NUTRITIVE VALUE OF SOME UNCOMMON GREENS AND THEIR ACCEPTABILITY

THESIS SUBMITTED TO THE
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BY
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C E R T I F I C A T E

This is to certify that the thesis entitled "NUTRITIVE VALUE OF SOME UNCOMMON LEAVES AND THEIR ACCEPTABILITY" submitted for the Degree of MASTER OF SCIENCE in Home Science of Andhra Pradesh Agricultural University, is a result of bonafide research work carried out by Miss SHEELA UDPA under my supervision and that the thesis has not formed in whole or in part the basis for the award of any degree, diploma or similar distinction.

The assistance and help received during the course of the investigation have been fully acknowledged.

K. Chittemma Rao. 6/5/72

(K. CHITTEMMA RAO)
Major Advisor.

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INTRODUCTION

INTRODUCTION

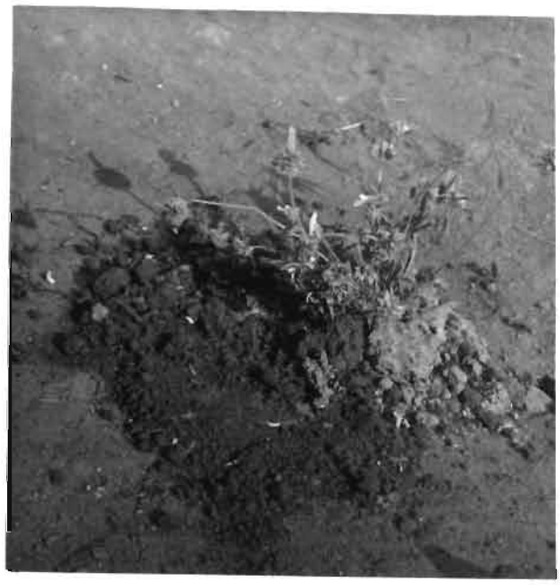
A large number of green leaves are edible. It is a fact, that leaves which are considered as edible in some parts of the country are not known to be so in other parts. Moreover, in the same area, there are some uncommon leaves that are consumed by few, but are not even known to be edible to a major section of the population.

Nutritive values of many uncommon leaves have been determined, but there are still some more rare edible leaves which need to be analysed.

The leafy vegetables are the most inexpensive among the protective foods and are easily available. The poorer sections of the population therefore, are generally the predominant consumers of the locally available greens. These are mostly weeds grown in and around the fields or which grow wildly in the area. These are collected by the agricultural workers while returning home after the day's work and are consumed in the form of chutneys and curries. In order that such edible greens are not allowed to remain wasted and unknown, it is necessary to popularise them.

Some of such uncommon greens are also believed to have medicinal value. They are used for the treatment of rheumatism, diseases of urino-genital organs, asthama, scorpion bite, etc. Some leaves even have auspicious significance

PHOTOGRAPH.1
Chemungaku (Cassia occidentalis)



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such as Thummikura (Leucas aspera) with which a dal curry is prepared and offered to God at the celebration of Ganesh Chaturthi.

Ten uncommon green leaves* which are consumed by a few people in Hyderabad are selected for analysis and acceptability tests. The leaves selected are Chenungaku (Cassia occidentalis), Thummikura (Leucas aspera) Thutikura (Ipomea reptans), Atthelukura (Lactuca runcinata), Rangula Ponnaganti (Alternanthera triandra), Gulmetakura (Astercantha longifolia), Guntakalavaraku (Eclipta alba, small variety), Theega Bacchali (Basella alba), Ceylon Bacchali (Talinum triangulare) and Guntaginjaraku (Eclipta alba).

Three samples of each leaf were collected from three different sources and the estimations were carried out separately for each sample. The leaves were estimated for their moisture, crude fibre, total ash, protein, ether extractives, carotene, vitamin C, total iron, phosphorous, calcium and oxalic acid content.

Mere determination of the nutritive value is of no use if the particular food is not acceptable. For this reason, an attempt has been made to test the acceptability of these uncommon leaves. The recipes commonly prepared with leaves such as greens with dal, stir fry and chutney were selected. The recipes were compared with corresponding well accepted preparations and tested for over-all acceptability by a panel of Judges.

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* Photographs 1-10

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Survey of literature shows that almost all the common foods consumed in India have been analysed for their nutrient content. But there are still some uncommon foods consumed in different parts of India, that have yet to be analysed.

Until 1936 no comprehensive survey of Indian food values was carried out. Stewart et al (1951) had published tables based on the chemical analysis of some common Indian foods. McCarrison's (1929)* "Food" which was widely used in planning diet schedules, provided data about a limited number of foods and included no information about mineral content. Mention may also be made of Rosedale's (1935) "Chemical analysis of Malayan foods".

Ghosh and Guha (1934) analysed the protein, thiamine, riboflavin, calcium, phosphorous and iron content of some of the foods commonly used in Bengal. Foods analysed included lat shak (Amarantus sp.), Gina shak (Erythroearox burghia), Kolmi shak (Ipomea reptans), Palong shak (Spinach oleracea), Cabbage, Poin shak (Bassela cordifolia), Patol (Trichosanthus dioica), Dherosh (Hibiscus esculentus), Man Kochoo (Colocasia indica), and Kanch kala (Musa paradisiaca). Lat shak, gina shak, kolmi shak and palong shak have been found to be the richest sources of iron, Cabbage, gina shak and poin shak were

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* McCarrison (1929) - Chemical analysis of some Indian Foods. "Food" Macmillan & Co. Madras.

reported to be rich in calcium; Patol, poin shak and dherosh were found to be good sources of phosphorous. The protein content was highest in palong shak, patol, gina shak and kolmi shak. The richest sources of thiamine were poin shak, dherosh, kanch kala and cabbage. Patol, palong shak and man kochoo were found to be fairly good sources of Riboflavin.

Ahmad (1935) estimated the vitamin C values of some common Indian fruits, vegetables and pulses by the chemical method. Celery, radish leaves, cabbage, lettuce, spinach, soya leaves, dhanya leaves and mint leaves were included for analysis among the other foods analysed for vitamin C.

Ranganathan et al (1936) analysed 200 food stuffs, covering most of the cereals and pulses, vegetables, nuts and oil seeds, fruits, condiments and spices and a few flesh foods in common use, for their moisture, fat, protein, ash, calcium, phosphorous, iron, thiamine, riboflavin, nicotinic acid and ascorbic acid content. Tender amaranth, bamboo shoots, brussel sprouts, cabbage, celery, corriander, curry leaves, drumstick leaves, fenugreek leaves, garden cress, gogu, impomea, lettuce, mint, neem, parseley, agathy, manathakalli and spinach were the leaves analysed in addition to other foods.

In continuation of investigations reported by Mitra (1938), Mittra et al (1940) on the composition of food stuffs in use in Bihar, the results of the examination of a

further series of 80 items were presented by Mitra and Mittra (1942). 27 Leafy vegetables, were chemically analysed for their moisture, protein, ether extractives, carbohydrates, mineral matter, calcium, phosphorous and crude fibre along with many other foods.

Swaminathan (1943) analysed and recorded the thiamine content of 130 common India foods. He concluded that vegetables in general (with the exception of green peas and other green legumes) are poor sources of thiamine. Green leafy vegetables, roots and tubers were reported to be better sources than other vegetables.

Florence Theophilus and Ratna Bai (1949) analysed eight different kinds of greens. Acalypha indica, boerhavia repens, Euphorbia hirta, cleome viscosa, tribulus terrestris, trianthema monogyna, corchorus, acutangulus and amaranthus viridis were analysed for their protein, vitamin C, total ash, calcium, phosphorous, iron, calorie and fat content.

Ghosh (1951) estimated the riboflavin content of 40 food stuffs microbiologically. The leaves analysed were Bethua leaves, corriander leaves, carrot leaves, curry leaves, cabbage, fenugreek leaves, ipomea, India sorrel, mint, onion stem and patol leaves. The leafy vegetables were found to be richer in riboflavin content than non leafy vegetables.

Aykroyd (1956) analysed several foods which are

commonly consumed in India, as well as the uncommon foods collected from Coonoor and North India. The different foods were analysed for their moisture, proteins, fats, mineral matter, fibre, carbohydrate, calcium, phosphorous, iron, calories, carotene, thiamine, niacin, riboflavin and vitamin C content. This information was recorded in the Health Bulletin No.23.

In the same year, I.C.M.R.* had published the nutritive value of several food stuffs, for which no information was available in the Health Bulletin No.23. Chakkur manis (Sauropus androgynus), Knolkhol leaves, beet leaves and turnip leaves were some of the uncommon leafy vegetables analysed. Moisture, fat, protein, mineral matter, calcium, phosphorous, iron, carotene, thiamine, riboflavin, nicotinic acid and ascorbic acid contents were estimated. These greens were found to be rich sources of carotene, iron, B Complex vitamins and calcium. Chakkur manis which was introduced from Borneo , was found to be a fairly good source of all the major nutrients.

Satyanarayana and Rama Rao (1957) analysed a new leaf sauropus androgynus (Chekkur manis) which is a common and popular vegetable throughout Jawa, eaten either raw or steamed. The Indian Council of Agricultural Research wanted the Central Food and Technological Institute, Mysore and the Nutrition

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* Indian Council of Medical Research annual report (1955 - 56)

Research Laboratories Coonoor, to analyse this leaf with a view to assess the nutritive value. It was found to contain 4.1 gms. of moisture, 15.4 gms of total ash, 1.5 gms of acid insoluble ash, 1.5 gms of ether extractives, 26 gms of protein, 2.3 gms of crude fibre, 44.8 gms of carbohydrates and 120 mgms of calcium per 100 gms of dried leaf powder.

The *Nutrition Research Laboratories, Coonoor reported in its annual report of 1956-57 the nutritive value of some leavy vegetables. Chukkurmanis, Knol Khal greens, beet root greens and turnip greens were found to contain fairly high quantities of total nitrogen on dry weight basis. A large proportion of this (40-50%) occured in the form of unextractable protein by the usual protein solvents. The extractable non-protein nitrogen was also found to be fairly high ranging between 25-42% of the total nitrogen.

@The department of Nutrition, Bombay carried out a number of estimations, regarding the nutritive value of foods during the period 1957 to 1961. During the year 1957, they analysed about 71 different food stuffs of local importance. Biological value and essential amino acid contents were also found out for some foods. In 1958, 19 food stuffs were analysed for about 27 different constituents. These determinations included edible portion, moisture, proteins, ether extractives

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* Indian Council of Medical Research annual report (1956-57)
@ Report of the department of Nutrition, Bombay State (1958-1961)

crude fibre, mineral matter, sodium, potassium, calcium, iron, total phsophorous, phytin phosphorous, magnesium, copper, oxalates, chlorides, suplphur, acidity, alkalinity, thiamine, riboflavin, niacin, carotene and vitamin C. In some food stuffs, wide variations in the same nutrient for the same variety of food stuffs purchased from different districts were observed. Lysine and phynylalanine were estimated in Ghol leaves (Portulaca oleracea) and Rai leaves. In 1959, 32 food stuffs were analysed for various chemical constituents. Drumstick leaves, amaranth, tamrind leaves and dried tamrind leaf powder were some of the foods analysed along with the other foods. Chemical analysis of Ambadi (Hibiscus cannabinus) and Methi (Trigonella foenum graecum) were also done. In 1960 and 1961, 23 and 59 different foods were analysed respectively by the same department, for values of essential nutrients which were missing in Health Bulletin No.23. Foods analysed included water cress, lettuce leaves, spinach, bengal gram leaves, gogu and carrot leaves. The edible portion, moisture, fibre, carotene, thiamine, riboflavin, nicotinic acid and vitamin C were the nutrients estimated.

Balasubramanian et al (1962) investigated several Indian foods comprising cereals, pulses, begetables, fruits, nuts and some unfamiliar foods for their moisture, fat, fibre, total ash, proteins, carotene, vitamin C, thiamine, riboflavin, niacin calcium, phosphotous, phytin phosphorous, iron, oxalic acid, sodium, potassium and chloride contents. Some of the

unusual foods analysed were decoiled conconut, chookri ka patta, phog flowers, lotus stem dry etc. besides others.

Satyanarayana and Kodkal (1963) from the Central Food Technological Research Institute Mysore, analysed 44 different foods stuffs among cereals, pulses, oilseeds spices and vegetables brought from different places of Mysore, for their carotene, niacin and riboflavin content. Neem leaves and Bathua leaves were the leaves analysed besides the other common leaves.

Ambagaokar et al (1964) carried out studies on nutritive value of Indian food Stuffs. They analysed 59 foods for proximate principles, minerals and vitamins. The leafy vegetables included for analysis were colocasia leaves, sorrel, ipomea leaves, ghol, cow pea leaves, mula leaves (knol knol), Rai leaves, rajgira leaves and fetid cassia.

Achutha Murthy and Meena Rao (1965) from the Central Food and Technological Research Institute Mysore, determined the phytin phosphorous content of some of the food stuffs. They also undertook the analysis of some food stuffs of regional importance which have not been listed in the Health Bulletin No.23 and estimated the proximate principles, vitamins and minerals. Sopsige soppu, (Pencedenum graveolans) and cabbage pink (Brassica oleracea capitata) were the leaves analysed.

