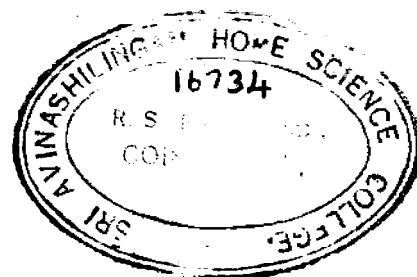


**UTILITION OF CALCIUM PHOSPHORUS AND NITROGEN
FROM JUNGLE GREENS (KALAVAI KERRAI)
BY SIX WOMAN STUDENTS**

BY

L. SANZARI



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I. INTRODUCTION

The world today faces a great crisis to feed its teeming 3000 millions. As Sen (1961)¹ reports, hunger is still a problem in many developing countries, in spite of the advances in science, technology and international aid. It has been estimated by the FAO (1962)² that hunger and malnutrition are permanent threats to nearly half the world's population. Malnutrition is the result of lack of essential nutrients in the diet. Inadequate production and utilisation of protective foods, explosion of population and low purchasing power of the people all contribute towards malnutrition.

Many dietary surveys conducted in the different parts of India by Aykroyd and Krishnan (1937)³, Aykroyd and Krishnan (1937)⁴, Aykroyd (1941)⁵ and Basu (1946)⁶ have revealed that children suffer from malnutrition resulting from deficiencies of calcium, vitamin A, riboflavin, and protein. Of these, the deficiency of calcium is strikingly due to the lack, or complete exclusion of protective foods such as milk, green leafy vegetables and eggs in the dietaries. Some rich food sources of calcium, vitamins and proteins are milk,

eggolk, and green leafy vegetables. Among the millets, ragi is the most outstanding in its calcium content. Inclusion of milk and eggolk in the daily diet is not within the economic means of a majority of people in our country, where the average per capita annual income is only Rs. 327.30 (1962)⁷. On the other hand, as Devadas (1963)⁸ points out, green leafy vegetables are within the reach of all. The easiest and inexpensive means to solve the problem of deficiencies of calcium and nitrogen, therefore, appears to be inclusion of green leafy vegetables in the daily diets. Being rich in calcium, iron and vitamins, the leafy vegetables have very high protective value. Singh and Jeehi (1960)⁹ advocate them as good sources of carotene, ascorbic acid and roughage. The high calcium content, low cost and ready availability at all seasons make green leafy vegetables an excellent source of calcium, even surpassing milk. They are a boon especially to the poor income groups.

A number of different varieties of cultivated green leafy vegetables have been analysed for their nutritive values by Basu and Ghosh (1943)¹⁰ and Aikroyd *et al* (1963)¹¹. Besides, several jungle greens grown as weeds in fallow lands have been analysed by Theophilus and Arulanandam (1949)¹². Devadas *et al* (1964)¹³ have studied the utilisation of calcium by albino rats from jungle greens. However, the availability of calcium,

phosphorus and nitrogen to the human body from these sources needs investigation. The present study was therefore undertaken to compare the utilisation of calcium, phosphorus and nitrogen from "Kalavai Keerai" which is a mixture of jungle greens and from non-fat dry milk solids, through a balance study on six women students.

II. REVIEW OF LITERATURE

Role of Calcium in the body.

Irving (1957)¹⁴ states that calcium occurs in the largest quantity in the human body, compared to all the other inorganic elements. Lampert (1947)¹⁵ estimated that 1.6 per cent of the human body is calcium. Maynard (1956)¹⁶ records that 99 per cent of the calcium in the body's present in the bones. The remaining one percent is distributed in the colloidal form in other parts, mainly the organs and tissues. Kleiner and Orten (1958)¹⁷ point out that calcium is required in the blood for physiological balance. Calcium exists in the blood in the ionized and non-ionized forms, the latter probably in combination with proteins or as a citrate complex. Wood (1950)¹⁸ reports that calcium is needed in relatively large amounts by children and young animals. Swanson (1963)¹⁹ points out that calcium is utilized to build and shape the framework of the body, namely, the bones and teeth, and impart strength and hardness to those structures. Cantrow (1946)²⁰ has shown that, calcium is responsible for the regulation of water balance, and ^{acid} base balance ✓ and the maintenance of several other processes in ^vitue of ✓

its small concentration in the body fluids.

Sherman (1956)²¹ regards calcium as a coordinator of the mineral elements present in the tissue fluids. If sodium, potassium or magnesium is in an unbalanced proportion, calcium corrects the imbalance and reestablishes normal equilibrium. Kleiner and Orten (1959)¹⁷ stress that the particular and important effect of calcium ion is upon the nervous tissue. According to Berukes (1948)²², Gilbert (1948)²³, Wilson *et al* (1961)²⁴ and West and Todd (1961)²⁵ calcium is needed for the normal rhythm of heart and excitability of other muscles. White *et al* (1959)²⁶ report that calcium activates the enzymes, lipase, succinic dehydrogenase, adenosine triphosphate and several of the proteolytic enzymes.

Effects of Deficiency of Calcium.

Nicholls (1961)²⁷ claims that insufficiency of calcium in the diet results in the subnormal development of skeleton and the consequent stunting of growth. He observed that dental caries were common among the children of labouring classes. Gilbert (1948)²³ indicates that the calcium deficiency results in carious teeth, bowed legs, small chest and other bone deformities. On the basis of his long term studies on rats, Sherman (1950)²³ reported that a high calcium intake had many beneficial effects, while its deficiency affected reproduction and

longevity. Walker (1955)²⁹ and World Health Organisation (WHO) (1962)³⁰ regard that hypocalcaemia is one of the most constant features in hyperpara-thyroidism rickets, osteomalacia, sprue, osteopathy, nephrosis, nephritis, kala azar and maternal tetany. Lutwak and Whedon (1963)³¹ state that if dietary calcium is deficient in the diet or the gastro-intestinal absorptive mechanism is defective, increased resorption from the bone takes place resulting in osteoporosis.

Factors Affecting the Calcium Retention and Absorption.

Mitchell (1937)³² stated that lactose helped in greater retention of calcium in rats, with a corresponding increase in the bone ash. A similar effect was found by Mills *et al* (1940)³³ on the calcium retention in children. Patton and Sutton (1952)³⁴ found that when calcium was supplied as lactates, gluconates, sulphates and carbonates to young college women utilization was the same in all cases. Marks *et al* (1953)³⁵ reported that glycogen appeared to be connected with the preparatory stages of inorganic salt deposition in the cartilage. Cobbs *et al* (1953)³⁶ confirmed that the bone cells showed rapid formation of the calcifiable matrix in the presence of phosphorylase and glycogen. Studying effect of milk fat on calcium metabolism, Teggs and Mitchell (1951)³⁷ indicated that milk fat diet favoured calcium absorption.

Ohlson (1955)³⁸ however found that when calcium intake was low, fat had no effect on calcium absorption in adults. Irving (1957)¹⁴ stated that the formation of an insoluble calcium soap with unabsorbed fat in the intestinal wall may interfere with the availability of calcium.

McCance *et al.* (1942)³⁹ proved that calcium absorption was dependent on protein intake. Sherman and Conner (1936)⁴⁰ found that in rats, the total body calcium was raised during growth by increasing the proteins. Desikacher and Subramanyan (1949)⁴¹, and Wasserman *et al.* (1956)⁴² noted that calcium as well as phosphorus were better utilized on a high protein diet.

Johnston (1944)⁴³ suggested that the percentage of calcium retention could be increased in girls by increasing their vitamin D intake. Hegsted *et al.* (1952)⁴⁴ reported that vitamin D₂ did not have any effect on calcium metabolism in rats, regardless of the amount of calcium in the diet. Ohlson (1955)³⁸ concluded that when an adult was receiving sufficient vitamin D₂, further addition of calcium to his diet was of no value.

