | 2        | M   | 85.0          | 87.6          | 90.4          | 93.5          | 95.5          | 98.5          | 100.4         |
| 8.             | 2½       | F   | 83.8          | 86.5          | 88.5          | 91.4          | 93.4          | 95.8          | 96.5          |
| 9.             | 3        | M   | 72.5          | 75.5          | 77.4          | 79.5          | 82.6          | 84.4          | 86.5          |
| 10.            | 2½       | F   | 86.0          | 87.8          | 90.2          | 92.4          | 94.5          | 96.8          | 98.5          |
| 11.            | 2½       | F   | 86.8          | 89.0          | 91.4          | 93.1          | 95.0          | 96.5          | 97.5          |
| 12.            | 2        | M   | 81.5          | 86.1          | 88.0          | 90.4          | 92.0          | 93.5          | 95.5          |
| 13.            | 2½       | M   | 81.4          | 84.0          | 86.2          | 88.6          | 90.0          | 93.6          | 94.6          |
| 14.            | 2½       | F   | 85.0          | 86.8          | 89.0          | 91.1          | 93.5          | 95.6          | 97.8          |
| 15.            | 3        | F   | 80.8          | 85.0          | 86.5          | 87.5          | 89.7          | 92.5          | 94.5          |
| 16.            | 1½       | F   | 94.4          | 96.0          | 98.6          | 101.5         | 104.0         | 106.2         | 107.5         |
| 17.            | 3        | M   | 86.0          | 88.9          | 90.0          | 92.5          | 94.5          | 96.1          | 98.5          |
| 18.            | 1½       | F   | 85.8          | 87.6          | 91.0          | 93.8          | 95.4          | 96.5          | 98.0          |
| 19.            | 1½       | F   | 80.0          | 85.5          | 85.1          | 88.0          | 91.5          | 92.4          | 95.5          |
| 20.            | 2        | F   | 81.0          | 85.0          | 86.5          | 89.5          | 91.4          | 93.6          | 95.5          |
| <b>Total</b>   |          |     | <b>1657.6</b> | <b>1692.0</b> | <b>1759.1</b> | <b>1789.7</b> | <b>1832.6</b> | <b>1878.8</b> | <b>1912.9</b> |
| <b>Mean</b>    |          |     | <b>81.9</b>   | <b>84.6</b>   | <b>86.9</b>   | <b>89.5</b>   | <b>91.6</b>   | <b>93.9</b>   | <b>95.1</b>   |