Ambegaokar and Radhakrishna Rao et al (1965) studied

the nutritive value and amino acid composition of six leafy vegetables and four millets in common use. The leaves included were chakwat (Chenopodium album), Colocasia, knol khol, safflower, shepu (Pencedanum graveolens) and spinach which were estimated for their moisture, nitrogen, crude protein, minerals and amino acid content.

Kaul and Verma (1967) estimated the oxalate content of foods commonly used in Kashmir, because of the high incidence of renal lithiasis among the local people. Cabbage, knol khol leaves, radish leaves, spinach, and ambat chuka were the leaves analysed and their oxalate content ranged between 17.2 mgms to 699 mgms%.

Singh and Niyam Charan (1969) from the department of Physiology, Kanpur, analysed 51 green leafy vegetables, for their calcium, insoluble oxalate and phosphorous content to evaluate them as a source of calcium. Some of the leaves analysed were those of bitter gourd, tamarind, cabbage, cauliflower, pumpkin, bottle gourd, pea and radish leaves. They concluded that out of 51 green leaves, only 19 contain calcium not bound as oxalate (eg. garlic, knol khol, mustard, cauliflower leaves etc.) and 20 leaves contain both soluble and insoluble oxalates (Amaranth, spinach, colocasia etc.) and 12 contain insoluble oxalates. Leaves of gram, kabuli gram, carriander leaves, ipomea etc. contained no soluble oxalate.

Umamaheshwar Rao (1970) from the Central Marine Fisheries Research Institute (Mandapam Camp) analysed several fresh sea weeds available along the Indian coast which could be directly utilised as human food. He reported that although the large amounts of carbohydrates are present in sea weeds, they are difficult to digest. They are reported to be good sources of minerals, trace elements,protein and vitamins. They have a very high content of iodine, protein, and all amino acids essential for a human diet.

Bhatnagar and Tewari (1970) estimated the nutritive value of some uncommon vegetables of North India. This study aimed at determining the chemical composition of some edible parts of certain trees and climbers not generally used as vegetables, but which could be so used. The leaves of Trewia nudiflora were analysed for proximate principles, trace minerals, iron, copper and manganese along with other foods.

Sengupta and Pal (1970) analysed eleven wild greens of West Bengal for their moisture, protein, carbohydrates, ash, crude fibre, calcium, phosphorous, iron, niacin, vitamin C and calorie content. The leaves analysed were Enhydra fluctuans, Hydrocotyl asiatica, Herpestis monneira, Oxalis corniculata, Mollugo spergula, Mollugo hirta, Cephalandra Idica, Hydrophilia spinosa, Amaranthus spinosus, Rumex visicarious and Trianthema monogyna.

Acceptability of foods :

Jessie Whitcare et al (1943) determined the eating

quality and some aspects of composition of turnip greens at successive stages of growth. Samples of seven tops of turnip greens were harvested at different stages of growth. Portions were submitted for chemical analysis, used for objective tests of tenderness and judged for palatability after cooking. The greens were grown under 16 different fertilizer treatment in factorial arrangement. Cooking test of this study suggest, that 120 gms. of raw washed greens will make an average serving when cooked. The eating quality was not related to the stage of growth whether tested by families or food classes and irrespective of whether stems were cooked or discarded. Greens cooked in three cups or six cups of water to 3/4 pound of raw greens were rated higher on tenderness, degree of bitterness and characteristic turnip greens flavour by the scores of home economic students and instructors than other lots from the same sample cooked in 1/2 or one cup of water.

Mary et al (1949) determined the relative palatability of four varieties of kale cooked by boiling, pressure cooking and steaming by approximately 20 tasters over a period of five seasons. Boiling in an uncovered pan for 6-9 minutes when covered with water to about half its depth was generally preferred, but individual tastes varied . Some liked longer cooking, some liked kale cooked in pressure saucepan. Steamed

kale was generally disliked. Dwarf blue scoth curled and Siberian were preferred to dwarf green scoth curled or tall green scoth curled.

Isabelle Trefethen et al (1951) determined the effect of increased temperature, with increased pressure on the total cooking time, palatability, ascorbic acid, thiamine and riboflavin retention in locally grown broccoli. The cooking methods used besides boiling at atmospheric pressure were 5, 10, and 15 p.s.i.g. The amount of water was such that the same amount of water was left at the end of each cooking. Broccoli cooked by all four methods was considered acceptable by the judges. The average summation scores for the broccoli cooked by 0, 10 and 15 p.s.i.g. was the same 12. The average summation score for the broccoli cooked at 5 p.s.i.g. was 13. Neither the above difference nor the difference in scores for colour, texture and flavour of broccoli cooked by all four methods were significant.

Rajammal Devadas and Mangala et al (1965) determined the iron content and acceptability of amaranth leaves cooked in iron, aluminium and brass vessels, with and without the addition of tamarind fruit pulp extract. The results showed that the iron contents of amaranth cooked in aluminium or tin coated brass vessels were 11.4 and 11.3 mgms per 100 gms. Cooking with tamarind pulp slightly increased the iron contents.

Cooking in cast iron pans increased the iron content to a very large extent. The results of the organoleptic evaluation revealed that the acceptability of Amaranth cooked in aluminium pan was better than that cooked in tin coated brass pan or iron pan.

Kamalanathan and Usha et al (1969) evaluated the acceptability of some recipes with leaf protein concentrates manufactured from Lucerne leaves. The protein concentrate was incorporated at the predetermined levels of 5 gms. of serving, 10 gms of serving and 15 gms of serving and the six preparations prepared were ragi adai, dhal balls, sweet potato curry, potato bath, greens chutney and chutney powder. The judges were favourable towards dal balls, chutney powder and adai at the lower level of leaf protein concentrate incorporation. Towards greens chutney at both low and medium levels of incorporation, the judges expressed definite liking. Neutral attitude was evinced towards chutney powder and ragi adai at a higher level of incorporation, but only at a low level of incorporation towards sweet potato curry and potato bath.

MATERIAL AND METHODS

MATERIALS AND METHODS

Ten Green leafy plants, which are consumed by a few people in Hyderabad but not commonly consumed by many were selected for analysis. These leaves grow wild in open areas and are consumed by the low income group and local tribes.

The ten leaves selected for analysis are Chenungaku (Cassia occidentalis), Thutikura (Ipomea reptans), Atthelukura (Lactuca runcinata), Rangula Ponnaganti (Alternanthera triandra), Gulmetakura (Asteracantha longifolia), Guntakalavareku (Eclipta alba, small variety), Theega Bacchali (Baselle Alba), Ceylon Bacchali (Talinum triangulare) and Guntaginjaraku (Eclipta alba). The photographs of these leaves are given in the preceding few pages with their genetic and botanical names.

Three samples of each leaf were procured from the outskirts of Hyderabad, each sample being obtained from a different source. One sample of Rangula Ponnaganti was obtained from Bapatla within 48 hours after plucking and two samples of Guntaginjaraku were obtained from Chittoor within 24 and 36 hours respectively. All the other green leaves were obtained within three to four hours after plucking. They were collected in plastic bags and sealed immediately to avoid loss of moisture and brought to the laboratory.

The estimations of moisture, crude fibre, ash

carotene, vitamin C, calcium, iron, phsophorous, oxalic acid, proteins and ether extractives were carried out in duplicate for each sample.

For moisture, Vitamin C, carotene and oxalic acid estimations fresh leaves were used. For the rest of the nutrients, moisture free samples were used for which the fresh leaves were washed with distilled water to remove any adhering dirt and then dried in hot air oven at 60-80° C for 12-24 hours. These dried samples were powdered and stored away from light in glass toppered bottles. Weighed samples of these powders were taken for the estimation of crude fibre, total ash, calcium, phosphorous, iron and ether extractives.

Vitamin C was estimated within 4 to 5 hours after plucking except in the case of one sample of Rangula Ponnaganti, and two samples of Guntaginjaraku obtained from Bapatla and Chittoor respectively. In these samples vitamin C was estimated within 48 hours.

Carotene and oxalic acid estimations were carried out with fresh leaves, leaves being stored at 0° C prior to estimation. The chemical methods for the analysis of each nutrient are given below.

Moisture [1]:

Three grams of fresh leaves were weighed into a

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1 - Official methods of Analysis, Association of Official Agricultural Chemist, 22, 003, 1964.

petri dish and dried in the hot air oven at 60-80° C till the weight of the dish with its contents remained constant. The percentage of moisture was calculated from the difference in initial and final weights.

Crude fibre [1].

Two grams of moisture and fat free sample was weighed into a 500 ml beaker and 200 ml of boiling 0.255 normal (1.25% W/V) sulphuric acid was added. The mixture was boiled for 50 minutes, keeping the volume constant by the addition of distilled water at frequent intervals. A glass rod was inserted into the beaker to help smooth boiling. At the end of the period, the mixture was filtered through a muslin cloth and the residue washed with hot water till free from acid. The material was then transferred to the same beaker and 200 ml. of boiling 0.313 normal (1.25%) sodium hydroxide was added. After boiling for 30 minutes keeping the volume constant as before, the mixture was filtered through muslin cloth. The residue was washed with hot water till it was free from alkalis followed by washing with some alcohol and ether. It was then transferred to a crucible, heated overnight at 80-100°C and weighed. The crucible was heated in a muffle furnace at 600°C for 2-3 hours, cooled and weighed again. Crude fibre per 100 gms of

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1 - Manual of laboratory Techniques. National Institute of Nutrition.

moisture and fat free sample was calculated using the formula.

$$100 \frac{[(\text{Wt. of ash + fibre}) - \text{Wt. of ash}]}{\text{Wt. of moisture and fat free sample taken}}$$

Ether extratives [1]:

2.5 Grams of dried sample was put into a weighed thimble and the ether soluble fraction was extracted using the soxhlet apparatus.

Proteins [2]:

The N_2 content was determined by Macro Kjeldahl method. 0.5 grams of dried and powdered sample was taken and digested with 10 ml. of concentrated sulphuric acid and the digested sample was distilled together with required amount of 40% NaOH and the liberated ammonia collected in a conical flask containing 20 ml of 0.1 N sulphuric acid. The nitrogen content was determined by titration with 0.1 N sodium hydroxide and the protein content was obtained by multiplying the nitrogen content with the factor 6.25.

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1 - Hawk P.B. Oser. B.L, and Summerson W.M. (1954) - Practical Physiological Chemistry.
McGraw Hill Book Company, New York, p.239.

2 - Association of Official Agricultural Chemists (1965, 10th Edition).
Methods of analysis, Washington D.C. p. 327.

Ash[1] :

Two grams of moisture free samples was weighed into a crucible and kept over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 5 to 8 hours at 600° C. It was then colled in a desicator and weighed. The percentage of ash on moisture free basis was then calculated.

Minerals :

The ash obtained by the previous experiment, was moistened with a small amount of distilled water (0.5 to 1 ml.) and 5 ml. of hydrochloric acid was added to it. The mixture was evaporated to dryness on a boiling water bath. Another 5 ml. of hydrochloric acid was added again and the solution evaporated to dryness as before. 4 ml. of hydrochloric acid and a few ml. of distilled water were then added and the solution warmed over a boiling water bath and filtered into a 100 ml. volumetric flask using Whatman No 40 filter paper. After colling, the volume was made upto 100 ml. and suitable aliquots were used for the estimation of phosphorous, iron and calcium.

Iron[2] :

Iron content was estimated, making use of the fact that ferric iron reacts with thiocyanate to give ferric

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1 - Manual of Laboratory Techniques (1965). National Institute of Nutrition.

2 - Farrar C.E. (1935)
J.Biol. Chem. 110 : 685

thiocyanate which was determined calorimetrically.

Took different aliquots of the standard iron solution containing 0.01 mg/ 1 ml. and made up the volume to 7.5 ml. with distilled water. Added 0.5 cc of saturated potassium persulphate followed by 2 cc of potassium thiocyanate and read the colour in a Biochem calorimetre using green filter within 30 minutes. The same procedure was repeated with the sample and the iron content was determined making use of the standard graph.

Phosphorous [1];

The principle behind phosphorous estimation is, that when the protein free filterate is treated with an acid molybdate, it forms phosphomolybdic acid. The phosphomolybdic acid is reduced by the addition of 1 Amino, 2 Naphtol, 4 Sulphonic acid reagent to produce a blue colour whose intensity is proportional to the amount of phosphate present.

Different aliquots of standard phosphate solution containing 0.4 mgms. in 5 ml. were taken and the volume made upto 8.6 ml. by the addition of distilled water. 1 ml. of molybdate solution (25 gms of ammonium molybdate dissolved

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1 - Fiske and Subba Rao, Hauk's practical physiological Chemistry, 13 ed. p.629.

in 200 ml. of water) followed by 0.4 ml. of 1 Amino, 2 Naphtol, 4 Sulphonic acid was added. The colour was then read in a Biochem calorimeter using red filter.

This procedure was repeated with the sample. Phosphorous content of the food sample was calculated with the help of the standard graph.