Macy *et al.* (1947)⁴⁵ found that calcium retention was affected by the phosphorus intake. The best calcium retention occurred when the intakes of calcium and phosphorus were approximately equal. On the other hand, Leinshenring

et al (1951)⁴⁶, Patton et al (1953)⁴⁷ and Patton (1955)⁴⁸ indicated that at each level of calcium intake, an increase in phosphorus intake was without effect on calcium retention. When phosphorus level was kept constant an increase in calcium resulted in a significant increase in calcium balance. Experimenting on nine college women, Leimbearing (1951)⁴⁶ found that the amount of phosphorus in the diet was a factor in determining the calcium utilization. Dann et al (1956)⁴⁹ inferred that the amount of phosphorus in the diet was a factor which affected the urinary calcium to some extent and the faecal calcium to a greater extent. An increase of phosphorus above one gram level depressed both the calcium and phosphorus contents in the urine. Irving (1957)¹⁴ has shown that excess of phosphorus in the diet associated with a low dietary calcium adversely affected calcium absorption, resulting in the typical low calcium rickets. The WHO (1962)³⁰ points out that the calcium phosphorus ratio is one of the determinants in assessing calcium requirement. Holman et al (1963)⁵⁰ studied the quantitative relationship between the absorption of calcium and phosphorus and derived the formula,

$$\text{Faecal Phosphorus} : 0.5 \times \frac{\text{Faecal calcium}}{\text{Calcium} : \text{Phosphorus in diet}}$$

Irving (1957)¹⁴ states that calcium absorption is more favourable in an acid medium. McGowan (1933)⁵¹ reports

that the gastric hydrochloric acid plays an important part in calcium absorption. Subramaniam et al (1961)⁵² claim that the pH of the gastrointestinal tract influences the absorption of calcium, since, the solubility and ionisation of most calcium salts (increase with acidity). According to Irving (1957)¹⁴ Insulin increases the blood calcium level while it lowers the inorganic phosphate level. West and Todd (1951)²⁵ indicate that during menopause, many women develop negative calcium balance, because of hormonal disturbances leading to a type of osteoporosis. Such negative balances are markedly improved by the administration of the different hormones such as estrogen with estradiol, or androgen such as, testosterone. Studying the influence of the anterior pituitary gland on calcium metabolism, Krishnan (1942)⁵³ concluded that the animals treated with 'Antuitrin' Growth* retained more calcium than the controls. Pincus et al (1951)⁵⁴ reported that cortisone caused an increased excretion of calcium in the urine and faeces, whereas in normal animals, both cortisone and adrenocorticotrophic hormone did not change the blood calcium level. The parathyroid glands also control calcium metabolism, according to Irving (1957)¹⁴. Clark et al (1958)⁵⁵ report that the calcium excretion in normal adult male

* Anterior pituitary extract.

rats is affected by magnesium sulphate instantaneously, parathyroid extract after eight hours and hydrocortisone after 24 to 48 hours.

Other factors which influence the absorption of calcium are phytic acid and oxalic acid. Phytic acid which occurs as a large part of organic phosphorus of cereals, partly in free state and partly in free state as phytin, forms an insoluble salt with calcium in the intestines. McCance and Widdowson (1942)⁵⁶, Walker *et al* (1949)⁵⁷ and Callumbe *et al* (1950)⁵⁸ demonstrated that the administration of phytic acid adversely affected calcium absorption. However Ohlson (1955)⁵⁸ questions the interference of phytic acid with the absorption of calcium. He argues that if an adult's diet contains the recommended amount of calcium, phytic acid in moderate amounts, may not exert a harmful effect. Bronner *et al* (1956)⁵⁹ also noted that phytic acid did not affect the calcium absorption in boys 13 to 14 years of age.

The detrimental effects of oxalic acid on calcium metabolism have been brought out in several studies. As early as 1927 MacLaughlin (1927)⁶⁰ found that calcium in milk was absorbed better than the calcium in spinach, although spinach was high in calcium. The reasons being that it was also high in oxalic acid.

Johnston
Harrison et al (1952)⁶¹ reported that a daily consumption of 120 gram of spinach by adult women resulted ⁱⁿ an increase in faecal calcium.

Aykroyd et al (1965)¹¹ points out that certain foods are rich in calcium, most of which is present as insoluble calcium oxalate rendering the calcium unavailable to the body. Subramanyam et al (1961)⁵² state that the deterring effect of oxalic acid on calcium metabolism is counter-acted by vitamin D.

It has been established that when calcium intake is increased, the percentage of its absorption decreases. Brine and Johnston (1955)⁶² found that at an intake of 400 to 500 mg. calcium per day, 43 per cent (corrected for endogenous calcium) of calcium were absorbed, whereas at an intake of 1,099 mg. the absorption decreased to 23 per cent.

The ability of the human body to adapt to low levels of calcium intake has been observed by many workers. Walker et al (1943)⁵⁷ showed that adult subjects could adapt to low intakes of calcium and yet maintain a positive balance. In their study on Peruvian prisoners who had been on a low calcium diet Hegsted et al (1952)⁴⁴ recorded a high calcium absorption by these subjects. Murthy et al (1954)⁶³ observed that adult human beings could maintain positive calcium balance on

intakes of 400 to 500 mg.

Trends in Recommendations on Calcium Requirements.

On an appraisal of the results of the balance studies then available Sherman (1921)⁶⁴ suggested 450 mg. calcium per day per man of average weight, as the minimum requirement. Expressing the calcium requirement on the basis of body weight Steggers *et al* (1946)⁶⁵ suggested 7.0 to 7.5 mg. per kg. of body weight. Jeans (1949)⁶⁶ recommended that the goal value of calcium requirement must be 800 mg. to 1000 mg. per day per adult male. Goldsmith (1955)⁶⁷ concluded that the body adapts remarkably to the various levels of calcium intake, and the individual variations in the efficiency of utilization are great, and the allowance 800 mg. per day would be adequate. Ohlson (1955)⁶⁸ points out that after the skeleton attaining maturity, a healthy adult male would reach a state in which the calcium intake and output would be approximately equal.

The WHO (1962)³⁰ defined the minimum requirement of calcium for an adult as the smallest amount of a nutrient which will maintain health and body over a period of years, when the nutritive intake is otherwise adequate. They adapted the term "suggested practical allowance", for the majority of the population, and recommended intake of 400 to 500 mg. per day.

Aykroyd et al (1963)¹¹ recommend that the standard fixed by the Nutrition Advisory Committee of the Indian Council of Medical Research, of 1000 mg. a day is not on the higher side, if allowance is made for the fact that much of the calcium from dietaries based on cereals is apt to be unavailable because of the high phytin content.

Sources of Calcium.

Basu and Ghosh (1943)¹⁰ concluded from their experiments on albino rats and on adult humans, that calcium from cabbage (*Brassica ^{varca Capitata} Oleifera*) was as well utilised as that from milk. In the case of other vegetables, namely ladies finger (*Hibiscus Esculent*) the utilisation of calcium was much lower, while amaranth came next to milk. Subramanyan et al (1949)⁶⁸ stated that leafy vegetables contained proteins, carbohydrates, and all the other factors needed for the metabolic process. Subramanyan (1949)⁶⁸ observed that dedicated lucerne leaf was an excellent supplement to the poor rice diet on growth, reproduction and lactational performance of the rats. He further noted that when amaranth was fed with the poor rice diet as a supplement, it was useful in correcting the vitamin A, iron and calcium deficiencies of the diet. Theophilus et al (1949)¹² report that the green leaves such as Kuppamoni (*Acalypha indica*),

Mukkarratal (*Boerhavia repens*), Pacharisi keerai (*Euphorbia hirta*), Vella keerai (*Cleome viscosa*), Merringi (*Tribulus terrestris*), Saravalli keerai (*Trianthema monogyne*), Pannaku keerai (*Cerechorus acutangulus*) and Kuppa keerai (*Amaranthus viridis*) were good sources of calcium and supplemented the poor rice diet successfully to overcome the calcium deficiency in the diet. Devadas (1959)⁶⁹ has referred to amaranth, drumstick leaves, mustard leaves, spinach, and many other varieties as rich in calcium.

Singh and Joshi (1960)⁹ point out that leafy vegetables have high protective food value being rich in calcium and iron. Adish et al (1932)⁷⁰, Mallon et al (1933)⁷¹, Rao et al (1938)⁷², and Sar and Subramanyam (1952)⁷³ found that the calcium from lettuce, celery, Chinese cabbage, lucerne and kale were utilized well. Mc Carrison (1956)⁷⁴ recommends that the best way of supplying calcium to pregnant and lactating mothers, is through milk and green leafy vegetables which are good sources of calcium, a nutrient in which typical rice diets are deficient. Devadas et al (1964)¹³ state that the calcium from jungle gree (Kalavai keerai) which grew in abundance in the fields, is retained in a greater proportion than that from amaranth (*Amaranthus gangeticus*) which is most commonly used in the urban areas.

The best source of calcium for human diets is

milk or its products as stated by Ken (1959)⁷⁵, McCollum et al (1959)⁷⁶, Nicholls (1961)²⁷ and Basu (1946)⁶ suggested that the Indian dietaries without milk are extremely deficient in calcium which can be improved by supplementing them with at least 10 oss. of milk. 500 ml. of cow's milk supply 70 per cent of calcium, riboflavin, besides substantial quantities of protein calories and vitamin A required by a five year old child. Lampert (1947)¹⁵ claims that milk contains more calcium per unit of the dry matter than most other foods. Since milk is costly and not within the economic means of millions, the Central Food Technological Research Institute (C.F.T.R.I) has standardized and popularized an inexpensive substitute groundnut milk states Moorjani (1953)⁷⁷. He studied the effects of milk as a substitute to ground nut milk on rats and concluded that groundnut milk could be used in the place of milk because of the low cost.