APPENDIX VII  
B. MONTHLY HEIGHT (IN CMS) OF CONTROL GROUP

| Sub-<br>ject<br>No. | Age<br>yrs. | Sex | INITIAL       | 1             | 2             | 3             | 4             | 5             | Final         |
|---------------------|-------------|-----|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1.                  | 1           | F   | 82.6          | 84.7          | 86.8          | 87.4          | 89.4          | 90.6          | 92.4          |
| 2.                  | 2 1/2       | F   | 90.7          | 93.0          | 97.8          | 100.1         | 101.4         | 102.8         | 104.6         |
| 3.                  | 1 1/2       | M   | 94.4          | 97.8          | 98.8          | 99.4          | 101.3         | 103.0         | 105.5         |
| 4.                  | 2 3/4       | M   | 80.3          | 82.1          | 84.6          | 86.3          | 87.5          | 88.6          | 90.5          |
| 5.                  | 3           | F   | 76.3          | 78.3          | 82.3          | 84.6          | 86.3          | 87.9          | 89.5          |
| 6.                  | 1           | M   | 78.4          | 81.5          | 83.8          | 86.5          | 87.6          | 88.8          | 90.5          |
| 7.                  | 3           | M   | 71.4          | 74.0          | 77.2          | 78.9          | 80.3          | 81.6          | 83.4          |
| 8.                  | 2 1/2       | F   | 72.6          | 74.0          | 76.0          | 77.6          | 78.5          | 80.3          | 81.5          |
| 9.                  | 2 1/2       | M   | 86.3          | 88.6          | 89.3          | 90.4          | 92.3          | 94.2          | 95.5          |
| 10.                 | 2           | F   | 80.7          | 83.3          | 85.0          | 87.5          | 88.8          | 91.8          | 91.8          |
| 11.                 | 2           | F   | 73.9          | 77.0          | 78.8          | 80.3          | 81.3          | 82.8          | 83.8          |
| 12.                 | 2           | F   | 93.0          | 92.0          | 93.8          | 95.8          | 98.1          | 99.3          | 100.4         |
| 13.                 | 2 1/2       | F   | 71.5          | 74.0          | 78.4          | 79.5          | 80.4          | 82.8          | 83.4          |
| 14.                 | 2           | M   | 70.4          | 73.0          | 76.5          | 78.0          | 80.3          | 81.9          | 82.3          |
| 15.                 | 2 1/2       | F   | 90.8          | 95.2          | 96.3          | 97.9          | 99.1          | 101.3         | 103.8         |
| 16.                 | 1           | F   | 90.3          | 92.6          | 93.3          | 97.3          | 98.9          | 101.3         | 103.6         |
| 17.                 | 3           | M   | 83.6          | 84.3          | 84.4          | 89.3          | 90.1          | 91.6          | 92.8          |
| 18.                 | 2           | M   | 83.3          | 85.3          | 87.0          | 88.3          | 89.3          | 91.1          | 93.3          |
| 19.                 | 2 1/2       | M   | 80.3          | 81.6          | 84.6          | 85.8          | 86.3          | 87.1          | 89.4          |
| 20.                 | 1 1/2       | M   | 77.9          | 79.0          | 82.3          | 83.3          | 84.3          | 85.8          | 87.1          |
| <b>Total</b>        |             |     | <b>1626.2</b> | <b>1573.2</b> | <b>1723.3</b> | <b>1733.6</b> | <b>1782.2</b> | <b>1813.6</b> | <b>1844.3</b> |
| <b>Mean</b>         |             |     | <b>81.3</b>   | <b>83.7</b>   | <b>86.4</b>   | <b>87.6</b>   | <b>89.1</b>   | <b>90.7</b>   | <b>92.2</b>   |