Calcium [1]:

Calcium was determined by precipitating it as calcium oxalate and titrating the solution of oxalate in dilute sulphuric acid against standard potassium permanganate.

About 25 ml. of mineral solution was taken into a dry beaker and the volume was made upto 150 ml. with distilled water. Two drops of methyl red indicator was added and the solution was neutralized with strong ammonia till it turned yellow. Then heated it to boil, added 10 ml. of 6 % ammonium oxalate, continued boiling for few more minutes and few drops of glacial acetic acid was added till the solution changed to distinct pink colour. The solution was kept aside for precipitation for about 6 hours in a warm place.

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1 - Mannual of laboratory Techniques (1965). National Institute of Nutrition.

The precipetate was filtered through Whatman No.40 filter paper and washed with warm distilled water till the filterate was free of oxalic acid. The precipitate was transferred into a beaker by peircing a hole in the filter paper and pouring about 10 ml. of 2 normal sulphuric acid. The solution was heated to about 70° C and titrated immediately with standard potassium permanganate and calculated the calcium content taking the following equation : 1 ml. of 0.05 normal $KMNO_4$ = 1 mg. of ca.

Oxalic acid [1]:

Ten grams of the fresh sample was taken and macerated well with 25 ml. of 2 normal hydrochloric acid in a pestle and mortar. The ground sample was then transferred to a beaker, weighed and then boiled in a water bath for 5 mts. The beaker with its contents was weighed again and the weight was adjusted to the previous weight by the addition of distilled water. Then the volume was made upto 100 ml. with 2 normal hydrochloric acid and filtered. 25 ml. of the filterate was taken and 5 ml. of phosphotungatate reagent was added to precipitate the proteins, and kept overnight. Next day it was centrifuged and filtered again. 20 ml. of this filterate was taken, added 2-3 drops of methyl red indicator

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1 - Manual of Laboratory Techniques (1965)
National Institute of Nutrition.

and neutralized with ammonia till the colour changed to yellow. Then 5 ml. of calcium chloride buffer was added to precipitate the oxalates and left over night. Next day it was filtered through Whatman No.40 filter paper and washed several times with water to free it from chlorides and then the filter paper was transferred to a beaker, followed by addition of 5 ml. of 2 normal sulphuric acid and titrated against 0.01 normal potassium permanganate solution. Oxalic acid content was calculated using the formula :

$$\text{Titre value} \times \text{Strength of } KMNO_4 \times \frac{0.45}{0.01} \times \text{dilutions} \times \frac{100}{\text{wt. of leaves.}}$$

Vitamins :

Carotene[1] : One gram of mascertated fresh leaves was taken in a Erlen Meyer Flask and saponified by the addition of 20 ml. of saturated ethanolic potassium hydroxide and refluxed for 30 minutes over a water bath.

The sample was cooled and 25 ml. of petroleum ether was added, shaken well and transferred into a separating funnel. The contents of the flask were extracted with 20 ml. of petroleum ether twice transferring the extract to the seperating funnel each time. 50 ml. of water was then

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1 - Analysis of foods by Winton (1958)
John Wiley & Sons. Inc. Chapman & Hall, Ltd. 313.

poured into the seperating funnel, shaken well and the alkaline ethonolic solution was drawn off. 30 ml. of petroleum ether was added to the seprating funnel thrice, shaking the apperating funnel each time after the addition. The petroleum ether extracts were then washed with 25 ml. of water till the extract was free from alkali. To remove the xanthophylls, the extract was shaken well for 20 minutes with 20 ml. of 90% methanol. The methanol was drawn off and the treatment repeated until the washings were colourless. The extract was then washed with 25 ml. of water several times to remove the Methanol. Then anhydrous sodium sulphate was added to the extract to remove moisture and the volume was made upto 50 ml. with petroleum ether. The colour of the solution was read in Klett Summerson Calorimeter using 440 mμ filter and the carotene content calculated by comparing with standard.

Vitamin C[1] :

Vitamani C content was determined calorimetrically, which is based upon the measurement of the extent to which 2, 6, dichloro phenol indophenol solution is decolourized by ascorbic acid sample extracts or in standard ascorbic acid solutions. Since reduction of the dye with reducing interfering substances is slow, rapid determination would be measuring mainly the ascorbic acid content.

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1 - Loffler and Pointing Modification, Ind. Eng. Chem. Anal. Ed. 1942, 4; 846.

To get a representative sample, 25 to 50 grams of fresh leaves were blended with an equal weight of 6% metaphosphoric acid and the macerated mixture was made upto a suitable volume and filtered.

Standard curve :

To dry test tubes, requisite volume of standard ascorbic acid solution (containing 40 µg/ml) was pipetted and the volume was made upto 5 ml with 2% metaphosphoric acid. 10 ml. of the dye was added with a pipette, shaken well and the reading taken within 15to 20 seconds in a Biochem Calorimeter. The instrument was set to 100% transmission using a blank consisting of 5 ml. of 2% metaphosphoric acid solution and 10 ml. of distilled water. The colour was read using a yellow green filter (518 mµ). The absorbance was plotted against concentration.

Sample :

5 ml. of the extract was placed in a dry test tube and after adding 10 ml. of the dye, the colour was read as in the case of standard.

Vitamin C was calculated as mg. of ascorbic acid per 100 gms. of sample using the formula:

$$\frac{\text{Ascorbic acid content}}{\text{ml. of the extract taken}} \times \frac{\text{Volume made up}}{100} \times \frac{100}{\text{gms. of wt. of sample}}$$

Palatability test :

To ensure that the recipes from these ten leaves are acceptable, a palatability test was conducted before a selected panel consisting of four staff members from the foods and nutrition department and two students from the M.Sc. final year.

Dal with greens, stir fry and chutney were the three recipes selected. Amaranth (Amaranthus gangeticus) was taken as a standard for recipes of dal with greens and stir fry. Each time these recipes were prepared with other leaves, the corresponding recipe with Amaranth was also prepared, and served for comparison. Gongura (Hibiscus cannabinus) chutney was taken as a standard for comparison of chutneys.

In case of dal with greens slight variations in the proportion of greens to dal needed to be done as they were found unacceptable when prepared as per the standard recipe. Thummikura, Atthelukura and Guntakalavaraku are the leaves which were used in lesser quantities than other leaves. Chenungaku leaf was found to be unacceptable when used with dal and hence chutney was prepared out of it. Chutneys were also prepared with Guntaginjaraku, and Guntakala-varaku leaves as they are generally used for chutney preparations. Curd

chutney was prepared with only chenungaku leaves, as it is prepared that way in Mysore State. Some leaves like Thummikura, Atthelukura, Theega Bacchali, Ceylon Bacbhali , Guntakalavaraku and Chenungaku could not be used as stir fry preparations, as some were found to be unpalatable and some not suitable for stir fry. Hence stir fry preparations were not attempted with these leaves.

The recipes used for different preparations were as follows :

DAL WITH GREENS

Ingredients -

Greens	..	50 gms.
Red gram dal	..	25 "
Onions	..	10 "
Green chillies	..	2 "
Tamarind	..	5 "
Oil	..	1 Table spoon.
Seasonings	..	Few grains of mustard and fenugreek.
Salt to taste.		

Dhal was cooked, and seasoned. Then added greens, salt and turmeric and cooked till tender. The recipe was the same for the Amaranth (standard recipe), Thutikura, Rangula Pennaganti, Ceylon Bacchali, Theega Bacchali, Gulmetakura and Guntaginjaraku. In case of Thummikura, Atthelukura and Guntakala-varaku, 12 gm of leaves were used instead of 50 gms, the rest of the recipe being the same.

STIR FRY

Ingredients -

Greens	..	50 gms.
Onions	..	25 gms.
Green chillies	..	2 gms.
Oil	..	1 table spoon.
Seasonings	..	Few grains of mustard and cumin seeds.
Salt to taste.		

Chopped onions were seasoned in oil along with the seasongings. Then added chopped greens with salt and turmeric and cooked till tender. Stir fry preparations were prepared with Amaranth (standard recipe), Rangula Ponnaganti, Thutikura, Gulmetakura and Guntaginjaraku as per the above recipe.

CHUTNEY

Ingredients -

Greens	..	50 gms.
Red chillies	..	2 gms.
Tamarind	..	10 gms.
Oil for seasoning & frying leaves.	..	30 gms.
Dry coconut	..	10 gms.
Seasonings	..	Few grains of mustard seeds.
Salt to taste.		

Greens were fried in oil along with red chillies, tamarind and ground with salt and coconut. Chutneys were prepared using the above recipe with gongura (standard), Chenungaku and Guntakalavaraku. Guntaginjaraku chutney was prepared in the following way. The leaves and red chillies

were fried seperately and ground along with tamarind and salt. The proportions of the ingredients used were the same as that used for the standard recipe.

CURDS CHUTNEY

Ingredients -

Greens	..	20 gms.
Curd	..	100 ml.
Coconut	..	50 gms.
Cumin seeds	..	1/2 Tea spoon.
Oil for frying the leaves and seasoning.		20 gms.
Green chillies	..	2
Seasonings	..	Few grains of mustard and Asafoetida.
Salt to taste.		

The leaves were fried in oil and ground along with cumin seeds, salt and green chillies. Then the ground paste was mixed with curds and seasoned. This preparation was only made with chenungaku leaves as this is the most common recipe prepared with these leaves in Mysore State.

Storing :

A score card was prepared (appendix - 1) to evaluate the recipes. Colour, appearance, texture, odour, sourness, taste, doneness and over all acceptability were graded. The Judges were explained about the quality characteristics and grading. Eventhough numerical score was given to each characteristic under consideration, it was not indicated in the score card.

The Judges were asked to record the grade in the boxes opposite to each characteristic. Subsequently the grades given for physical characteristics were reduced to corresponding predetermined numerical scores.

The recipes were tested at 11-00 A.M. or at 3-00 P.M. Five to six recipes were tested at a time, each time comparing with the corresponding standard recipe. The dal with greens and stir fry preparations were kept in the hot plate and served hot to the judges. All the recipes were served in uniform steel bowls, which were labelled numerically. The identity of the leaves were not revealed to the judges to prevent subjectivity. For the first two days, the same recipes were repeated to test the consistancy of judgement of the Judges.

RESULTS AND DISCUSSION

RESULTS

Green leaves were analysed for their moisture, crude fibre, total ash protein, ether extractives, carotene, Vitamin C, Total iron, total phosphorous, calcium and oxalic acid content. Three samples of each leaf were obtained from different sources and estimations were carried out for each sample separately in duplicate. The percentages are calculated for each sample separately. The individual values of the three samples of each leaf are given in Appendix II (Table A-J).

The moisture, carotene, Vitamin C and oxalic acid were estimated using fresh leaves. For each estimation, the percentages on fresh weight basis were calculated and the average was obtained. Crude fibre, total ash, protein, ether extractives, total iron, total phosphorous and calcium were estimated on dry weight basis, the percentages were calculated for each estimation and the mean values were found out. The percentages of the nutrients estimated on dry weight basis are expressed on fresh weight basis making use of the moisture content of each sample.

The percentage values (average of three samples) for moisture crude fibre, total ash, protein and ether extractives of the leaves analysed on dry weight basis are given in the Table I. The moisture content of the greens ranged between 72.2 to 92.9 gms.% the least being observed in Atthelukura (72.2 gms.%) and Thummikura (72.3 gms.%) and the highest in ceylon Bacchali. Crude fibre

Table I : Percentage values (Average of three samples) of proximate principles of the leaves analysed on dry weight basis.

Leaves	Moisture (Gms)	Crude fibre (Gms)	Total ash (Gms)	Proteins (Gms)	Ether extractives (Gms)
1. Chenungaku ..	79.6	5.7	10.5	16.0	11.0
2. Thummikura ..	72.3	11.7	8.9	11.6	5.9
3. Atthelukura ..	72.2	12.5	15.2	12.8	10.9
4. Thutikura ..	85.5	11.5	9.7	12.7	4.4
5. Rangula Ponnaganti ..	87.7	10.6	23.0	13.2	9.9
6. Gulmetakura ..	80.3	8.9	20.0	15.8	5.5
7. Guntaginjaraku ..	86.2	9.9	13.1	8.1	7.1
8. Theega Bacchali ..	91.6	7.7	21.3	14.4	10.0
9. Guntakalavaraku ..	81.9	8.7	20.4	11.5	5.9
10. Ceylon Bacchali ..	92.9	5.6	21.4	14.6	3.7

content of the leaves on dry weight basis ranged between 5.6 (Ceylon Bacchali) to 12.5 gms.% (Atthelukura). The total ash content is given in Table I. Rangula Ponnaganti has the highest percentage of total ash (23%)and Thummikura the least (8.9%) on dry weight basis. The protein content of the leaves ranged from 8.1 (Guntaginjaraku) to 16 gms.% (Chenungaku) on dry weight basis. The values of ether extractives on dry weight basis ranged from 3.7 to 11 gms.%, the highest being observed in Chenungaku and the least in Ceylon Bacchali.

Table II gives the percentage values (average of the three samples) of crude fibre, total ash, protein and ether extractives calculated on fresh weight basis. The average moisture content of each leaf is also given.