Among the cereals, ragi is the best source of calcium, wheat coming next. Joseph et al (1959)⁷⁸ and Kurien (1961)⁷⁹ studied the partial and complete replacement of rice with ragi. They concluded that ragi was a good supplement as a source of calcium. Kurien et al (1961)⁸⁰ conducting metabolic experiments on children by replacing wheat in poor Indian diets by a blend of wheat flour and tapioca flour called 'Paustic atta' concluded that the

blend could supplement wheat in the poor Indian diet.

Methods of Assessing the Status of Calcium Nutrition

In the studies with rats and human beings for assessing calcium nutrition, the following criteria have been used widely; calcium content of bones and carcass; blood calcium levels; isotopic techniques^{and} calcium retention.

Calcium Content of Bones and Carcasses:

The quantitative determination of calcium in bones appears to have been the criteria of assessing calcium nutrition from early times. Mergulis and Gies (1914)⁸¹ determined the calcium content in bones of the rats. They dried the bones uniformly to constant weight at 100 to 110°C. Calcium was determined in duplicates by McCrudden's method in 100 ml. portions of each ash solution. In a study of experimental rickets in rats, Shipley et al (1921)⁸² split the bones longitudinally, and examined them under the microscope. McClean and Bloom (1942)⁸³, and Wood (1943)⁸⁵ examined the bone under the microscope to get a clear picture of the distribution of bone salts. Another method is the study of bone density through the use of Roentgenogram.

Blood Calcium Levels:

✓ L. V. King et al (1957)⁸⁴ report that despite ✓

variations in the diet, the level of the blood calcium of the adult male human beings remains remarkably constant. ^{Kirkpatrick and Robertson} Geoffrey (1953)⁸⁵ and Hark et al (1957)⁸⁶₁₉₄₇ opine that the level of calcium in blood is largely maintained by the action of the parathyroid glands.

Isotopic Techniques:

Sacks (1954)⁸⁷ regards that tracer studies on calcium metabolism have contributed considerably to the understanding of both the absorption and excretion of this element. Ca^{45} was first produced by Walker (1940)⁸⁸, Campbell and Greenburg (1940)⁸⁹ used Ca^{45} in a quantitative study of the fate of calcium salts administered to a rat. Harrison and Harrison (1950)⁹⁰ used $\text{Ca}^{45} \text{Cl}_2$ to study the absorption of calcium in relation to vitamin D. They studied the activity of the serum-calcium levels, two hours after the oral administration of $\text{Ca}^{45} \text{Cl}_2$. Harrison (1954)⁹¹ gave tracer Ca^{45} to rats and found that the urinary calcium varied with the amounts of calcium present in the intestines.

Calcium Balance Studies:

Sampson (1952)⁹² states that healthy full grown human beings when consuming an adequate diet maintained 'equilibrium' or 'balance' between intake and output with regard to certain elements such as nitrogen, carbon,

calcium, phosphorus, electrolytes and water. The chief feature of the balance study is the precise controlled measurement of the substance being investigated and a thorough record of food intake (all solids and liquids) and the output through (urine, faeces and sweat). According to Sherman (1945),⁹³ calcium balance has been used by many investigators as a most direct approach to determine the amounts of calcium and phosphorus required in human nutrition. Ohlson (1955)²⁷ reports that as many as 17000 balance studies have been conducted on adults of all age. Many balance studies have been conducted on children as well.

Basu and Ghosh (1934)²³ recorded that the addition of milk to rice and wheat diets had favourable effect on calcium balance. Basu and Ghosh (1937)³⁰ studied the retention of calcium from ladies finger, amaranth, drumstick leaves and cabbage in comparison with that of milk in an adult man. They found that calcium retention in the case of amaranth was almost equal to that of milk. Brown *et al.* (1948)⁹⁴ conducted calcium balance studies on obese college women and they reported that the retention of calcium, phosphorus and nitrogen was poor during the weight reduction period on a low calorie, low fat diet. Bricker *et al.* (1949)⁹⁵ studied the effect of cocoa upon the utilisation of calcium and retention of nitrogen. They concluded that no statistically significant difference was present

between the calcium balance of subjects on non-cocoa diets and non-cocoa diets. Johnson *et al* (1950)⁹⁶ studied the retention of calcium from one level of intake by six adolescent girls and concluded that variation in the amount of calcium retained by different subjects on the same intake may be due to the rate of calcification, supply of vitamin D, and the amount of glandular secretions.

Hurthy *et al* (1954)⁶³ and *et al* (1955)⁹⁷ conducted metabolic studies with reference to nitrogen, calcium and phosphorus on under nourished children. The former reported that in spite of the low intake, the subjects maintained positive balance on the basal diet, but the effect of supplementary ground nut milk increased the retention. Damm *et al* (1955)⁹⁸ conducted calcium balance studies on seven subjects aged 55 to 83 and observed that over a long period of time the calcium appears as an individual constant but smaller variations do occur with changes of intake. Glidden *et al* (1955)⁹⁹ studied the calcium utilisation of preadolescent girls and noted that an endogenous factor or factors caused irregularities in calcium balance.

Joseph *et al* (1957)¹⁰⁰ found that supplementary M P P increased the retention of nitrogen, phosphorus and calcium. Joseph *et al* (1958)¹⁰¹ compared the retention of calcium, nitrogen and phosphorus on poor

Indian diets, based on husked, under milled and milled raw rice. They noted that the retention on husked rice was the poorest.

Joseph et al (1955)¹⁰², (1959)¹⁰³ further report that children maintained positive balance when their rice diet was supplemented or replaced by ragi. From his experiments on calcium metabolism on 44 physically active adult men Baisley (1960)¹⁰⁴ concluded that calcium retention was not found to be related to height, weight body size or age, but was depressed by emotional tension. Kurien (1961)¹⁰⁵ Kurien et al (1961)¹⁰⁶ observed that in children on a Jovar diet there was a positive balance with reference to calcium, nitrogen and phosphorus. Children on a poor Indian diet based on bajra also maintained positive calcium balance though the retention was low.

Foxan et al (1965)¹⁰⁷ conducted balance studies with 25 normal full term infants fed pooled human milk. They found that the retention of calcium and phosphorus was generally greater in older infants than in the younger ones.

III EXPERIMENTAL PROCEDURE.

The experimental procedure of the study on the comparison of utilisation of calcium, phosphorus and nitrogen from jungle greens (Kalavai keerai)* and from non-fat dry milk solids, by six women students, were:

- A. Selection of the materials and subjects for the study,
- and B. A study of retention of calcium, phosphorus and nitrogen.

A. Selection of the material and subjects for the study.

The material selected for the study consisted of:

1. The jungle greens,
2. The basal and experimental diets

1. Selection of Jungle Greens

The mixture of jungle greens for this study was selected on the basis of a survey conducted in the village Kalappanayakanpalayam which is situated six miles north of Coimbatore city, in order to determine the types of jungle greens available and consumed by the rural families who constitute 70 percent of India's population according to India (1962)⁷.

*Jungle greens are edible weeds growing in fields and fallow land, called in Tamil 'Kalavai keerai' indicating it is a mixture of green leafy vegetables.

The interview method was adopted since 99 percent of the selected home-makers were illiterate and no other method would be suitable to secure information.

The data was collected by interviewing hundred selected home-makers with the help of a schedule framed for the purpose, as given in Appendix I. Numerous varieties of jungle greens were found to be growing in abundance in the fields as weeds and used in the village diets. The list of the names of these greens is given in Appendix II. The types of green leafy vegetables consumed and the frequency of their appearance in the diet of selected families is given in Table I.

TABLE I

AVERAGE PER CAPITA CONSUMPTION OF LEAFY VEGETABLES
PER DAY IN THE SELECTED FAMILIES

Leafy Vegetables.	Average per person per day in gms.	Frequency of consumption.	Number of families using.
Amaranth	13	Fortnightly	8
'Arakeerai'	50	Two times a week	32
'Murungai keerai'	40	Fortnightly	21
Jungle greens	60	Daily	7
Jungle greens	60	Two times a week	43
Jungle greens	40	Two times a week	9
Jungle greens	25	Three times a week	11

From Table I it is evident that among the green leafy vegetables used, jungle greens are used often by the selected families. Ten varieties of jungle greens which the villagers were using frequently and in adequate quantities throughout the year were selected for the study. The details of the ten varieties of jungle greens selected for the study are given in Table II.

From Table II it may be observed that the weeds selected for the study are available throughout the year samples of the ten selected greens are given in Appendix III.