APPENDIX VIII <sup>(IN CMS)</sup>  
 A. MONTHLY HEAD CIRCUMFERENCE OF EXPERIMENTAL  
 GROUP

| Sub-<br>ject<br>No. | Age<br>yrs. | Sex | Initial | 1     | 2     | 3     | 4     | 5     | Final  |
|---------------------|-------------|-----|---------|-------|-------|-------|-------|-------|--------|
| 1.                  | 2 1/2       | M   | 46.0    | 46.8  | 47.4  | 48.8  | 49.1  | 49.5  | 50.5   |
| 2.                  | 3           | F   | 45.0    | 45.7  | 46.8  | 47.1  | 47.4  | 47.9  | 48.5   |
| 3.                  | 2           | F   | 49.1    | 49.4  | 49.6  | 50.0  | 50.2  | 50.5  | 51.0   |
| 4.                  | 2           | M   | 47.0    | 47.3  | 48.4  | 48.9  | 49.7  | 50.4  | 51.4   |
| 5.                  | 1 1/2       | M   | 46.2    | 46.4  | 46.5  | 46.7  | 47.8  | 48.5  | 49.0   |
| 6.                  | 3           | M   | 46.1    | 46.5  | 48.1  | 49.0  | 49.5  | 49.7  | 50.0   |
| 7.                  | 2           | M   | 45.1    | 45.4  | 46.0  | 46.4  | 47.5  | 48.2  | 49.5   |
| 8.                  | 2 1/2       | F   | 44.0    | 44.5  | 45.5  | 46.5  | 47.5  | 48.4  | 49.5   |
| 9.                  | 3           | M   | 46.5    | 46.6  | 47.6  | 48.4  | 49.0  | 49.5  | 50.0   |
| 10.                 | 2 1/2       | F   | 47.2    | 47.6  | 48.7  | 49.0  | 49.5  | 49.8  | 50.0   |
| 11.                 | 2 1/2       | F   | 47.5    | 48.6  | 49.8  | 50.1  | 50.4  | 51.0  | 51.5   |
| 12.                 | 2           | M   | 46.4    | 47.0  | 47.5  | 48.0  | 48.5  | 49.0  | 49.5   |
| 13.                 | 2 1/2       | M   | 48.8    | 50.5  | 51.0  | 51.5  | 51.8  | 52.0  | 52.5   |
| 14.                 | 2 1/2       | M   | 46.5    | 47.5  | 48.5  | 49.1  | 49.5  | 50.0  | 50.5   |
| 15.                 | 3           | F   | 46.1    | 46.5  | 47.5  | 48.0  | 48.5  | 49.0  | 49.5   |
| 16.                 | 1 1/2       | F   | 45.1    | 45.5  | 45.5  | 46.4  | 47.5  | 47.9  | 48.5   |
| 17.                 | 3           | M   | 47.1    | 47.5  | 48.0  | 48.5  | 49.0  | 49.5  | 50.0   |
| 18.                 | 1 1/2       | F   | 48.2    | 48.4  | 49.0  | 49.8  | 50.5  | 51.4  | 52.5   |
| 19.                 | 1 1/2       | F   | 46.1    | 46.8  | 47.1  | 47.5  | 48.1  | 48.9  | 49.0   |
| 20.                 | 2           | F   | 47.1    | 48.0  | 48.5  | 49.0  | 49.2  | 49.5  | 50.0   |
| Total               |             |     | 930.7   | 941.9 | 947.0 | 968.5 | 979.8 | 990.5 | 1002.9 |
| Mean                |             |     | 46.5    | 47.1  | 47.4  | 48.4  | 48.9  | 49.5  | 50.1   |