Crude fibre content of the leaves on fresh weight basis (Table II) ranged from 0.4 (Ceylon Bacchali) to 3.5 gms.% (Atthelukura). The similar observation was made when expressed on dry weight basis. Regarding the total ash content, Atthelukura had the highest (4.2 gms.%) and Thutikura the least (1.4 gms.%). The protein values on fresh weight basis ranged from 1 (Ceylon Bacchali) to 3.5 gms.% (Atthelukura). The values of ether extractives on fresh weight basis ranged from 0.2 (Thummikura) to 3% (Atthelukura).

The percentage values (average for the three samples) for total iron, total phosphorous and calcium on dry weight basis are given in Table III. Highest iron content on dry weight basis is observed in Ceylon Bacchali (278 mgms.%), the next

Table II : Percentage values (Average of three samples) of the proximate principles of the leaves analysed on fresh weight basis.

Leaves	Moisture (Gms)	Crude fibre (Gms)	Total ash (Gms)	Proteins (Gms)	Ether extractives (Gms)
1. Chenungaku ..	79.6	1.1	2.1	3.2	2.3
2. Thummikura ..	72.3	3.2	2.5	3.2	0.2
3. Atthelukura ..	72.2	3.5	6.2	3.5	3.0
4. Thutikura ..	85.5	1.7	1.4	1.8	0.6
5. Mangula Ponnaganti ..	87.7	1.3	2.8	1.6	1.2
6. Gulmetakura ..	80.3	1.4	4.0	3.1	1.1
7. Guntaginjaraku ..	86.2	1.3	1.8	1.3	1.0
8. Theega Bacchli ..	91.6	0.6	1.8	1.2	0.8
9. Guntakalavaraku ..	81.9	1.5	3.6	2.1	1.0
10. Ceylon Becchali ..	92.9	0.4	1.5	1.0	0.3

Table III : Percentage values (average of three samples) of the mineral contents of the leaves analysed on dry weight basis.

Leaves		Moisture (Gms)	Total iron (Mgs)	Total Phosphorous (Mgs)	Calcium (Mgs)
1. Chenungaku	..	79.6	87.3	192.0	988.6
2. Thummikura	..	72.3	92.7	250.0	1312.0
3. Atthelukura	..	72.2	49.4	137.0	2941.0
4. Thutikura	..	85.5	110.8	365.3	1240.0
5. Rangula Ponnaganti	..	87.7	111.0	315.0	1946.0
6. Gulmetakura	..	80.3	230.0	455.0	2906.0
7. Guntaginjaraku	..	86.2	48.1	490.0	1010.0
8. Theega Bacchali	..	91.6	134.0	178.0	3856.0
9. Guntakalavaraku	..	81.9	241.0	437.0	2133.0
10. Ceylon Bacchali	..	92.9	278.0	287.0	1176.0

being Guntakalavaraku (241 mgms.%) and the least occuring in Guntaginjaraku (48.1 mgms.%). Total Phosphorous content of the leaves ranged from 137 mgms.% (Atthalukura) to 490 mgms.% (Guntaginjaraku). Calcium values on dry weight basis are also given in Table III. The calcium values ranged from 988.6 (Ghanungaku) to 3856 mgms.%(Theega Bacchali).

The percentage values of total iron, total phosphorous. calcium and oxalic acid calculated on fresh weight basis are given in the Table IV with the mosture content. The highest iron content on fresh weight basis is seen in Gulmetakura (46.5 mgms.%), next being Guntakalavaraku (44 mgms.%) and the least occurring in Guntaginjaraku. The total phosporuous content on fresh weight basis ranged from 14.5 (Theega Bacchali) to 87 mgms.% (Gulmetakura.). The calcium values of the leaves on fresh weight bais ranged from 76.13 (Thutikura) to 815.6 mgms.%(Atthalukura). The oxalic acid content of the leaves ranged from 37.8 (Atthalukura) to 1930 mgms.%(Thummikura).

The percentage values (average of three samples) for carotene, vitamin A and vitamin C content of the leaves analyased on fresh weight basis are given in Table V. The highest Carotene content is found in Chenungaku (15,583 µgms.) and the least in Thutikura (2500 µmgs). The vitamin C values ranged from 28 mgms.(Atthalukura) to 95 mgms.% (Ceylon Bacchali).

Palatability Test:

The Amaranth dal preparation was repeated six times and subjected to palatebility test to a panal of six members. The scores given by each judge for these six preparations are shown in Table VI. The mean and the standard deviations are also given in the same table, Statistical analysis

Table IV : Percentage values (average of three samples) of the mineral content of the greens analysed on fresh weight basis.

Leaves	Moisture (Gms)	Total iron (mgs)	Total Phosphorous (mgs)	Calcium (mgs)	Oxalic acid (mgs)
1. Chenungaku ..	79.6	17.8	39.1	201.0	149.3
2. Thummikura ..	72.3	25.6	69.4	363.4	1930.0
3. Atteheulukura ..	72.2	23.0	38.8	815.6	37.8
4. Thutikura ..	85.5	16.1	53.0	76.0	524.4
5. Rangula Ponnaganti ..	87.7	13.8	38.7	238.7	1071.0
6. Gulmetakura ..	80.3	45.5	87.0	491.3	282.0
7. Guntaginjaraku ..	86.2	6.6	67.8	135.9	39.6
8. Theega Bacchali ..	91.6	11.2	14.5	324.0	1270.0
9. Guntakalavaraku ..	81.9	44.0	79.0	382.3	252.0
10. Ceylon Bacchali ..	92.9	19.7	20.4	77.0	1048.5

Table 4: Percentage values (average of three samples) of the vitamin content of the greens analysed on fresh weight basis.

Leaves	Moisture (gms)	Carotene (ugms)	Vitamin A (I.U.)	Vitamin C (mgs)
1. Chenungaku ..	79.6	15,583	25,972	31.5
2. Thummikura ..	72.3	7,250	12,083	84.5
3. Atthelukura ..	72.2	12,222	20,370	28.0
4. Thutikura ..	85.5	2,500	4,166	75.00
5. Rangula Ponnaganti ..	87.7	8,847	14,752	54.0
6. Gulmetakura ..	80.3	10,041	16,736	44.0
7. Guntaginjaraku ..	86.2	11,083	18,333	76.5
8. Theega Bacchali ..	91.6	5,166	8,611	72.3
9. Guntakalavaraku ..	81.9	7,208	12,013	54.3
10. Ceylon Bacchali ..	92.9	9,249	15,066	95.0

(analysis of variance) revealed that the scores given by each judge for the same recipe repeated six times, did not differ significantly at 10% level.

TABLE VI

Score given for six Amaranth Dal preparations by six judges with mean standard deviation.

Recipe No.	Judges					
	1	2	3	4	5	6
1	88	92	83	80	71	85
2	85	80	92	86	85	82
3	86	79	74	91	83	78
4	80	78	77	79	88	72
5	80	65	77	91	83	75
6	88	81	80	94	91	72
Mean	83.61	79.16	86.93	86.83	83.5	77.33
Standard deviation.	2.8	7.8	5.8	5.7	6.25	4.88

Table VII gives the scores given by six judges for Amaranth and Gulmetakura dal. The average scores are 82.3 and 71.3 respectively. The means are tested by t test and it was found that they are not significantly different at 5% level in their acceptability (1.77; $t_{.05} = 2.228$).

Table VII : The total score given for Amaranth and Gulmetakura dal by six Judges.

Judges	Total score for Amaranth Dal	Total score for Gulmetakura Dal
1	86	86
2	78	68
3	79	81
4	74	58
5	91	58
6	86	85
Mean	82.3	71.3

The scores given by six judges for Amaranth, Ceylon Bacchali and Atthelukura dal are given in Table VIII. The averages scores obtained by Amaranth, Ceylon Bacchali and Atthelukura dal are 85.0, 82.1 and 87.3 respectively. The

Table VIII : The total score given for Amaranth, Ceylon Bacchali and Atthelukura Dal by six Judges.

Judges	Total score for Amaranth Da.	Total score for Ceylon Bacchali Dal	Total score for Atthelkura Dal.
1	85	91	91
2	82	82	91
3	88	80	88
4	92	98	100
5	86	84	92
6	85	88	92
Mean	85.0	82.1	87.3

mean score given for these three recipes were test by t test and

they were found not significantly different at 5% level (0.1517; $t_{.05} = 2.228$).

Table IX gives the scores given by six Judges for Amaranth and Thutikura dal, their means being 83.1 and 81.3 respectively. Their mean scores were tested by t test and found not significantly different from each other at 5% level (0.0532; $t_{.05} = 2.228$).

Table IX : The total score given for Amaranth and Thutikura Dal by six Judges.

Judges	Total score for Amaranth dal	Total score for Thutikura dal.
1	88	85
2	85	79
3	92	74
4	83	79
5	80	83
6	71	78
Mean	83.1	81.3

Table X shows the scores obtained for Amaranth and Guntakalavaraku dal. Their means are almost the same being 79 and 79.6 respectively. The mean score of these two were observed to be not significantly different from each other by t test at 5% level (0.1517; $t_{.05} = 2.228$).

Table X : The total score given for Amaranth and Guntakalavaraku Dal by six Judges.

Judges	Total score for Amaranth Dal	Total score for Guntakalavaraku Dal
1	80	63
2	72	88
3	78	66
4	77	86
5	79	94
6	88	82
Mean	79	79.6

Table XI gives the total scores given by six Judges for Amaranth, Rangula Ponnaganti and Guntaginjaraku dal. Their mean values are 78.4, 64.6 and 66.5 respectively. These values

Table XI : The total score given for Amaranth, Rangula Ponnaganti and Guntaginjaraku Dal by six Judges.

Judges	Total score for Amaranth Dal.	Total score for Rangula Ponnaganti dal.	Total score for Guntaginjaraku Dal.
1	80	78	75
2	75	54	51
3	65	59	53
4	77	56	78
5	81	64	77
6	83	77	65
Mean	78.4	64.6	66.5

were found not significantly different from each other by f test (5.74; $f_{.01}$= 7.56) at 1% level with degrees of freedom 10.

In Table XII the scores given by six judges for Amaranth, Thummikura and Theega Bacchali dal are tabulated.

Table XII - The total score given for Amaranth, Thummikura and Theega Bacchali dal by six judges.

Judges	Total score for Amaranth dal	Total score for Thummikura dal	Total score for Theega Bacchali dal
1	80	55	78
2	88	80	81
3	81	47	86
4	80	71	83
5	94	71	86
6	91	80	73
Mean	85.6	67.3	81.1

Their mean scores are 85.6, 67.3 and 81.1 respectively. Their scores were also found not significantly different at 1% level by f test with degrees of freedom 10 (7.36 $f_{.01}$ = 7.56).

Table XIII gives the scores given by six judges for five chutneys, Gongura (mean score 79), Guntaginjaraku (59.5), Guntakalavaraku (79.3), Chenungaku (80.3) and Chenungaku curds

chutney (77.6). Their scores were found to differ significantly at 1% level with degrees of freedom 20 when subjected

Table XIII : The total score for Gongura, Guntaginjaraku, Guntakalavaraku, Chenungaku, Chutney and Chenungaku Curds chutney given by six Judges.

Judges	Gongura chutney	Guntaginjaraku chutney	Guntakalavaraku chutney	Chenungaku chutney	Chenungaku Curds chutney
1	71	64	69	68	75
2	75	51	85	88	85
3	80	61	82	89	86
4	78	59	80	77	75
5	82	60	82	75	77
6	77	62	78	84	68
Mean	79	59.5	79.3	80.3	77.6

to f test (11.49; $f_{.01} = 4.43$). The might have been due to the low score obtained by Guntaginjaraku Chutney.

Table XIV and XV give the scores obtained for stir fry preparations. In table XIV the scores given by six judges for Amaranth, Thutikura and Gulmetakura stir fry preparations are given. Their mean values being 82.0, 78.8 and 58.8 repsectively, f Test indicated that their scores are slightly different from one another at 1% level with degrees of freedom 10 (7.82; $f_{.01} = 7.56$). This might be due to the low score obtained by Gulmetakura cury.

Table XIV : The total score given for Amaranth, Thutikura and Gulmetakura Stir fry preparations by six Judges.

Judges	Amaranth fry	Thutikura fry	Gulmetakura fry
1 7	79	77	59
2	76	94	60
3	83	57	53
4	80	69	51
5	87	81	37
6	87	95	85
Mean	82	78.8	58.8

Table XV gives the scores for Amaranth, Rangula Ponnaganti and Guntaginjaraku stir fry preparations, their values being 75.1, 77 and 59.5 respectively. The score of these

Table XV : The total score given for Amaranth, Rangula Ponnaganti and Guntaginjaraku stir fry preparations by six Judges.

Judges	Amaranth fry	Rangula Ponnaganti fry.	Guntaginjaraku fry
1	64	78	64
2	74	58	51
3	66	79	61
4	78	72	59
5	90	86	60
6	82	89	62
Mean	75.1	77	59.5

stir fry preparations were also found significantly different from each other when subjected to f test at 1% level with degrees of freedom of 10 (7.996; $f_{.01} = 7.56$). This might be due to the low scores obtained by Guntaginjaraku stir fry preparation.