2. Selection of the Basal and Experimental Diets

The basal and experimental diets were selected on the basis of the

- a) the assessment of average intake of the subjects, during normal period,
- b) the subject's food preferences and tastes,
- and c) the level of calcium and other nutrients.

a) Assessment of Average Intake:

The food intakes were computed for each subject individually for a period of seven days, by serving a weighed portion of each item of the food, and weighing the leftover. Simultaneously, an average serving of each item of the food was weighed and collected in a jar. A whole day's meal was thus collected, homogenized and brown acid digest as suggested by Stearns (1929)¹⁰⁸ was prepared. Aliquots of the digest were taken for analysis of calcium, phosphorus, nitrogen and calories, as only these nutrients were ~~relevant~~ relevant to the purpose of the study. The basal and experimental diets were then planned to supply all the nutrients in these quantities, with the difference that the basal diet was low in calcium. The analysed value of the diet is given ^{below:-} follows:-

Calories	...	2091
Protein	...	53.18 g.
Calcium	...	716 mg.
Phosphorus	...	798 mg.

Diet was also adequate in other nutrients, as compared with the recommended dietary allowances of Aykroyd et al (1963)¹¹.

b) Subjects Preference and Tastes

A questionnaire was given to the subjects in order to elicit information regarding their food likes and dislikes and preferences (Appendix IV). The replies showed that the subjects preferences were 'plain rice', 'sambar', 'chapathi', 'keetu', 'bujji', 'dosa', 'vada', 'appalam', 'payasam', 'bread', butter and jam. Care was taken to include these items in the menu whenever possible.

c) Level of Calcium and other Nutrients

The basal diet was planned to be adequate in all the nutrients except for calcium which was kept just at maintenance level and very similar to the calcium level of an average village diet at Kalappanayakan, Alayam, as given in Appendix IV being only 33 percent of the recommended allowance of calcium as prescribed by Aykroyd et al (1963)¹¹ of the maintenance level recommended by WHO (1962)³⁰.

Table III presents data regarding the composition and the calcium, phosphorus, nitrogen and calories contents of the basal diet, as only these nutrients were determined for the study.

TABLE III
COMPOSITION OF THE BASAL DIET

No.	Food stuffs	Quantity in g.	Calories	Pro. g.	Ca. mg.	P. mg.
1.	Rice (parboiled)	250	363	16.0	15	130
2.	Wheat flour (white soft variety)	100	358	12.0	22	30.0
3.	Red gram dhal	30	119	3.4	24	19.0
4.	Black gram dhal	10	39	3.7	17	4.9
5.	Bengal gram dhal flour	50	136	11.4	20	20.0
6.	Cabbage	50	14	0.9	20	3.5
7.	Potato	50	49	0.8	5	18.5
8.	Tomato	100	21	1.0	48	....
9.	Onion (small)	25	15	0.5	3	2.0
10.	Appalam	10	29	2.9	6	12.0
11.	Gingely oil	30	270	....	...	....
12.	White sugar	40	160	....	...	....
13.	Carrot	10	5	0.1	8	....
14.	Non-fat dry milk solids	5	18	2.9	47	....
15.	Banana (ordinary)	50	52	0.5	5	7.0
Total - calculated value		....	2157	61.1	240	246.9
Analysed value			2038	65.2	217.3	345.9

It is evident from Table III that diet supplies calcium of 217 mg. which is according to the level adopted by Patton *et al.* (1955)⁴⁷ for balance studies. Menu for a week is given in Appendix V.

Experimental Diet with Jungle Greens:

As for the experimental diet, the basal diet was modified by incorporating in the day's diet, 100 grams of jungle greens furnishing 480 milligrams of calcium, into two 50 gram portion, for lunch and dinner. Ten varieties of greens were in equal quantities of 10 g./100g. of mixture. The greens were served as 'kootu' and 'masial' which are two common preparations in the rural area. In order to maintain the basal and experimental diet 'iso-calorie', 50 grams of banana fruit, and coconut 5 grams were reduced from the basal diet. Typical lunches - shown in Figures 1 and 2.

Experimental Diet with Non-fat Dry Milk Solids:

As milk is the best source of calcium it was selected for comparison with jungle greens. Non-fat dry milk solids have the same quality of calcium as whole milk. The basal diet was thus modified to the experimental diets by incorporating 35 grams of non-fat dry milk solid as payasam at lunch, and as curds at lunch and dinner time. To render the diet iso-calorie, rice-10 grams, banana fruit-50 grams, sugar-5 grams, and coconut-5 grams were reduced. Nutritive values of the basal and two experimental diets are given in Table IV.

TABLE IV
NUTRITIVE VALUE OF THE BASAL AND EXPERIMENTAL DIETS

Nutrients	Basal diet	Experimental diet with jungle greens.	Experimental diet with non- fat dry milk solid.
Calories	2098	2104	2109
Protein g.	65.17	63.63	74.2
Calcium mg.	217.3	702.9	704.6
Phosphorus mg.	345.9	1055.0	815.7
Iron mg.	13.1	12.1	17.35
Vitamin A. I.U.	2544	5644	2544
Vitamin B ₁ g.	1.21	1.21	1.16
Vitamin B ₂ mg.	.97	.96	.97
Vitamin C. mg.	153	152	153

From table IV it is evident that the basal and experimental diets supply all the nutrients in adequate quantities.

3.2. Selection of the Subjects:

Six women students in the age range of 19 to 21 years, were selected for this study on the basis of their willingness, anthropometric measurements, biochemical and clinical tests and integrity, reliability and ability to cooperate.

Only those who were enthusiastic about the experiment willing to undergo the discipline, and obtained written permission from their parents or guardians were included.

The heights and weights of all the students who offered themselves for the experiment in the age group of 19 to 21 years were noted to the nearest decimeter and tenth of kilo gram as per Davidson and Passmore (1963)¹⁰⁹. The means and standard deviations were calculated for the heights and weights, and those who were within the ranges of 47.7 ± 1.9 kg. for weights and within 155.6 ± 3.5 centimeters for heights were selected. The age heights and weights of the subjects who were designated as A, B, C, D, E and F are presented in Table V.

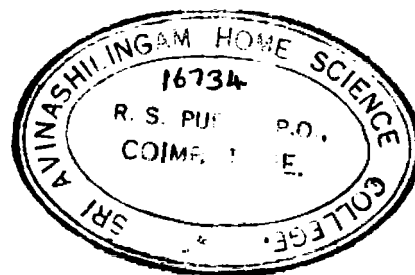
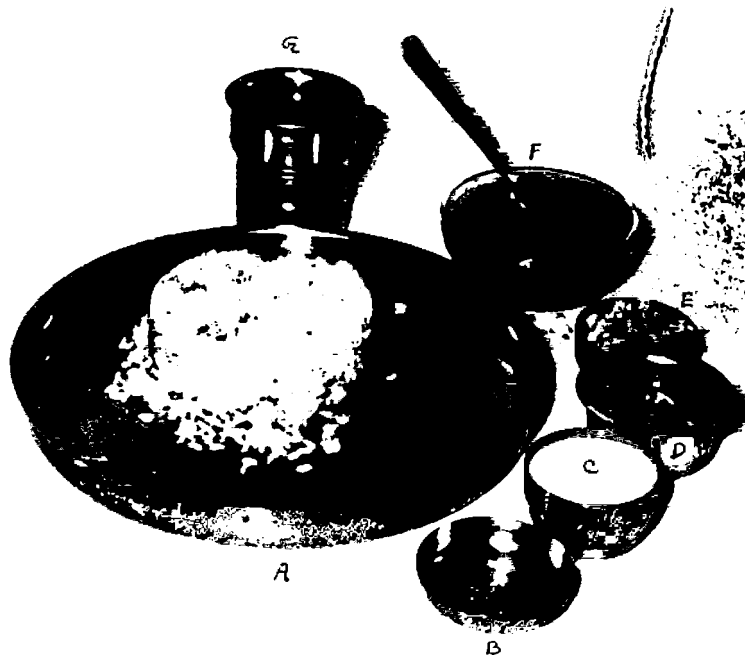
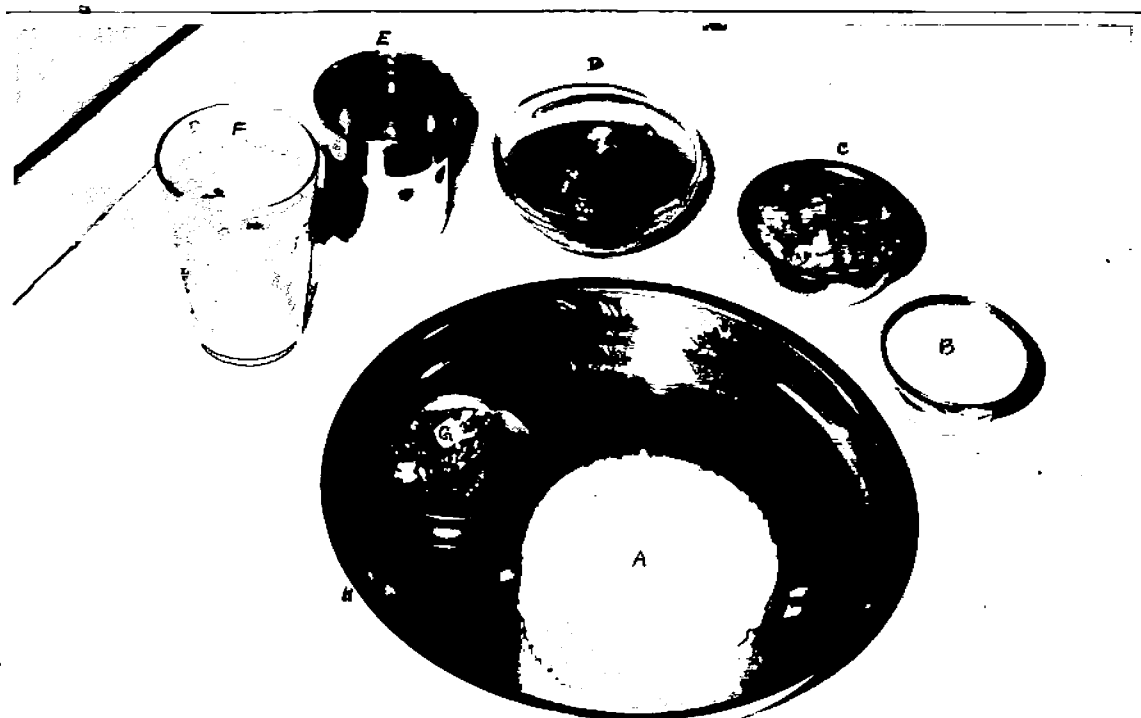