APPENDIX VIII  
B. MONTHLY HEAD CIRCUMFERENCE (IN CMS) OF CONTROL  
GROUP

| Sub-<br>ject<br>No. | Age<br>yrs. | Sex | Initial | 1     | 2     | 3     | 4     | 5     | Final  |
|---------------------|-------------|-----|---------|-------|-------|-------|-------|-------|--------|
| 1.                  | 1           | F   | 44.0    | 45.5  | 46.0  | 47.0  | 47.5  | 48.0  | 50.5   |
| 2.                  | 2 1/2       | F   | 48.5    | 48.5  | 49.0  | 49.4  | 49.8  | 50.2  | 50.2   |
| 3.                  | 1 1/2       | M   | 45.1    | 45.7  | 46.0  | 46.5  | 47.0  | 49.0  | 51.0   |
| 4.                  | 2 3/4       | M   | 47.5    | 47.4  | 47.5  | 48.0  | 48.5  | 49.0  | 51.4   |
| 5.                  | 3           | F   | 45.0    | 45.5  | 46.0  | 46.5  | 47.0  | 47.2  | 49.0   |
| 6.                  | 1           | M   | 47.1    | 47.5  | 48.1  | 48.5  | 49.0  | 49.4  | 50.0   |
| 7.                  | 3           | M   | 47.9    | 48.1  | 48.4  | 48.7  | 49.5  | 49.5  | 49.5   |
| 8.                  | 2 1/2       | F   | 46.5    | 46.8  | 47.0  | 47.5  | 47.5  | 48.0  | 49.5   |
| 9.                  | 2 1/2       | M   | 45.0    | 45.5  | 46.0  | 46.2  | 46.5  | 49.0  | 50.0   |
| 10.                 | 2           | F   | 45.1    | 45.5  | 45.5  | 46.0  | 46.4  | 47.1  | 50.0   |
| 11.                 | 2           | F   | 46.1    | 46.5  | 47.0  | 47.4  | 47.8  | 49.9  | 51.5   |
| 12.                 | 2           | F   | 46.5    | 47.0  | 47.2  | 47.4  | 47.7  | 48.0  | 49.5   |
| 13.                 | 2 1/2       | F   | 46.5    | 47.0  | 47.5  | 48.0  | 48.5  | 48.5  | 52.5   |
| 14.                 | 2           | M   | 48.0    | 48.2  | 48.5  | 48.4  | 48.8  | 49.0  | 50.5   |
| 15.                 | 2 1/2       | F   | 46.5    | 46.5  | 48.0  | 48.5  | 48.5  | 49.0  | 49.5   |
| 16.                 | 1           | F   | 48.0    | 48.2  | 48.5  | 48.4  | 48.4  | 48.5  | 48.5   |
| 17.                 | 3           | M   | 48.1    | 48.2  | 48.5  | 48.5  | 49.1  | 49.6  | 50.0   |
| 18.                 | 2           | M   | 48.0    | 48.0  | 48.1  | 48.5  | 48.8  | 49.5  | 52.6   |
| 19.                 | 2 1/2       | M   | 47.0    | 47.5  | 48.0  | 48.2  | 48.9  | 49.0  | 49.0   |
| 20.                 | 1 1/2       | M   | 46.5    | 47.0  | 47.2  | 47.4  | 47.8  | 48.5  | 50.0   |
| Total               |             |     | 931.9   | 939.7 | 947.4 | 954.2 | 962.4 | 965.4 | 1004.7 |
| Mean                |             |     | 46.6    | 47.0  | 47.4  | 47.7  | 48.1  | 48.5  | 50.2   |

## APPENDIX IX

MONTHLY  
 A. CHEST CIRCUMFERENCE (IN CMS) OF EXPERIMENTAL GROUP

| Sub-<br>ject<br>No. | Age<br>(yrs) | Sex | Initial | 1     | 2      | 3      | 4      | 5      | Final  |
|---------------------|--------------|-----|---------|-------|--------|--------|--------|--------|--------|
| 1.                  | 2½           | M   | 46.8    | 48.0  | 49.0   | 49.5   | 50.0   | 50.5   | 51.0   |
| 2.                  | 3            | F   | 50.1    | 51.1  | 51.9   | 51.5   | 53.1   | 53.8   | 54.4   |
| 3.                  | 2            | F   | 48.5    | 50.0  | 51.5   | 52.5   | 53.4   | 54.1   | 55.5   |
| 4.                  | 2            | M   | 47.5    | 48.0  | 49.2   | 50.4   | 51.0   | 52.9   | 52.4   |
| 5.                  | 1½           | M   | 47.5    | 50.0  | 51.0   | 51.5   | 52.0   | 52.5   | 53.4   |
| 6.                  | 3            | M   | 48.4    | 50.0  | 51.0   | 51.2   | 51.8   | 52.5   | 53.0   |
| 7.                  | 2            | M   | 49.3    | 51.0  | 52.0   | 52.5   | 52.7   | 53.0   | 53.5   |
| 8.                  | 2½           | F   | 46.8    | 49.0  | 50.0   | 51.3   | 51.9   | 52.3   | 52.3   |
| 9.                  | 3            | M   | 46.3    | 48.0  | 49.5   | 50.1   | 50.8   | 51.4   | 52.5   |
| 10.                 | 2½           | F   | 50.5    | 51.3  | 52.0   | 52.4   | 52.8   | 53.2   | 53.5   |
| 11.                 | 2½           | F   | 50.0    | 50.0  | 51.5   | 51.9   | 52.1   | 52.9   | 53.2   |
| 12.                 | 2            | M   | 46.5    | 48.0  | 49.8   | 51.3   | 52.0   | 52.4   | 53.0   |
| 13.                 | 2½           | M   | 48.0    | 49.0  | 50.0   | 50.7   | 51.4   | 52.0   | 52.5   |
| 14.                 | 2½           | M   | 50.5    | 51.0  | 51.5   | 51.9   | 52.1   | 52.3   | 52.5   |
| 15.                 | 3            | F   | 48.5    | 51.0  | 52.0   | 52.4   | 53.2   | 54.1   | 54.9   |
| 16.                 | 1½           | F   | 49.8    | 51.0  | 52.0   | 52.5   | 53.1   | 54.8   | 55.4   |
| 17.                 | 3            | M   | 49.8    | 51.0  | 52.0   | 52.4   | 53.0   | 53.8   | 54.2   |
| 18.                 | 1½           | F   | 49.7    | 50.8  | 51.8   | 52.5   | 53.0   | 54.0   | 54.5   |
| 19.                 | 1½           | F   | 46.6    | 48.6  | 49.8   | 51.5   | 52.6   | 53.0   | 54.4   |
| 20.                 | 2            | F   | 48.2    | 49.8  | 50.7   | 51.5   | 52.2   | 53.8   | 55.2   |
| Total               | ..           | ..  | 969.6   | 997.1 | 1018.2 | 1031.5 | 1044.9 | 1058.3 | 1072.4 |
| Mean                | ..           | ..  | 48.5    | 49.9  | 50.9   | 51.7   | 52.2   | 52.9   | 53.6   |