DISCUSSION

The nutrient content of any plant product differs from sample to sample, due to a number of factors namely location, season, type of soil, fertilisation of the soil and maturity of the sample. This was also observed in the case of the three samples of each leaf analysed for the present study. But these variations in the nutrient content from sample to sample cannot be attributed to the level of fertilization, as the leaves obtained for the present study were not cultivated. They were mostly obtained from the fields and open areas during the same season (from December to February). Hence the variations in the nutrient content from sample to sample can be attributed to the differences in location, type of soil and the maturity of the leaves.

All the nutrients did not vary from sample to sample to the same extent. The values for carotene, Vitamin C, total iron, total Phosphorous, Calcium and Oxalic acid varied considerably from sample to sample of the same leaf. Where as the values for moisture, crude fibre, total ash protein and ether extractives did not vary much. The values of individual samples with their ranges are given in Appendix II (Table-A-3).

To get a representative value of any of the nutrient especially for carotene, iron, phosphorous, calcium and oxalic acid, it is necessary to procure several samples for analysis

and do the individual estimation of each sample or collect samples from different sources, homogenise them and take the homogenate for the analysis. Level of maturity and location of the plant, seemed to be having an effect on the carotene, iron,phosphorous, Vitamin C,calcium and oxalic acid content of the leaves. To see their effect, leaves at different levels of maturity can be analysed.

Most of the leaves analysed are found to be rich in their nutrient content. Their nutritive value is compared with the nutritive value of Amaranth, as this is the most commonly consumed green leafy vegetable in this part of the country.

It is obvious from Fig.1, that Atthelukura and Thummikura have exceptionally high content of crude fibre on fresh weight basis (3.5 and 3.2 gms. % respectively). High values were observed on dry weight basis also. The crude fibre content of these two leaves is 3 1/2 times as that of Amaranth (1 gm.%). Ceylon Bacchali and Theega Bacchali contain very less of crude fibre on fresh weight basis (0.4 and 0.6 gms.% respectively). (These two leaves can be included in low fibre diets.

Rangula Ponnaganti has the highest content of total ash on dry weight basis (23 gms.%) and Thummikura the least (8.9 gms.%). On fresh weight basis (Table II) Atthelukura has the highest content of total ash (4.2 gms.%). The values of total ash on fresh weight basis for Atthelukura Gulmetakura and Guntakalavaraku are remarkably higher (4.2 gms.%, 4 gms.% and 3.6 gms.% respectively),

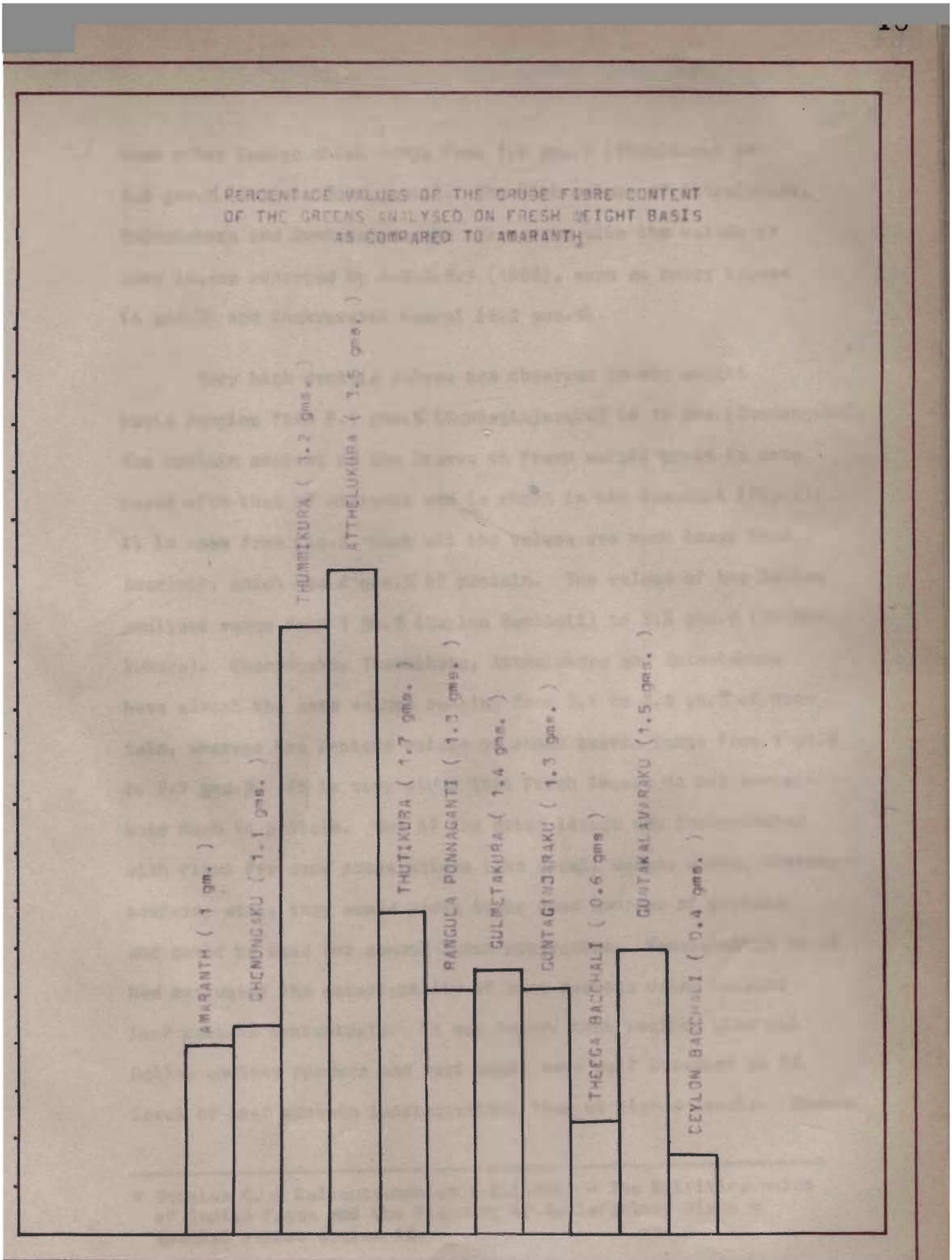
PERCENTAGE VALUES OF THE CRUDE FIBRE CONTENT
OF THE GREENS ANALYSED ON FRESH WEIGHT BASIS
AS COMPARED TO AMARANTH
AMARANTH (1 gm.)
CHENUNGSKU (1.1 gms.)
THUMMIKURA (3.2 gms.)
ATTHELUKURA (3.5 gms.)
THUTIKURA (1.7 gms.)
RANGUGA PONNAGANTI (1.3 gms.)
GULMETAKURA (1.4 gms.)
GUNTAGINJIRAKU (1.3 gms.)
THEEGA BACCHALI (0.6 gms)
GUNTAKALAVARAKU (1.5 gms.)
CEYLON BACCHALI (0.4 gms.)

FIG. 1

than other leaves which range from 1.4 gms.% (Thutikura) to 2.8 gms.% (Rangula Ponnaganti). The high values of Atthelukura, Gulmetakura and Guntakalavaraku correspond with the values of some leaves reported by I.C.M.R.* (1966), such as curry leaves (4 gms.%) and Chakravarti Keerai (4.2 gms.%).

Very high protein values are observed on dry weight basis ranging from 8.1 gms.% (Guntaginjaraku) to 16 gms.(Chenungaku). The protein content of the leaves on fresh weight basis is compared with that of Amaranth and is shown in the barchart (Fig.2). It is seen from Fig.2 that all the values are much lower than Amaranth, which has 4 gms.% of protein. The values of the leaves analysed range from 1 gm.% (Ceylon Bacchali) to 3.5 gms.% (Atthelukura). Chenungaku, Thummikura, Atthelukura and Gulmetakura have almost the same values ranging from 3.1 to 3.5 gm.% of protein, whereas the protein values of other leaves range from 1 gm.% to 2.1 gms.%. It is very clear that fresh leaves do not contribute much to protein. But if the dried leaves are incorporated with flour for some preparations like dosai, wadas, uppma, chutney powders, etc., they would prove to be good sources of protein and could be used for school lunch programmes. Kamalanathan et al had evaluated the acceptability of some recipes using Lucerne leaf protein concentrate. It was found, that recipes like dal balls, chutney powders and ragi adai, were well accepted at 5% level of leaf protein incorporation, than at higher levels. Greens

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* Gopalan C. & Balasubramanian S.C.(1966) - The Nutritive value of Indian Foods and the Planning of Satisfactory Diets - Special report series 42.

PERCENTAGE VALUES OF THE PROTEIN CONTENT
OF THE GREENS ANALYSED ON FRESH WEIGHT
BASIS AS COMPARED TO AMARANTH

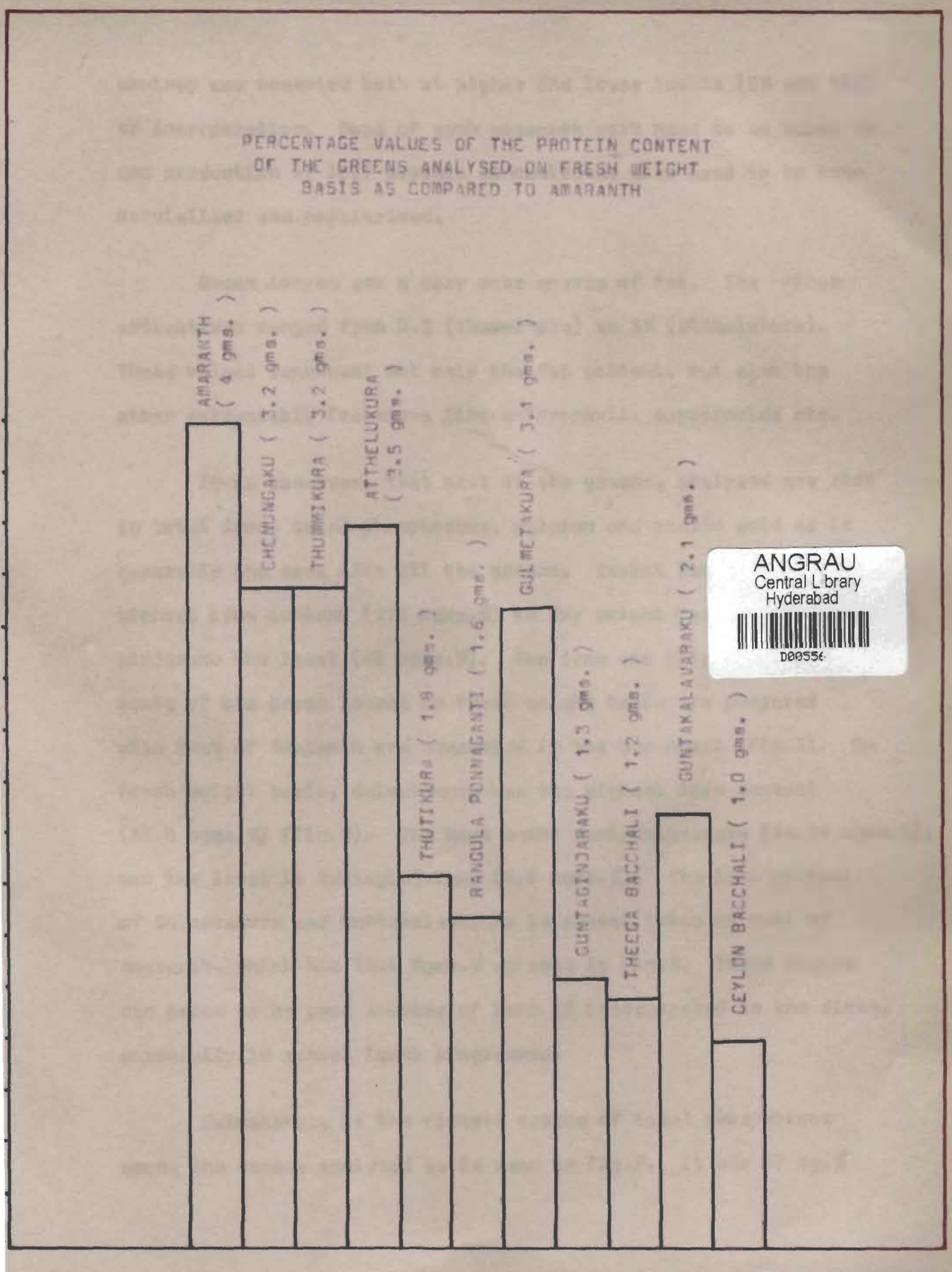

FIG. 2

chutney was accepted both at higher and lower levels (5% and 10%) of incorporation. More of such research work need to be taken up and production of leaf protein concentrates also need to be commercialised and popularised.

Green leaves are a very poor source of fat. The ether extractives ranged from 0.2 (Thummikura) to 3% (Atthelukura). These values represent not only the fat content, but also the ether extractable fractions like chlorophyll, carotenoids etc.