FIGURE 1
 A TYPICAL LUNCH OF EXPERIMENTAL DIET WITH
 JUNGLE GREENS AS SERVED TO A SUBJECT.



A	.....	RICE
B	.....	PICKLE
C	.....	BUTTERMILK
D	.....	VASEEL
E	.....	PORIYAL
F	.....	KOOTU
G	.....	WATER

FIGURE 2..
 A TYPICAL LUNCH OF THE EXPERIMENTAL DIET WITH
 NON-FAT DRY MILK SOLID AS SERVED
 TO A SUBJECT.



A	....	RICE
B	....	CURDS
C	....	FORIYAL
D	....	SAMBAR
E	....	WATER
F	....	TA YA SAM
G	....	SALAD
H	....	PICKLE

TABLE V

AGE, HEIGHT AND WEIGHT OF THE SIX SELECTED SUBJECTS

Subjects.		Age in Yrs. Months.		Height cms.	Weight kg.
A	..	20	2	155.2	43.7
B	..	20	7	153.5	44.8
C	..	20	3	156.5	46.8
D	..	20	5	155.9	46.9
E	..	19	9	154.5	47.4
F	..	20	1	156.5	49.4

From the data presented in Table V it is evident that the age levels of the subjects were consistent, the maximum difference being only nine between the oldest and the youngest. All the subjects were residents in College Hostel.

As Martin (1954)¹¹⁰ states biochemical tests are helpful means of assessing the nutritional status of people. In this study the blood picture of the subjects was studied through the haemoglobin estimation, red blood cell count and differential leucocytes Count according to the methods described by Hutchison (1955)¹¹¹. The haemoglobin was estimated in Sahli's haemoglobinometer and expressed in grams per cubic millimeter of blood. The Red Blood Cells were counted under the Neubauer ruling

scale and was expressed as millions per cubic millimeter of blood. The differential leucocyte count was calculated by Leishman's Stain Method. The results of the biochemical tests conducted on the blood of the subjects are presented in Table VI.

TABLE VI

THE BLOOD PICTURE OF THE SIX SELECTED SUBJECTS.

Subjects	Red Blood cell in million	Haemo- globin per- centage	DLC				
			Neutro phils	Baso phils	Eosino- phils	Lympho- cytes	Mono- cytes
A	4.8	103.5	69	0	3	26	2
B	4.8	100.5	65	2	2	28	3
C	4.8	102.2	69	2	3	25	2
D	4.8	101.5	65	0	3	28	4
E	4.8	101.5	67	1	2	26	3
F	4.8	103.0	65	2	3	30	2

The blood picture shown by Table VI assured that the subjects were all in uniform, normal health.

Through clinical tests conducted by a physician who is the professor of physiology in the faculty, the subjects were declared normal with reference to for ear, nose and throat conditions, blood pressure, pulse rate, respirative rate, digestive excretory system and nervous system.

B. Study of the Retention of Calcium, Phosphorus and Nitrogen:

The procedure of conducting the balance experiments was as follows:

1. Designing the experiment,
2. Preparation for the study,
3. Collection and preservation of the samples,
- and
4. Analysis of the samples for calcium, phosphorus, nitrogen and calories.

1. Designing the Experiment:

The experiment was designed to be conducted in four stages, during a continuous four weeks period, each phase lasting a week as specified below:

- Phase 1: Basal diet designated as B1,
 Phase 2: Experimental diet with jungle greens (E1),
 Phase 3: Basal diet (B2),
 and
 Phase 4: Experimental diet with non-fat dry milk solids (E2).

In each phase, the first two days constituted the adjustment period and the next five days collection period.

2. Preparation for the Study:

Details of the procedures to be followed in eating and collecting excreta, and the precautions to be taken were explained to the subjects. The time chosen for the study was such that they did not have any examination, as metabolic processes might be affected by emotional stress. They were given preliminary training collection of urine and faeces

for two days to understand the procedure and develop self-confidence. The rapport established between the subjects and investigator was such that the subjects fully cooperated.

The subjects were comfortably accommodated with easy access to the place of cooking and dining - Figure 3. Two well-ventilated bedrooms were provided with attached bath rooms and lavatory, to facilitate the collection of urine and faeces for the experiment.

Purchase of food-stuffs:

The entire quantity of non-perishable foods required by six subjects, for four weeks, and the amount of food needed for analysis, was bought in one lot and stored. Parboiled rice, wheat flour (white soft variety), red gram dhal, dry peas, gingelly oil, salt, condiments and spices, potato, and colacasia, were bought one week before the commencement of the experiment, cleaned, dried and stored in clean containers. The quantities purchased, and the cost are given in Appendix VI.

The perishable items of food such as cauliflower, cabbage, ash gourd and lime were bought once in a week and stored in a refrigerator. The tomatoes were bought daily from the college garden. Biscuits and bread were baked from the same lot of flour, jam, mango pickle, 'appalam' and 'vadam' were prepared in bulk prior to the commencement of experiment, to be used throughout the study. Jungle greens

FIGURE 3

THE SUBJECTS ON EXPERIMENTAL DIET
WITH JUNGLE GREENS.



IV CHAPTER

RESULTS AND DISCUSSION

The results of the study on the comparison of the utilisation of calcium, phosphorus and nitrogen from jungle greens (Kalavai keerai) and from non-fat dry milk solids, by six college women students are presented and discussed under the following headings:

- A. Nitrogen,
- B. Calcium,
- and C. Phosphorus.

A. Nitrogen:

Table V gives the mean retention of nitrogen by the six subjects during the four weeks of the experimentation on the basal (B_1 and B_2) and experimental (E_1 and E_2) diets and in Table VI are presented the statistical analysis of the data.

TABLE VII

THE MEAN NITROGEN RETENTION ON THE BASAL AND EXPERIMENTAL DIETS BY THE SIX SELECTED SUBJECTS:

Diet	Calories Intake	Nitrogen g/day			Retention	percentage		
		Intake	Urinary	Faecal			Total	
B ₁	2093	10.43	4.86	3.57	3.43	2.00	19.2 ± .06	✓
B ₂	2104	10.98	5.02	3.67	3.69	2.29	20.8 ± 2.4	✓
E ₁	2099	10.42	5.21	3.51	3.72	1.70	16.7 ± 1.5	✓
E ₂	2109	12.05	5.21	3.76	8.37	3.06	25.4 ± 5.4	✓

TABLE VIII

ANALYSIS OF VARIANCE FOR THE RETENTION OF NITROGEN BY SIX SELECTED SUBJECTS ON BASAL AND EXPERIMENTAL DIETS

Diet	Between	F. Ratio	Standard error	Significant level
B ₁ -B ₂		2.8	.57	Not significant
B ₁ -E ₁		59.82	.19	1 % level
B ₂ -E ₂		93.49	.37	1 % level
E ₁ -E ₂		22.62 22.62	.40	1 % level

†† on page 41 (para. 2)

It is evident from Tables V//and VI//the retentions of nitrogen on both the experimental diets over the basal diet were higher and the increase of retention statistically significant at one percent level. The increase in the retention of nitrogen on the E₂ diet over that of the E₁ diet was also statistically significant at one percent level. This may be attributed to the higher and better quality the non-fat dry milk solids. The retention of nitrogen by individual subjects on basal and experimental diets are given in Appendix XV and the method of statistical analysis is given in Appendix XVI.