## APPENDIX IX

B. MONTHLY CHEST CIRCUMFERENCES (IN CMS) OF CONTROL GROUP

| Subject No. | Age (yrs) | Sex | Initial | 1     | 2     | 3     | 4     | 5     | Final  |
|-------------|-----------|-----|---------|-------|-------|-------|-------|-------|--------|
| 1.          | 1         | F   | 47.0    | 47.5  | 48.0  | 48.5  | 49.0  | 49.3  | 51.5   |
| 2.          | 2½        | F   | 46.8    | 47.3  | 47.4  | 47.6  | 47.9  | 48.0  | 49.0   |
| 3.          | 1½        | M   | 49.1    | 50.3  | 51.0  | 51.5  | 51.5  | 52.4  | 53.5   |
| 4.          | 2½        | M   | 48.0    | 48.5  | 49.5  | 49.5  | 50.0  | 50.3  | 51.4   |
| 5.          | 3         | F   | 46.5    | 47.3  | 47.6  | 48.1  | 48.5  | 48.5  | 49.5   |
| 6.          | 1         | M   | 47.4    | 48.5  | 49.0  | 49.5  | 50.2  | 50.5  | 51.0   |
| 7.          | 3         | M   | 46.5    | 47.5  | 48.0  | 48.2  | 48.5  | 49.0  | 50.4   |
| 8.          | 2½        | F   | 47.5    | 49.5  | 48.5  | 50.0  | 50.5  | 51.0  | 52.6   |
| 9.          | 2½        | M   | 45.4    | 47.5  | 48.0  | 48.5  | 48.5  | 49.0  | 50.5   |
| 10.         | 2         | F   | 46.5    | 47.5  | 48.5  | 49.0  | 49.0  | 49.5  | 50.5   |
| 11.         | 2         | F   | 46.0    | 47.0  | 48.5  | 49.0  | 49.2  | 49.5  | 50.5   |
| 12.         | 2         | F   | 47.1    | 47.5  | 48.0  | 48.5  | 49.0  | 49.0  | 50.0   |
| 13.         | 2½        | F   | 45.0    | 46.5  | 47.5  | 48.5  | 49.0  | 49.5  | 50.5   |
| 14.         | 2         | M   | 47.0    | 48.0  | 48.5  | 49.0  | 49.5  | 49.5  | 50.0   |
| 15.         | 2½        | F   | 46.0    | 46.5  | 47.5  | 47.5  | 48.0  | 48.5  | 49.0   |
| 16.         | 1         | F   | 46.5    | 47.5  | 47.5  | 48.0  | 48.4  | 49.1  | 49.5   |
| 17.         | 3         | M   | 47.0    | 47.5  | 48.5  | 49.0  | 49.5  | 50.3  | 51.5   |
| 18.         | 2         | M   | 49.0    | 49.5  | 50.0  | 50.5  | 51.4  | 52.4  | 53.5   |
| 19.         | 2½        | M   | 46.7    | 47.5  | 48.0  | 48.5  | 49.0  | 49.4  | 49.5   |
| 20.         | 1½        | M   | 47.5    | 48.0  | 48.4  | 49.1  | 49.7  | 50.3  | 50.5   |
| Total       | ..        | ..  | 938.5   | 946.9 | 968.9 | 978.0 | 985.8 | 995.0 | 1014.4 |
| Mean        | ..        | ..  | 46.9    | 47.3  | 48.4  | 48.9  | 49.3  | 49.8  | 50.7   |