It is observed, that most of the greens, analysed are rich in total iron, total phosphorous, calcium and oxalic acid as is generally the case with all the greens. Ceylon Bacchali has the highest iron content (278 mgms.%) on dry weight basis and Guntaginjaraku the least (48 mgms.%). The iron and phosphorous contents of the green leaves on fresh weight basis are compared with that of Amaranth and presented in the bar chart (Fig.3). On fresh weight basis, Gulmetakura has the highest iron content (45.5 mgms.%) (Fig.3). The next being Guntakalavaraku (44.04 mgms.%), and the least in Guntaginjaraku (6.6 mgms.%). The iron content of Gulmetakura and Guntakalavaraku is almost twice as that of Amaranth, which has 25.5 Mgms.% as seen in Fig.3. These leaves can prove to be good sources of iron if incorporated in the diets, especially in school lunch programmes.

Gulmetakura is the richest source of total phosphorous among the greens analysed as is seen in Fig.3. It has 87 mg.%

K E Y F O R

F I G U R E 3

1. AMARANTH
2. CHENUNGAKU
3. THUMMIKURA
4. ATTHELUKURA
5. THUTIKURA
6. RANGULA PONNAGANTI
7. GULMETAKURA
8. GUNTAGINJARAKU
9. THEECA BACCHALI
10. GUNTAKALAVARAKU
11. CEYLON BACCHALI

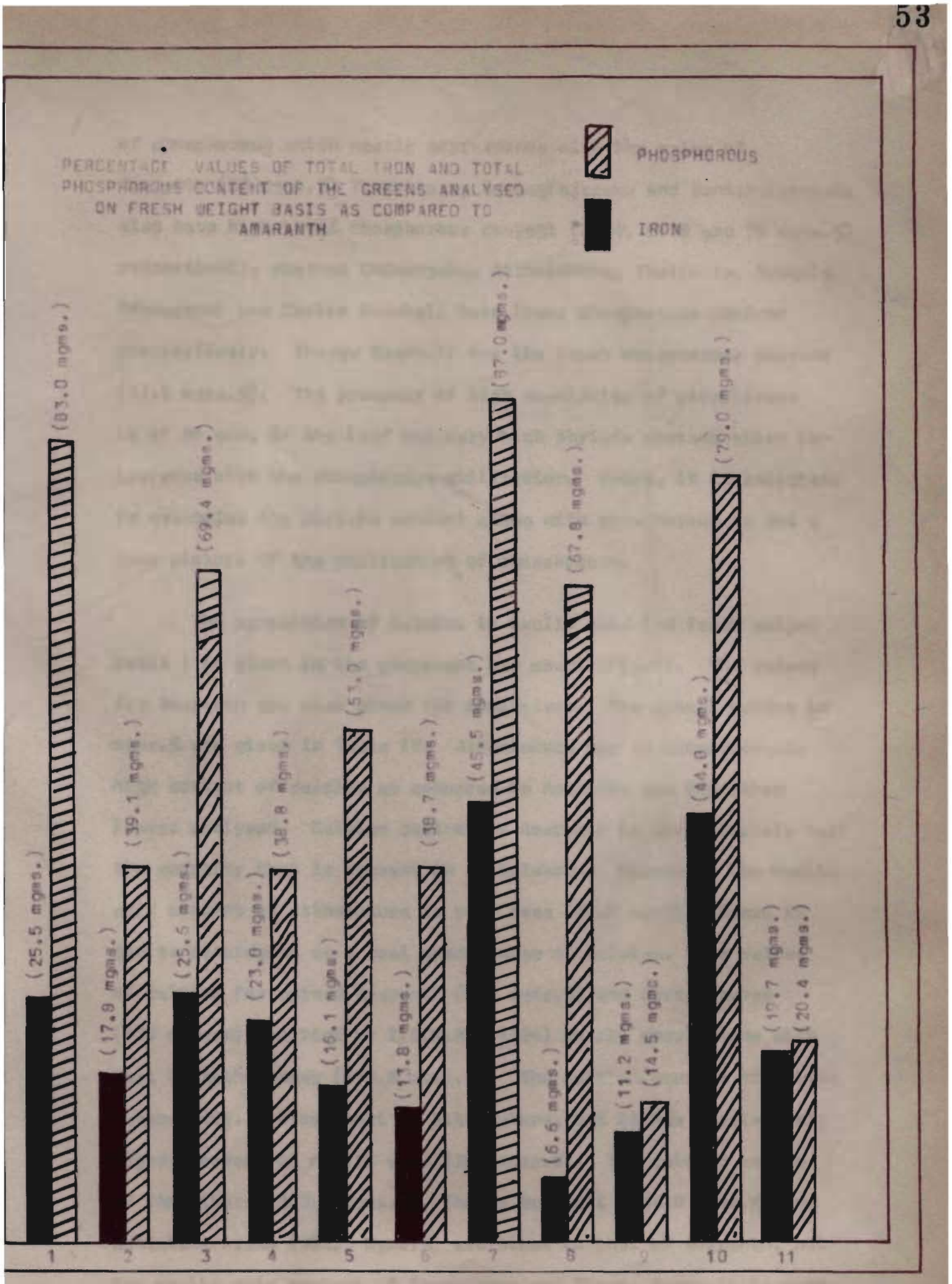
PERCENTAGE VALUES OF TOTAL IRON AND TOTAL PHOSPHOROUS CONTENT OF THE GREENS ANALYSED ON FRESH WEIGHT BASIS AS COMPARED TO AMARANTH
PHOSPHOROUS
IRON
(25.5 mgms.)
(83.0 mgms.)
(17.8 mgms.)
(39.1 mgms.)
(25.6 mgms.)
(69.4 mgms.)
(23.0 mgms.)
(38.8 mgms.)
(16.1 mgms.)
(53.2 mgms.)
(11.8 mgms.)
(38.7 mgms.)
(45.5 mgms.)
(87.0 mgms.)
(6.6 mgms.)
(67.8 mgms.)
(11.2 mgms.)
(14.5 mgms.)
(44.0 mgms.)
(79.0 mgms.)
(10.7 mgms.)
(20.4 mgms.)
1
2
3
4
5
6
7
8
9
10
11

FIG. 3

of phosphorous which nearly corresponds with the value of Amaranth (83 mgms.%) Thummikura, Guntaginjaraku and Guntakalavaraku also have high total phosphorous content (69.4, 67.8 and 79 mgms.%) respectively, whereas Chanungaku, Atthelukura, Thutikura, Rangula Ponnaganti and Ceylon Bacchali have lower phosphorous content comparatively. Theega Bacchali has the least phosphorous content (14.5 mgms.%). The presence of high quantities of phosphorous is of no use, if the leaf has very high phytate content which interferes with the phosphorous utilisation. Hence, it is important to determine the phytate content along with phosphorous to get a true picture of the utilisation of phosphorous.

The proportion of calcium to oxalic acid (on fresh weight basis) is given in the component bar chart (Fig.4). The values for Amaranth are also given for comparison. The actual values in mgms.% are given in Table IV. Atthelukura has an exceptionally high content of calcium as compared to Amaranth and the other leaves analysed. Calcium content of Amaranth is approximately half the quantity that is present in Atthelukura. Moreover, the oxalic acid content of Atthelukura is very less (37.0 mgm%). Hence it can be considered as a real good source of calcium. The values of calcium for spined Amaranth (800 mgms.%) and curry leaves (830 mgms.%) reported by I.C.M.R. (1966) nearly corresponds with that of Atthelukura (815.6 mgms.%). The calcium content of Gulmetakura (491.3) comes next to Atthelukura, but it has a relatively higher content of oxalic acid (282 mgms.%). The calcium values of Thummikura (363.4 mgms.%), Theega Bacchali (324.0 mgms.%) and Guntakalavaraku (382.3 mgms.%) are close to that of Amaranth, but the oxalic acid content of Thummikura and Theega Bacchali is very

PROPORTION OF CALCIUM TO OXALIC ACID OF THE GREENS ANALYSED ON FRESH WEIGHT BASIS AS COMPARED TO AMARANTH

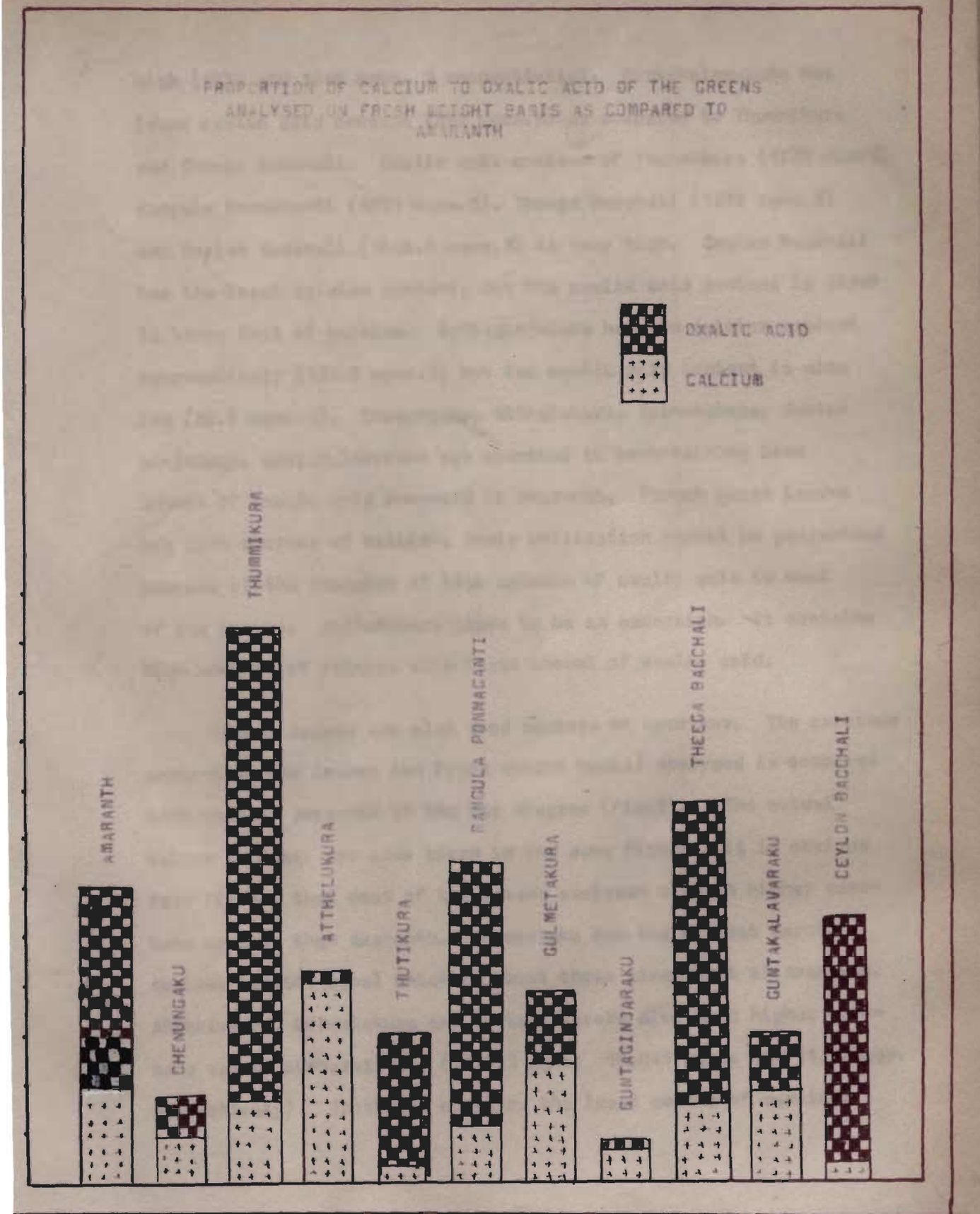

FIG. 4

high (1930 and 1048 mgms. % respectively). Guntakalavaraku has lower oxalic acid content (252 mgms.%) as compared to Thummikura and Theega Bacchali. Oxalic acid content of Thummikura (1930 mgms%) Rangula Ponnaganti (1071 mgms.%), Theega Bacchali (1270 mgms.%) and Ceylon Bacchali (1048.5 mgms.%) is very high. Ceylon Bacchali has the least calcium content, but the oxalic acid content is about 14 times that of calcium. Guntaginjaraku has low calcium content comparatively (135.9 mgms.%) but the oxalic acid content is also low (39.6 mgms.%). Chenungaku, Atthelukura, Gulmetakura, Guntaginjaraku, Guntakalavaraku are observed to becontaining less amount of oxalic acid compared to Amaranth. Though green leaves are rich sources of calcium, their utilization cannot be guaranteed because of the presence of high amounts of oxalic acid in most of the leaves. Atthelukura seems to be an exception. It contains high amounts of calcium with least amount of oxalic acid.