→F Ratio according to Snedecor (1956) is a ratio of the variances (or mean square) between the experimental variances and within replicates. If α , the probability of its occurrence by chance is less than .01., the difference obtained in the experiment as whole are very significant.

B. Calcium:

The data on calcium retention by the six subjects while on the basal and the two experimental diets are presented in Table VII and their statistical analysis in Table VIII. ✓

TABLE VII X

THE MEAN CALCIUM RETENTION ON THE BASAL AND EXPERIMENTAL DIETS BY THE SIX SELECTED SUBJECTS.

Diet	Calories Intake	mg.in- take	Calcium Urinary	per day Faecal	Total	Re- tention	Per- cent- age reten- tion
B ₁	2098	217.8	55.1	160.1	215.2	2.6	1.2 ± .14
B ₂	2104	702.9	104.0	291.9	395.9	307.0	43.66 ± 3.4
E ₁	2099	217.6	53.7	156.7	210.4	7.19	3.3 ± .16
E ₂	2109	704.6	87.9	221.2	308.7	396.1	56.2 ± 2.54

TABLE VIII X

ANALYSIS OF VARIANCES FOR THE RETENTION OF CALCIUM BY THE SIX SELECTED SUBJECTS ON THE BASAL AND EXPERIMENTAL DIETS.

Diets	F.Ratio	Standard error	Significant level
B ₁ = B ₂	3.5	5.95	not significant
B ₁ = E ₁	1219.0	30.73	1 % level
B ₂ = E ₂	3600.0	13.31	1 % level
E ₁ = E ₂	3.3	29.9	5 % level

It can be observed from Table ~~XIX~~^{XIX} and Figure ~~4~~⁴ that mean calcium retention was in positive balance on the basal diet (B₁), in which the calcium content of the diet was just sufficient for maintenance, that is, 217.8 mg. per day. However individually, subjects B was in negative balance of -0.92 percent and C of -0.03 percent as shown in Appendix XVII and details of statistical analysis in Appendix XVIII.

During the experimental period with jungle greens the mean calcium retention for the six subjects was 43.46 percent. The mean calcium retention for the subjects during the experimental period with the non-fat dry milk solids was 56.1² percent. Comparing the retention of calcium while on the two experimental diets, the retention of calcium from jungle greens was 77.2 percent as that of milk, which is of superior utilisability in calcium.

From Table ~~XIX~~^{XIX} it is evident that the difference in the retention of calcium, on two basal diets were not statistically significant, thereby indicating that the responses of the subjects remained consistent towards the same diets, during the different intervals. This may be due to the positive state of health, adjustability, co-operation and understanding of the subjects, as well as the homogeneity of the group with reference to age, height and weight.

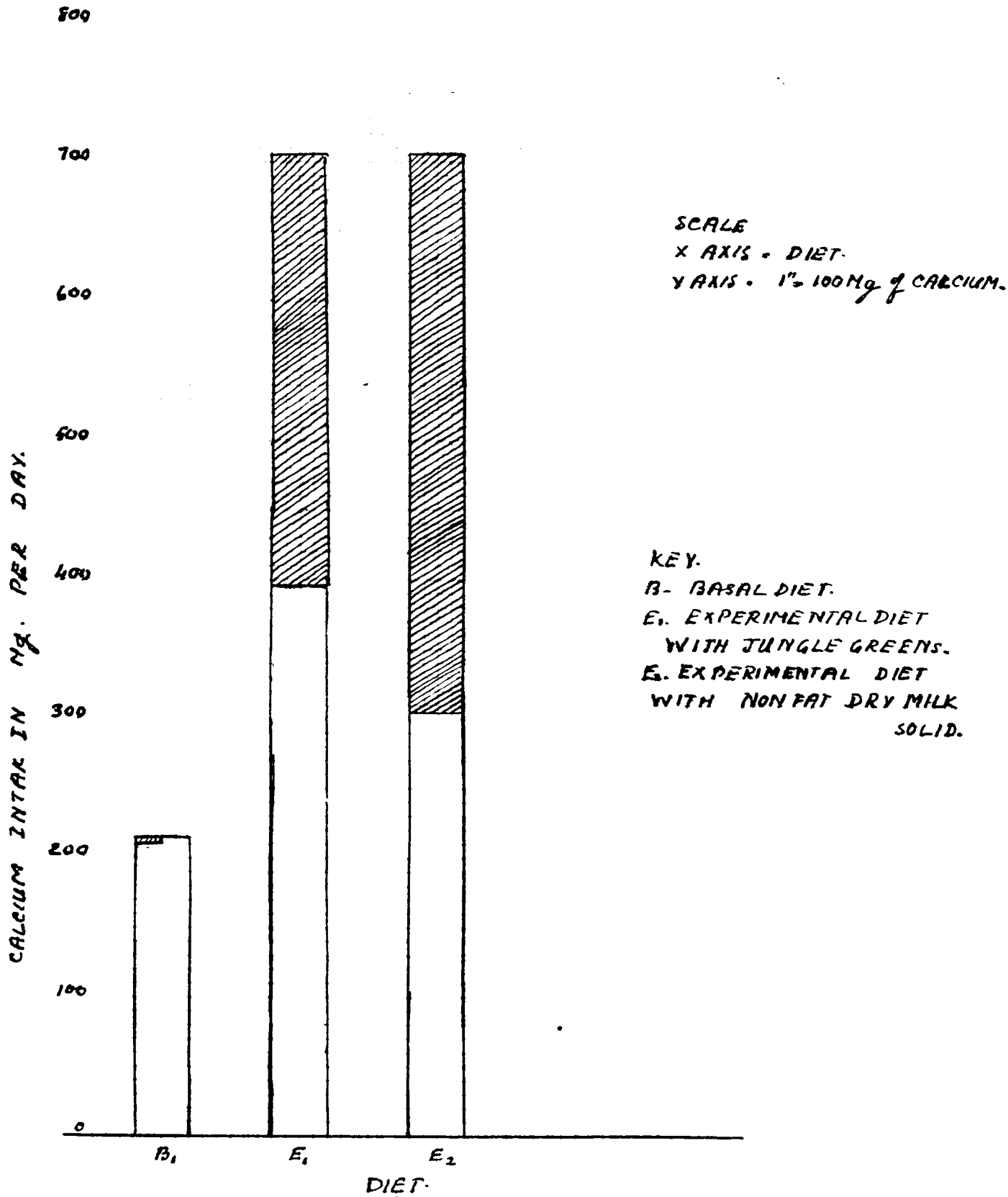


FIGURE 4.

THE MEAN CALCIUM RETENTION OF THE SUBJECTS ON BASAL AND EXPERIMENTAL DIET.

Digestibility Co-efficient:

For the six selected subjects, Table IX presents the Digestibility co-efficient of the calcium from the basal and experimental diets. Table X presents the data regarding the digestibility co-efficient of calcium statistically treated for significance. The digestibility co-efficient of calcium for individual subjects is given in Appendix XII and XI.

TABLE IX

THE MEAN DIGESTIBILITY CO-EFFICIENT OF CALCIUM BY THE SIX SELECTED SUBJECTS ON THE EXPERIMENTAL AND BASAL DIETS.

Diet	Intake MG.	Faecal excretion MG.	Digestibility co-efficient	Standard Deviation.
B ₁	217.8	156.1	28.4	± 1.7
E ₁	702.9	291.9	58.4	± 2.2
B ₂	217.6	156.7	27.6	± 1.8
E ₂	704.6	221.2	68.6	± 5.5

TABLE XII
ANALYSIS OF VARIANCE FOR THE DIGESTIBILITY CO-EFFICIENT OF
CALCIUM OF THE SIX SELECTED SUBJECTS ON BASAL EXPERIMENTAL DIETS.

Diets Between	F.Ratio	Standard error	Significant level
$B_1 - B_2$	4.52	.2	Not significant
$E_1 - E_1$	101.5	.18	1% level
$E_1 - E_2$	65.05	.17	1% level
$B_2 - E_2$	386.3	.28	1% level

From Table IX, it is evident, that the Digestibility co-efficient was highest, that is, 68.6 percent, on the experimental diet with non-fat dry milk solids. The experimental diet with jungle greens comes next with 58.8 percent. Digestibility co-efficient of Calcium from E1 was 86.04 percent as that of E2. Thus, jungle greens compare very well with the best source of calcium namely, non-fat dry milk solid. Details of calculation in Appendix XIX

It is evident from Table XI that the difference between the digestibility co-efficient of basal and experimental diets are significant beyond one percent level. Statistically the digestibility co-efficient of both experimental diets are higher than the basal diet. Figure 5 illustrates the mean digestibility co-efficient of calcium of the six selected subjects on the basal and experimental diets.