## APPENDIX X

A. MONTHLY ARM CIRCUMFERENCE (IN CMS) OF EXPERIMENTAL GROUP

| Sub-<br>ject<br>No. | Age<br>(yrs) | Sex | Initial | 1     | 2     | 3     | 4     | 5     | Final |
|---------------------|--------------|-----|---------|-------|-------|-------|-------|-------|-------|
| 1.                  | 2½           | M   | 12.1    | 13.2  | 13.5  | 13.8  | 14.0  | 14.3  | 14.5  |
| 2.                  | 3            | F   | 14.5    | 14.8  | 15.1  | 15.5  | 15.8  | 16.0  | 16.5  |
| 3.                  | 2            | F   | 10.5    | 11.1  | 12.5  | 13.0  | 13.7  | 14.8  | 15.2  |
| 4.                  | 2            | M   | 13.5    | 14.0  | 14.5  | 15.0  | 15.5  | 15.8  | 16.8  |
| 5.                  | 1½           | M   | 12.0    | 12.2  | 12.5  | 12.8  | 13.0  | 13.4  | 14.5  |
| 6.                  | 3            | M   | 12.5    | 13.0  | 13.6  | 14.2  | 15.0  | 15.5  | 16.0  |
| 7.                  | 2            | M   | 13.5    | 14.3  | 14.9  | 15.1  | 15.5  | 16.0  | 16.0  |
| 8.                  | 2½           | F   | 14.5    | 15.0  | 15.5  | 15.8  | 16.2  | 17.0  | 17.4  |
| 9.                  | 3            | M   | 12.0    | 12.4  | 13.0  | 13.5  | 14.4  | 15.3  | 16.0  |
| 10.                 | 2½           | M   | 12.0    | 12.4  | 12.8  | 13.2  | 13.8  | 14.4  | 15.0  |
| 11.                 | 2½           | F   | 13.5    | 14.0  | 14.5  | 14.9  | 15.2  | 15.8  | 16.2  |
| 12.                 | 2            | M   | 12.5    | 12.8  | 13.0  | 13.5  | 14.0  | 14.4  | 15.0  |
| 13.                 | 2½           | M   | 13.5    | 14.0  | 14.5  | 14.7  | 15.2  | 16.1  | 16.9  |
| 14.                 | 2½           | M   | 14.5    | 14.8  | 15.1  | 15.5  | 16.0  | 16.4  | 17.1  |
| 15.                 | 3            | F   | 13.8    | 14.4  | 15.0  | 15.5  | 16.1  | 16.8  | 17.2  |
| 16.                 | 1½           | F   | 15.0    | 15.2  | 15.5  | 15.7  | 15.9  | 16.1  | 16.9  |
| 17.                 | 3            | M   | 13.8    | 14.9  | 15.8  | 16.2  | 16.8  | 17.2  | 17.5  |
| 18.                 | 1½           | F   | 13.7    | 14.8  | 15.8  | 16.9  | 17.4  | 18.0  | 18.5  |
| 19.                 | 1½           | F   | 13.1    | 13.5  | 14.0  | 14.5  | 15.0  | 15.4  | 16.0  |
| 20.                 | 2            | F   | 13.0    | 13.5  | 13.8  | 14.3  | 14.8  | 15.6  | 16.4  |
| -----               |              |     |         |       |       |       |       |       |       |
| Total               | ..           |     | 263.5   | 274.3 | 283.9 | 293.6 | 303.3 | 314.3 | 325.6 |
| Mean                | ..           |     | 13.2    | 13.7  | 14.2  | 14.7  | 15.2  | 15.7  | 16.3  |