Green leaves are also good sources of carotene. The carotene content of the leaves (on fresh weight basis) analysed is compared with that of Amaranth in the bar diagram (Fig.5). The actual values in µgms. are also given in the same figure. It is obvious from Fig.5., that most of the greens analysed contain higher carotene content than Amaranth. Chenungaku has the highest carotene content (15,583 µgms) which is about three times that of Amaranth. Atthelukura, Gulmetakura and Guntaginjaraku also have higher carotene values comparatively (12,222 µgms; 10,041 µgms. and 11,083µgs. respectively). Thutikura contains the least amount of carotene

KEY FOR

FIGURE 5

1. AMARANTH
2. CHENUNGAKU
3. THUMMIKURA
4. ATTHELUKURA
5. THUTIKURA
6. RANGULA PONNAGANTI
7. GULMETAKURA
8. GUNTAGINJARAKU
9. THEEGA BACCHALI
10. GUNTAKALAVARAKU
11. CEYLON BACCHALI

PERCENTAGE VALUES OF CAROTENE CONTENT OF THE GREENS ANALYSED ON FRESH WEIGHT BASIS AS COMPARED TO AMARANTH

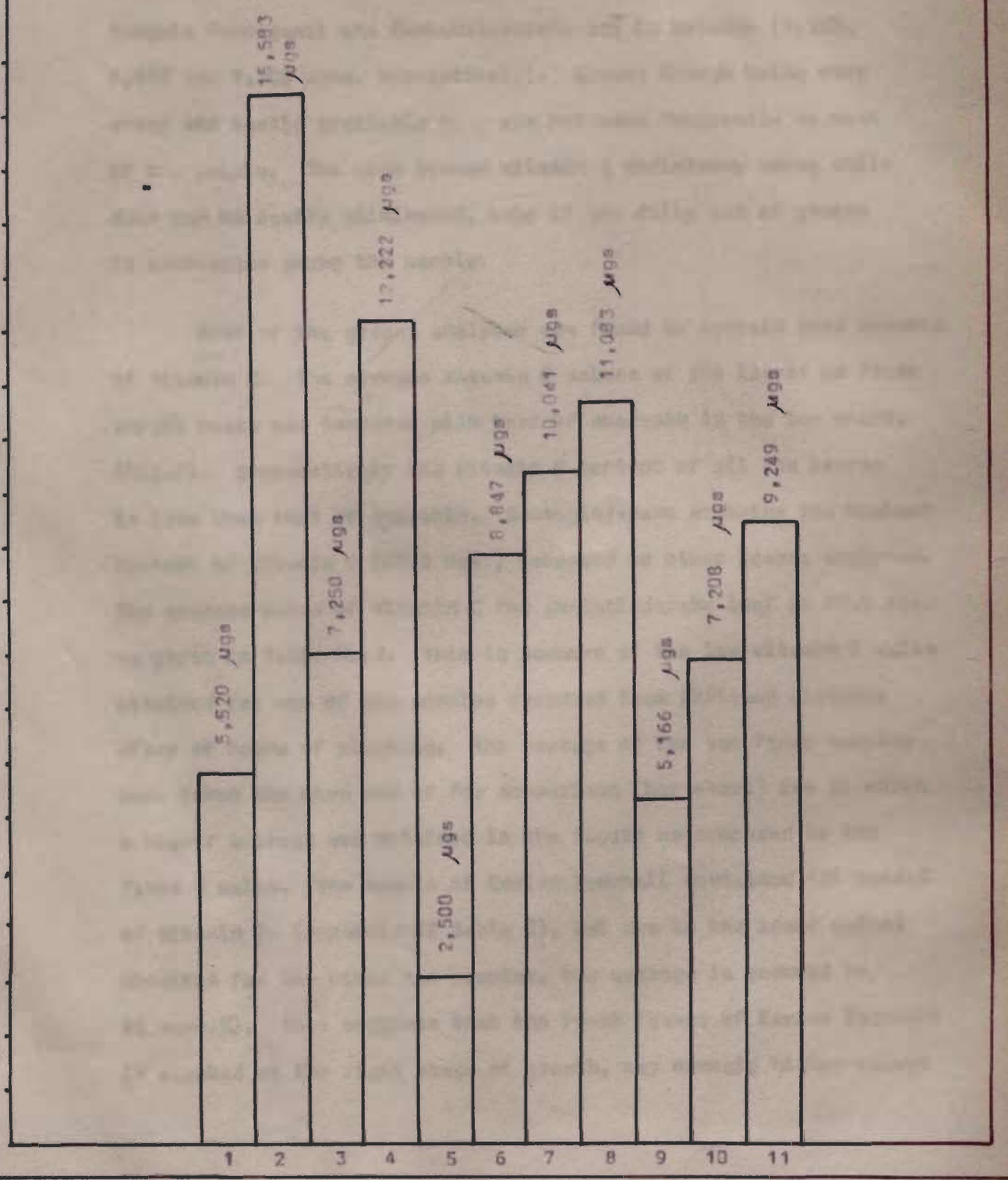

FIG. 5

(2,500 µgms), Theega Bacchali has almost the same amount of carotene (5,166 µgms) as that of Amaranth. The values of Thummikura, Rangula Ponnaganti and Guntakalavaraku are in between (7,250, 8,837 and 7,208 µgms. respectively). Greens though being very cheap and easily available they are not used frequently by most of the people. The wide spread vitamin A deficiency among children can be easily eliminated, only if the daily use of greens is propogated among the people.

Most of the greens analysed are found to contain good amounts of Vitamin C. The average Vitamin C values of the leaves on fresh weight basis are compared with that of Amaranth in the bar chart, (Fig.6). Comparatively the Vitamin C content of all the leaves is less than that of Amaranth. Guntaginjaraku contains the highest content of Vitamin C (97.0 mgs.) compared to other leaves analysed. The average value of Vitamin C for guntaginjaraku leaf is 76.5 mgs. as given in Table No.V. This is because of the low vitamin C value obtained for one of the samples procured from Chittoor district after 48 hours of plucking. The average of the two fresh samples were taken and made use of for comparison (bar chart) due to which a higher average was obtained in the figure as compared to the Table V value. One sample of Ceylon Bacchali contained 120 mgms.% of Vitamin C. (Appendix II Table 3), but due to the lower values obtained for the other two samples, the average is reduced to 85 mgms.%). This suggests that the fresh leaves of Ceylon Bacchali if plucked at the right stage of growth, may contain higher values

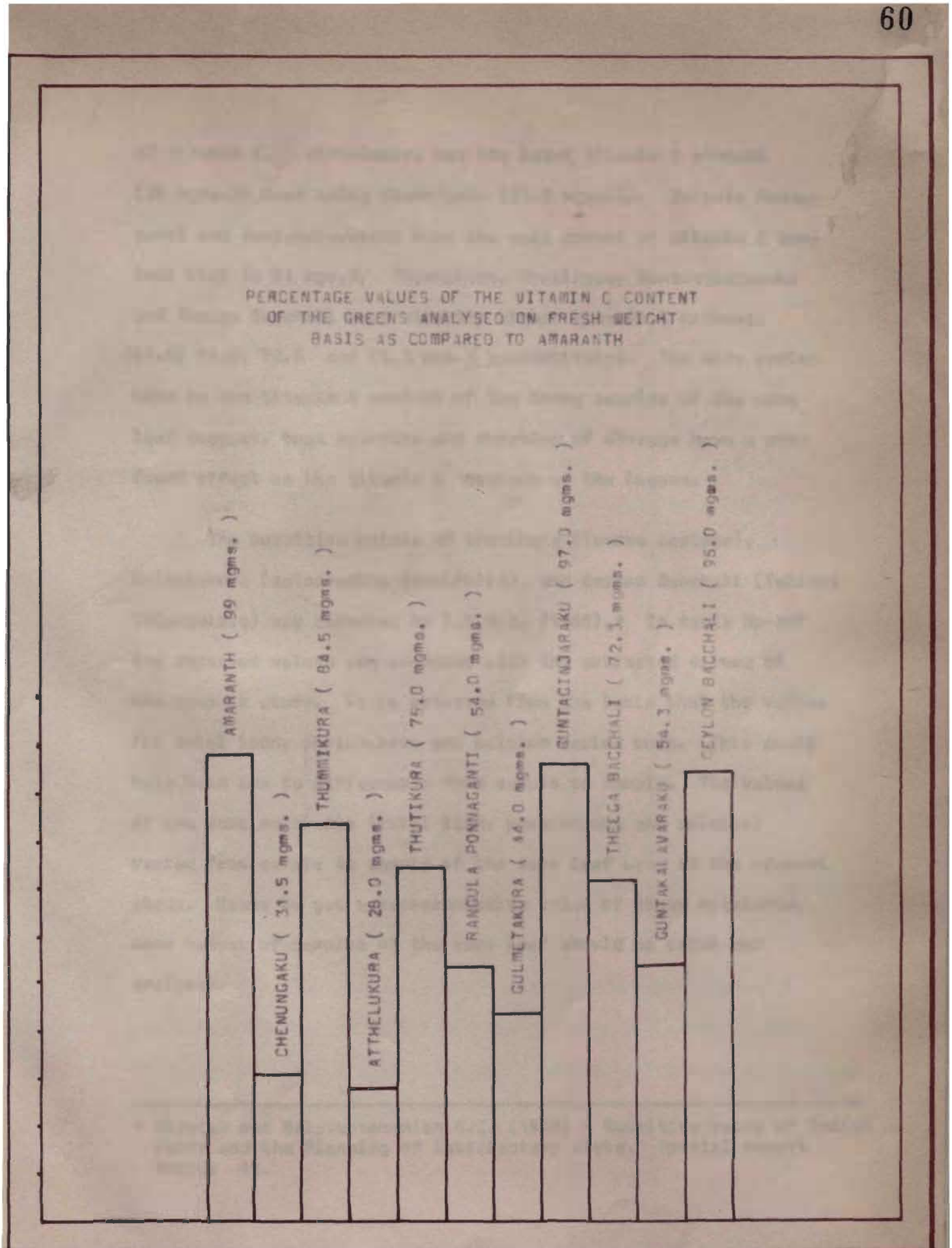
PERCENTAGE VALUES OF THE VITAMIN C CONTENT
OF THE GREENS ANALYSED ON FRESH WEIGHT
BASIS AS COMPARED TO AMARANTH
AMARANTH (99 mgms.)
CHENUNGAKU (31.5 mgms.)
THUMMIKURA (84.5 mgms.)
ATTHELUKURA (28.0 mgms.)
THUTIKURA (74.0 mgms.)
RANGULA PONNAGANTI (54.0 mgms.)
GULMETAKURA (44.0 mgms.)
GUNTAGINJARAKU (97.0 mgms.)
THEEGA BACCHALI (72.3 mgms.)
GUNTAKALAVARAKU (54.3 mgms.)
CEYLON BACCHALI (95.0 mgms.)

FIG. 6

of Vitamin C. Atthelukura has the least Vitamin C content (28 mgms.%) next being Chenungaku (31.5 mgms.%). Rangula Ponnaganti and Guntakalavaraku have the same amount of Vitamin C content that is 54 mgs.%. Thummikura, Thutikura, Guntakginjaraku and Theega Bacchali have slightly higher Vitamin C content. (84.5; 75.0, 76.5 and 72.3 mgs.% respectively). The wide variation in the Vitamin C content of the three samples of the same leaf suggest, that maturity and duration of storage have a profound effect on the Vitamin C content of the leaves.

The nutritive values of Thutikura (Ipomea reptans), Gulmetakura (Astercantha longifolia), and Ceylon Bacchali (Talinum Triangulers) are reported by I.C.M.R. (1966).* In table No-XVI the reported values are compared with the estimated values of the present study. It is observed from the table that the values for total iron, phosphorous and calcium varied much. This could have been due to differences from sample to sample. The values of the same nutrients (total iron, phosphorous and calcium) varied from sample to sample of the same leaf even in the present study. Hence to get a representative value of these nutrients, more number of samples of the same leaf should be taken and analysed.

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* Gopalan and Balasubramanian S.C. (1966) - Nutritive value of Indian Foods and the Planning of Satisfactory diets. Special report Series -42.

Palatability test:

The results of the palatability test showed, that all the recipes put forth for final testing were acceptable. Slight modifications in the basic recipe of dal with greens was necessary for some leaves regarding the proportion of greens to dal. When Guntakalavaraku dal was prepared according to the standard recipe, the judges expressed definite dislike towards the product (mean scores being 52.1 as against 85.1 for Amaranth). But when 12 gms. of Guntakalavaraku leaves were used instead of 50 gms. to the same quantity of dal, it was well accepted. Similarly Thummig-kura and Atthelukura were well accepted when 12 gms. of leaves were used. Thus it is seen that for dal preparation all the leaves cannot be used at the same level.

Dal with greens, stir fry and chutney could not be made with all the leaves. Some were better accepted as chutneys some as dals and others as fries. Thutikura, Gulmetakura and Rangula Ponnaganti were accepted both as stir fries as well as dal with greens, whereas Guntakalavaraku was accepted as dal with greens and in the form of chutney. Guntakalavaraku stir fry was expressed as being bitter and not accepted.

In the case of Thummikura, Atthelukura, Ceylon Bacchali and Theega Bacchali, the dal with greens preparation was made use of and they were all well accepted. Chenungaku leaves were accepted only as curds Chutney and chutney. In fact the curds chutney

TABLE XIV COMPARISON OF THE NUTRITIVE VALUES REPORTED BY I.C.M.R.* (1966) WITH THAT OF THE ESTIMATED VALUES.