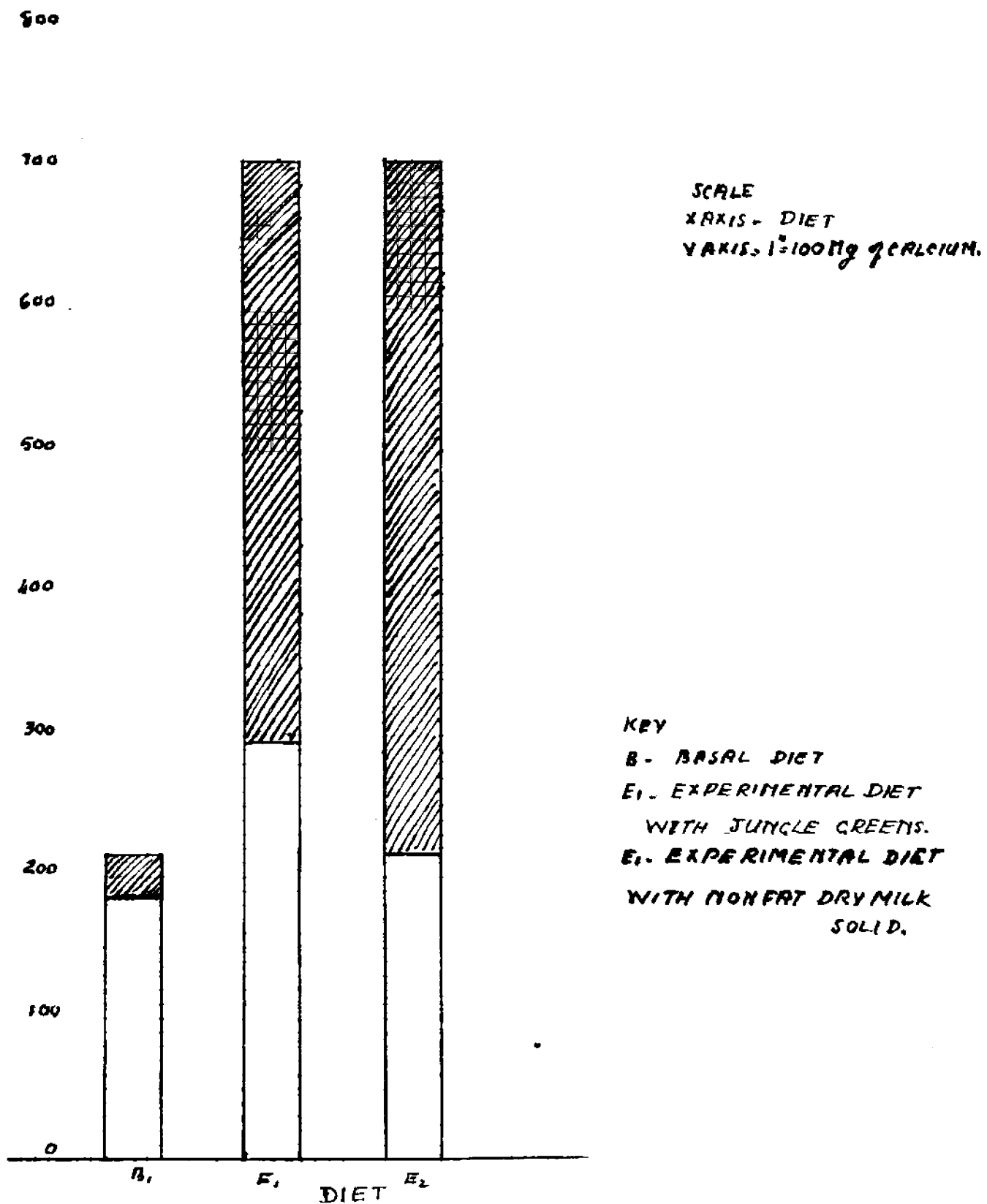


FIGURE 5

THE MEAN DIGESTIBILITY COEFFICIENT OF CALCIUM RETENTION OF THE SIX SUBJECTS ON BASAL AND EXPERIMENTAL DIET.

It may be noted that the mean calcium retention of the six subjects on the experimental diet with jungle greens was 43.4 per cent with the nitrogen intake of 10.98 g. per day. The calcium retention on experimental diet with non-fat dry milk solid was 56.39 per cent when the nitrogen intake per day was 12.03 g. Thus calcium retention appeared to increase with an increase in the nitrogen intake. This finding is in accordance with the observation of McCance *et al* (1942)³⁹.

Table XII presents the data on the analysis of oxalic acid content of the basal and experimental diets and the calcium retention.

TABLE XII

ANALYSIS OF THE OXALIC ACID CONTENT AND THE MEAN CALCIUM RETENTION ON BASAL AND EXPERIMENTAL DIETS BY THE SIX SELECTED SUBJECTS.

Diets	Oxalic acid mg.	Calcium intake mg.	Retention per cent.
B ₁	117.5	217.3	2.3
E ₁	302.7	702.9	43.65 ⁶⁶ ✓
B ₂	117.5	217.6	2.4
E ₂	117.7	704.6	56.39 ✓

5212
1942
10.6.3

From Table XIV it is seen evident that the oxalate content of the diet E_1 with jungle greens was the highest more than seven-hundred^{785 mgs.} higher than that of E_2 diet, and yet the calcium retention is 77.13 per cent as much as calcium from non-fat dry milk solid diet. If this oxalic acid had been neutralized by an organic acid or any other means, the calcium retention would be as much as that from non-fat dry milk solids or even higher.

Table XIV presents the relationship between the ratio of calcium to phosphorus and the calcium retention on the basal and experimental diets by the six selected subjects.

TABLE XIV

THE CALCIUM AND PHOSPHORUS RATIO AND THE CALCIUM RETENTION ON THE BASAL AND EXPERIMENTAL DIETS.

Diet	Calcium Intake	Phosphorus Intake	Ca/P	Calcium Retention%
B_1	217.9	345.9	1/1.5	2.3
E_1	702.9	1055	1/1.5	43.68
B_2	217.6	345.7	1/1.5	2.4
E_2	704.6	815.7	1/1.2	56.80

It is seen from Table XIV that the best calcium retention occurred on experimental diet with non-fat dry milk solids when the calcium phosphorus ratio was almost one. These findings were in accordance with the

observation of ^{Macy et al (1944)⁴⁵} ~~Lehmann~~ that the best retention of calcium occurs on diets containing approximately, equal amounts of calcium and phosphorus.

~~Cost:~~ On comparing the calcium retention from jungle greens with non-fat dry milk solids, the following facts are evident. The jungle greens grow wild in the fields and are available free in plenty. Table XIII gives the cost of jungle greens and non-fat dry milk solids supplying 480 mg. of calcium.

TABLE XIII V

COMPARISON OF THE COST OF JUNGLE GREENS AND NON-FAT DRY MILK SOLID BOTH SUPPLYING THE SAME QUANTITY OF CALCIUM.

Source	Intake g.	Calcium		Cost per Kilo gram urban	Rural
		content g.	Utilisation mg.		
Jungle Greens	100	480	307	15	NIL
Non-fat dry milk solid	55	480	330	7.70	Not available

Considering the percentage of calcium utilization as shown in the table the ratio of utilization with that of cost for jungle greens and non-fat dry milk solid is 1: 16.

C. Phosphorus.

Table XIV and XV present the data regarding the phosphorus balance of the subjects during the four weeks of the study. Table XV presents the data regarding the retention of phosphorus statistically treated for significance.

TABLE XIV

THE MEAN PHOSPHORUS RETENTION ON THE BASAL AND EXPERIMENTAL DIETS BY THE SIX SELECTED SUBJECTS.

Diet	Calories Intake	Phosphorus mg. per day			Retention	Percentage retention.
		Intake	Excretion urinary	Excretion Faecal		
B ₁	2098	345.9	134.5	162.3	296.8	43.1 ± 3.7
B ₁	2104	1055.0	356.4	487.9	944.3	210.7 ± 4.5
B ₂	2093	345.7	130.3	169.2	239.5	46.2 ± 4.3
B ₂	2109	315.7	310.4	373.6	694.0	131.7 ± 7.8

TABLE IV (1)

ANALYSIS OF VARIANCE FOR THE RETENTION OF PHOSPHORUS BY
THE SIX SELECTED SUBJECTS.

Diets	F. Ratio	Standard error	Significant level
$E_1 = E_2$	.92	.89	Not significant
$E_1 = E_1$	9.2	4.21	5% level
$E_2 = E_2$	42.1	7.5	1% level
$E_1 = E_2$	9.631	9.83	Not significant

Phosphorus retention is high in the diet supplemented with Jungle greens may be due to the high phosphorus content. Details of calculation are given in Appendix XII and XIII.