## APPENDIX XI

SCHEDULE FOR CLINICAL EXAMINATION

Date : \_\_\_\_\_ Age: \_\_\_\_\_  
 Name : \_\_\_\_\_ Sex: \_\_\_\_\_

## 1. General appearance

Good  
 Fair  
 Poor  
 Very Poor

## 2. Eyes

a) Conjunctiva

- i) Glistening and moist
- ii) Slightly dry on exposure for half a minute
- iii) Bitot's spot
- iv) Conjunctiva very dry

b) Pigmentation

- i) Normal colour
- ii) Slight discolouration
- iii) Moderate brown in patches
- iv) Severe discolouration

c) Discharge

- i) Absent
- ii) Watery (excessive lachrymation)
- iii) Micropurulent
- iv) Purulent

d) Xerosis of Cornea:

- i) Absent
- ii) Slight dryness
- iii) Diminished transparency
- iv) Ulceration

- e) Vascularisation of cornea:
- i) Absent
  - ii) Mild Vascularisation
  - iii) Moderate vascularisation
  - iv) Severe vascularisation

- f) Folliculosis:
- i) Absent
  - ii) A few granules
  - iii) Lids covered with extensive granules
  - iv) Hypertrophy

- g) Night blindness
- i) Absent
  - ii) Mild
  - iii) Moderate
  - iv) Severe

### 3. Mouth

- a) Condition of lips:
- i) Normal
  - ii) Angular stomatitis(mild)
  - iii) Angular stomatitis(moderate)
  - iv) Angular stomatitis (severe)

- b) Colour of tongue
- i) Normal
  - ii) Pale but not coated
  - iii) Coated
  - iv) Red and raw

- c) Condition of gums:
- i) Normal
  - ii) Bleeding
  - iii) Recession of gums
  - iv) Pyorrhoea

#### 4. Teeth

- i) Normal
- ii) Fluorosis
- iii) Chalky teeth
- iv) Mottled enamel and  
Discoloured teeth

#### 5. Hair

- i) Normal
- ii) Lack of lustre
- iii) Discoloured and dry
- iv) Sparse and brittle

#### 6. Skin      a. General appearance

- i) Normal
- ii) Loss of lustre
- iii) Dry and rough
- iv) Hyperkeratosis

#### b. Elasticity

- i) Normal
- ii) Diminished
- iii) wrinkled
- iv) Severely wrinkled

7. face

- a. Normal
- Nasolabial seberrhosa
- Symmetrical sub-orbital  
Pigmentation
- b. Oedema
- i) Absent
- ii) Present on dependant parts
- iii) Moon face
- iv) General oedema

8. Chest

- Normal
- Ricketic rosary (mild)
- Ricketic rosary (moderate)
- Ricketic rosary (severe)

9. legs

- Straight and well formed
- Knocked knee
- bowlegs (mild)
- bow legs (severe)

## 10. Frank

- signs of  
deficiency
- Kwashiorkor
- Marasmus
- Rickets
- Others (specify)