In the beginning of the experiment the subjects consciously restrained themselves that they were not allowed to eat between meals but soon adjusted well and refused eatables offered by friends however attractive. During the first adjustment period, some extra effort had to be extended for the collection of excreta, but later, they got used to the procedure and timings.

V. SUMMARY AND CONCLUSION

The utilization of calcium, phosphorus and nitrogen, from a mixture of ten varieties of jungle greens, by six college students as compared with the utilization from non-fat dry milk solids, was studied through a balance study of four weeks duration:

The subjects were placed:

During the first week on a basal diet supplying 217 milligrams of calcium and otherwise adequate in all other nutrients;

During the second week, on the basal diet supplemented with 100 grams of jungle greens supplying 490 milligrams of calcium;

During the third week, on basal diet again,

and During the fourth week, on the basal diet supplemented with 35 g. of non-fat dry milk solid supplying 490 milligram of calcium.

The findings of the study were:

The retention of calcium from jungle greens was 43.6 percent being 77.5 percent of the retention as non fat dry milk solid. In spite of its high oxalic acid content of 585 milligram percent.

The digestibility co-efficient of jungle greens was 85 percent as that of non fat dry milk solid.

In virtue of the high calcium content, percentage of retention, digestibility coefficient, availability throughout the year, low cost and acceptability it is concluded that jungle greens is a rich source of calcium and deserves an important place in the Indian dietary.

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APPENDIX VII

QUANTITIES AND THE COST OF PURCHASE

		Rs. NP.
1. Rice	70 litres	42 00
2. wheat flour	115 kg.	7 19
3. Bawal	3.5 kg.	2 19
4. Redgram dhal	6 litres	6 00
5. Black gram dhal	5 litres	3 00
6. Dry peas	2 litres	1 25
7. Bengal gram (whole)	2 litres	1 25
8. Bengal gram flour	3.5 kg	3 06
9. potatoes	11.5 kg	10 12
10. Colacasia	1 kg	0 75
11. Onions	2 kg	0 75
12. Salt	3 litres	0 18
13. Mustard	$\frac{1}{2}$ litre	0 50
14. Chilly powder	$\frac{1}{2}$ k.	1.75
15. Gingelly oil	1.25 litres	3.25
16. Sugar	5.75 kg.	3.38
17. Coffee powder	500 gm.	3.00

APPENDIX VI (1)

RECIPES USED FOR COOKING: COOKING

a. Recipe for Cooking Rice:

No. of servings	3
Cooking time	30 minutes.
Ingredients	Amount
Rice	24 gms.
Water	$\frac{1}{2}$ litre.

Method:

1. Measure and clean the rice.
2. Add the measured rice to the boiling water.
3. Cook over slow heat until water is absorbed.
4. Note the time of cooking.

b. Preparation of butter milk:

Ingredients	Amount
Curds	$\frac{1}{2}$ litre
Curry leaves	a few
Salt	a pinch
Water	$\frac{1}{2}$ litre.

Method:

1. Churn the curds with 2 cups of water and a pinch of salt.
2. Add curry leaves.
3. Serve cold.

C. Recipe for ~~Drumstick~~ Drumstick ~~sambhar~~ sambhar:

No. of servings .. 4

<u>Ingredients</u>	<u>Amount</u> <u>grams</u>	<u>Ingredients</u>	<u>Amount</u> <u>grams</u>
Drumstick	30	Turmeric powder	5
Salt	15	Red gram dhal	60
Chillies powder	20	Onion	30
Green chillies	10	Tamarind	30
Fenugreek seeds	5	Chillies	Two
Blackgram dhal	5	Mustard	5
Curry leaves	a few	Asafoetida	a pinch

Method: Wash the vegetables and cut them into long pieces of length of about 1½". Add the cut vegetables, chopped onion, chillies, chilli powder, salt and turmeric powder and 1 tea spoon of oil. Add the cooked dhal to the drumstick water mixture and boil it for 5 minutes. Extract the juice from the tamarind adding 1 cup of water. Add the tamarind juice to the dhal, vegetable mixture and boil for 5 minutes. Season with mustard, blackgram dhal, dry chillies and curry leaves. Roast fenugreek seeds and asafoetida and powder them. Sprinkle the powder just before removing from the fire and serve hot.

4. Recipe for Sundal:

No. of serving .. 2 ✓
Time taken for cooking 30 minutes.

<u>Ingredients</u>	<u>Amount</u>
Dry peas <i>peas</i>	100 g. ✓
Oil	15 g.
blackgram <i>blackgram</i>	10 g.
Mustard	5 g.
Dry chillies	10 g.
Water	½ litre
Salt	10 g.
Cocoanut scrapings	10 g.

Methods

Soak the ~~dry peas~~ *peas* in water for 24 hours. ✓
Wash it and cook till it is soft. Cut the chillies into slices. Heat the oil and add mustard, blackgram dhal. When the dhal becomes brown, add the cut chillies and fry for one minute. Add the cooked gram. Mix well and keep it on the fire for one minute. Remove from the fire and add coconut scrapings.

e. Recipe for green gram dhal payasam:

No: of servings .. 4 ✓
 Time taken .. 30 minutes.

<u>Ingredients</u>	<u>Amount</u> g.	<u>Ingredients</u>	<u>Amount</u> g.
Greengram dhal	60	Cashewnuts	30
Cardamoms	4	Water	$\frac{3}{4}$ litre
Milk	$\frac{1}{2}$ litre.	Cloves	4
Sugar	60	Ghee	10

Method:

1. Fry greengram dhal in ghee till the colour is golden brown.
2. Boil the water and add the green gram dhal to it.
3. Cook till very soft.
4. Add sugar and when it has dissolved and melts bring to boiling.
5. Fry cloves and powder with cardamoms. Fry cashewnuts.
6. Add all condiments and serve it.

f. Recipe for Dosai:

No. of servings	3
Time taken	40 minutes

<u>Ingredients</u>	<u>Amount</u>
Parboiled rice	250 g.
Blackgram dhal	60 g.
Fenugreek seeds	10 g.
Salt	10 g.

Method:

1. Wash, clean and soak for 4 to 6 hours, the rice and the dhal
2. Grind dhal to a light fluffy consistency.
3. Add fenugreek seeds to the rice and grind to a fairly smooth paste.
4. Mix together with salt and cover and set aside overnight to ferment.
5. Next morning the flour well and add water (if it is necessary) to bring the mixture to a 'pour batter' consistency.
6. Place the Dosaikkal on the fire.
7. When hot, pour one large laddle full of mixture with the back of the laddle spread the batter starting at the centre and spreading it with circular motion.

8. Add the oil.
9. When the upper surface is full of air spaces slightly dry, turn and cook a little longer.
10. Grease the pan often to prevent the sticking and burning of dough.

8. Recipe for Bajji:

No. of servings .. 1
 Time taken .. 20 minutes.

<u>Ingredients</u>	<u>Amount</u>
Brinjal	60 g.
Salt	5 g.
Turmeric powder	5 g.
Bengalgram flour	30 g.
Rice flour	10 g.
Soda Bi-carbonate	1 g.
Oil	$\frac{1}{2}$ litre.

Method:

1. Cut the Brinjal into $\frac{1}{8}$ " thick slices.
2. Rub over the pieces with salt and turmeric powder.
3. Prepare a bath with flour adding chillies powder and soda.
4. Add sufficient water to make a thick 'pour better'.

APPENDIX IX

COLLECTION AND PRESERVATION OF FAECES.

Equipment needed: Gelatin Capsule number 0, tightly packed with "Carmines", three grains, polythene bags and commodes. One carton per day, one per each of the bowel movement.

From the first appearance of carmine up to but not inclusive of those coloured by second capsule. From the faeces collected collected on the first day, separate and discount those part which preceeded the carmine. During the collection period the samples may be rinsed with water from the banks into a wide mouth Erlenmeyer flask containing hydrochloric acid so that the final concentration of the acid is cent per cent, keep the flask covered in the refrigerator until the collection is completed.

APPENDIX X//

DETERMINATION OF PHOSPHORUS

FISKE AND SUBBAROW METHOD

Principle: Phosphate reacts with molybdic acid to form phosphomolybdic acid. On treatment with 1, 2, 4 aminonaphthol sulfonic acid, phosphomolybdic acid is selectively reduced, to produce a deep blue colour (molybdenum blue) which is probably a mixture of lower oxides of molybdenum. This colour is then compared in a calorimeter or photometer with that obtained from a suitable standard phosphate solution.

Procedure: Measure into a 100 ml. volumetric flask enough urine to contain between 0.2 and 0.8 mg. of inorganic phosphorus (usually 1 or 2 ml.). Add water to bring the volume to about 70 ml., followed by 10 ml. of molybdate I reagent. Mix by gentle shaking and add 4 ml. of aminonaphthol sulfonic acid reagent. Again, mix, dilute to mark with water, mix several times by inversion and allow to stand for five minutes.