Leaves	Moisture (gms)	Crude Fibre (Gms)	Total ash (gms)	Protein (gms)	Total iron (mgs)	Phosphorous (mgs)	Calcium (mgs)	Oxalic acid (mgs)	Carotene (ugms)	Vitamin 'C' (mgs)
1. IPOMEA										
Reported values	90.3	1.2	2.1	2.9	3.9	46.0	110.0	..	3,300	137
Estimated "	85.5	1.7	1.4	1.8	16.1	53.0	76.1%	524.4	2,500	75
2. TALINUM TRIANGULERE										
Reported values	91.2	-	1.9	1.9	0.9	16.00	120.00	..	..	..
Estimated "	92.9	0.4	1.5	1.0	19.7	20.48	77.00	1048	9,249	95
3. ASTERCANTHA LONGIFOLIA										
Reported values	87.2	1.4	2.8	3.0	-	21.00	330.0	..	..	..
Estimated "	80.3	1.4	4.0	3.1	45.5	87.00	491.8	28.2	10,041	44

* Gopalan C. & Balasubrahmanyam S.C.(1966) - Nutritive value of Indian Foods and the Planning of Satisfactory Diets. Special report series 42.

scored much higher than the standard Gongura Chutney (Table XIII). Chenungaku dal was expressed as being very bitter and not accepted. Hence it was not put forth for final testing.

Thus it is seen that the same recipes do not hold good for all the leaves. Each leaf has its own taste and characteristic flavour, which must be carefully studied and then suitable recipes developed and standardised for each leaf separately. Most of the people would not accept a new recipe very easily. Hence the common preparations made with these leaves by the few people who consume these greens should be studied and with necessary modifications, they could be made well acceptable.

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSION

Ten uncommon green leaves were analysed for their moisture, crude fibre, total ash, protein, ether extractives, B Carotene, Vitamin C, total iron and phosphorous, calcium and oxalic acid content.

Results of analysis showed that most of these leaves are rich in total iron, phosphorous, calcium and Vitamin C. Oxalic acid content of these leaves was also found to be high except in the case of Atthelukura (Lactuca runcinata) and Guntajinjaraku (Eclipta alba). Some of the leaves such as Gulmetakura (Astercantha longi Folia) and Guntakalavaraku (Eclipta alba, small variety) contain exceptionally high amounts of iron. Most of the leaves analysed were also found to be rich in B Carotene. (Chenungaku (Cassia occidentalis) and Atthelukura were found to be the richest sources of B Carotene among the leaves analysed.

Maturity seemed to be having an affect on the B Carotene Vitamin C, Oxalic acid and mineral content of the leaves. This aspect can be taken up for further study.

Wide ranges for some nutrients like B Carotene, Vitamin C, Calcium, total Iron, total Phosphorous and Oxalic acid were observed. This might have been due to sampling error. To control this error and to get a representative value for the above mentioned nutrients, many samples of each leaf should be analysed.

There are still some more uncommon edible green leaves that need to be analysed. Along with chemical analysis supplementary studies can also be taken up with these leaves. The dried leaf powders can be used for such supplementary studies as they have a high protein content. The true protein content; the essential amino acid pattern can also be studied.

Along with chemical analysis acceptability tests were conducted and all these leaves were found to be well accepted. The standardisation of the recipes with these uncommon foods and testing them for their acceptability is very essential for popularising such rare nutritious foods among the public.

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APPENDICES

APPENDIX I

SCORE CARD FOR THE PALATABILITY TEST

Name of the Judge Date Time

Please check for each quality in the appropriate block. Proceed in the given order. Please finish evaluating one quality and then only proceed to the next. Evaluate one recipe at a time.

Scores	1	2	3	4
I. Appearance				
1. Very pleasing ..				
2. Moderately pleasing				
3. Neither pleasing nor displeasing ..				
4. Slightly unpleasent				
5. Unpleasant ..				
II. Colour				
1. Well enhanced ..				
2. Natural green colour ..				
3. Colour fairly well preserved ..				
4. Slightly discoloured(greenish brown).				
5. Highly discoloured or brown ..				

..2

Scores	1	2	3	4
III. Texture				
1. Very tender to eat ...				
2. Moderately tender				
3. Fairly soft ...				
4. Hard & fibrous ..				
5. Very fibrous ..				
IV. Odour				
1. Odour of well cooked greens (sweet & sour)..				
2. Odour of un-cooked greens ..				
3. Slightly foreign				
4. No odour at all.				
5. Very unpleasent.				
6. Odour resembling sulphur compounds				
V. Sourness				
1. Fairly sour ..				
2. Slightly less sour ..				
3. Not sour ..				
4. Very sour ..				

..3.

Scores	1	2	3	4
VI. Taste				
1. Excellent ..				
2. Very good ..				
3. Good ..				
4. Bland ..				
5. Very bland ..				
6. Insipid ..				
VII. Doneness				
1. Well cooked ..				
2. Fairly well cooked ..				
3. Slightly over cooked ..				
4. Slightly under cooked ..				
OVER ALL ACCEPTABILITY :				
1. Acceptable ..				
2. Neither liked nor disliked ..				
3. Not acceptable..				

APPENDIX II

: Percentage of proximate principles of Chenungaku leaves.

e	Moisture (gms)	On dry weight basis			
		Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives.(gms)
i)	80.38	5.14	10.40	15.92	10.38
i)	79.86	5.04	10.62	15.92	10.36
i)	78.49	5.67	10.74	15.75	10.60
i)	78.47	5.82	10.72	15.75	10.90
i)	80.20	6.10	10.30	16.28	11.90
i)	80.43	6.25	10.25	16.28	11.12
s*	1.96	1.21	0.49	0.53	1.54

: Percentage of vitamins and minerals of Chenungaku leaves.

s	Carotene (µgms)	Vitamin C (mgms)	Oxalic acid (mgms)	On dry weight basis		
				Iron (mgms)	Phosphourous (mgms)	Calcium (mgms)
i)	16,250	23.2	145.8	90.0	181.0	860
i)	16.250	23.2	145.8	90.0	181.0	860
i)	15,000	32.0	152.0	47.0	211.0	826
i)	15,000	32.0	162.0	47.0	211.0	826
i)	15,500	39.2	140.0	125.0	184.0	1280
i)	15,000	39.2	140.0	125.0	184.0	1280
s	1,250	16.0	22.0	78.0	30.0	454

ference between the maximum and minimum values.

: Percentage of proximate principles of Thummikura leaves.

e	Moisture	On dry weight basis			
	(gms)	Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives (gms)
)	72.50	10.70	8.90	12.25	6.42
)	73.00	11.32	8.82	12.25	6.55
)	73.00	12.40	9.02	11.02	7.93
)	72.65	12.82	9.18	11.02	7.81
)	71.14	11.91	8.70	11.72	6.25
)	71.52	11.20	8.75	11.72	6.40
s	2.14	2.12	0.48	1.18	1.58

: Percentage of vitamins and minerals of Thummikura leaves.

:	Carotene	Vitamin C	Oxalic acid	On dry weight basis		
	(µgms)	(mgms)	(mgms)	Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
.)	7000	73.50	1998.0	85.0	266.6	1170
.)	7500	73.50	-	85.0	266.6	1186
.)	6500	100.00	1917.0	78.3	253.0	1258
.)	6500	100.00	1917.0	78.3	253.0	1258
)	8000	80.00	1876.5	115.0	232.0	1440
.)	8000	80.00	1876.5	115.0	232.0	1560
)	1500	27.00	121.5	36.7	35.0	390

C(1) : Percentage of proximate principles of Atthelukura leaves.

Sample No.	Moisture (gms)	On dry weight basis			
		Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives (gms)
1 (i)	72.13	13.54	16.52	13.12	10.76
(ii)	71.64	13.00	16.72	13.12	10.92
2 (i)	72.53	11.60	13.60	12.80	11.24
(ii)	72.30	12.12	14.00	12.80	11.80
3 (i)	72.42	12.00	15.12	12.60	10.35
(ii)	72.60	12.50	15.22	12.60	10.56
Ranges	0.99	1.94	3.12	0.52	1.45

C(2) : Percentage of vitamins and minerals of Atthulukura leaves.

Sample No.	Carotene (µgms)	Vitamin C (mgms)	Oxalic acid (mgms)	On dry weight basis		
				Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
1 (i)	14,167	24.0	54.0	35.0	128.0	3000
(ii)	16,667	24.0	54.0	35.0	128.0	3010
2 (i)	11,250	38.0	38.0	48.3	164.0	2940
(ii)	11,250	38.0	38.0	48.3	164.0	2940
3 (i)	10,000	24.0	21.6	65.0	120.0	2880
(ii)	10,000	24.0	21.6	65.0	120.0	2880
Ranges	4,167	14.0	32.4	30.0	44.0	130

D(1) : Percentage of proximate principles of Thutikura leaves.

Sample No.	Moisture	On dry weight basis			
	(gms)	Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives(gms)
1 (i)	85.70	10.40	9.18	12.80	4.34
(ii)	86.60	11.00	9.20	12.80	4.45
2 (i)	85.00	11.41	9.66	12.50	4.81
(ii)	85.00	12.00	9.71	12.50	4.92
3 (i)	85.23	12.01	10.50	13.00	3.97
(ii)	85.23	12.30	10.39	13.00	3.96
Ranges	1.37	1.90	1.30	0.5	0.96

D(2) : Percentages of vitamins and minerals of Thutikura leaves.

Sample No.	Carotene	Vitamin C	Oxalic acid	On dry weight basis		
	(µmgs)	(mgms)	(mgms)	Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
1 (i)	2,500	63	529.2	101.25	372	1200
(ii)	2,500	63	529.2	101.25	372	1200
2 (i)	3,000	78	540.0	106.25	372	1240
(ii)	3,000	78	540.0	106.25	372	1240
3 (i)	2,000	84	504.0	125.00	352	1280
(ii)	2,000	84	504.0	125.00	352	1280
Ranges	1,000	21	36.0	23.75	20	80

E(1) : Percentage of proximate principles of Rangula Ponnaganti leaves.

Sample No.	Moisture (gms)	On dry weight basis			
		Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives (gms)
1 (i)	88.10	11.90	23.57	12.80	10.27
(ii)	87.50	11.52	23.61	12.80	10.30
2 (i)	88.00	9.14	23.00	13.60	9.24
(ii)	88.38	9.82	22.50	13.60	9.36
3 (i)	88.44	10.22	23.01	13.30	10.15
(ii)	88.02	11.00	23.00	13.30	10.10
Ranges	0.94	2.76	1.11	0.80	1.27

E(2) : Percentage of vitamins and minerals of Rangula Ponnaganti leaves.

Sample No.	Carotene (µmgms)	Vitamin C (mgms)	Oxalic acid (mgms)	On dry weight basis		
				Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
1 (i)	8,000	48	-	105	388	1800
(ii)	8,000	48	1107	105	388	1800
2 (i)	8,750	56	1080	150	352	1840
(ii)	8,750	56	1080	150	352	1840
3 (i)	10,000	60	1026	80	214	2200
(ii)	9,583	60	1026	80	214	2200
Ranges	2,000	12	81	70	166	400

G(1) : Percentage of proximate principles of Guntaginjaraku leaves.

Sample No.	Moisture (gms)	On dry weight basis			
		Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives (gms)
1 (i)	85.40	9.02	12.85	9.62	7.35
(ii)	85.53	9.80	13.01	9.62	7.34
2 (i)	86.91	10.15	13.27	10.50	7.20
(ii)	86.60	10.70	13.41	10.50	7.20
3 (i)	86.20	9.50	13.20	9.20	6.90
(ii)	86.63	10.00	13.12	9.20	6.98
Ranges	1.51	1.68	0.56	1.30	0.45

G(2) : Percentage of vitamins and minerals of Guntaginjaraku leaves.

Sample No.	Carotene (µmgs)	Vitamin C (mgms)	Oxalic acid (mgms)	On dry weight basis		
				Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
1 (i)	11,250	35.50	43.2	46.0	496	980
(ii)	11,250	35.50	43.2	46.0	496	980
2 (i)	10,750	90.00	40.5	43.3	512	1040
(ii)	10,750	90.00	40.5	43.3	512	1040
3 (i)	11,000	104.00	35.1	55.0	464	1000
(ii)	12,000	104.00	35.1	55.0	464	1020
Ranges	750	68.50	8.1	11.7	48	40

H(1) : Percentage of proximate principles of Theega Bacchali leaves.

Sample No	Moisture (gms)	On dry weight basis			
		Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives (gms)
1 (i)	91.72	7.30	20.17	14.90	10.01
(ii)	91.45	7.30	20.20	14.90	10.24
2 (i)	91.90	8.20	22.14	14.35	10.00
(ii)	91.71	8.00	22.08	14.35	10.14
3 (i)	91.60	7.54	21.60	14.00	9.90
(ii)	91.22	7.70	21.50	14.00	9.80
Ranges	0.68	0.89	1.97	0.90	0.44

H(2) : Percentage of vitamins and minerals of Theega Bacchali leaves.

Sample No.	Carotene (µmgs)	Vitamin C (mgms)	Oxalic acid (mgms)	On dry weight basis		
				Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
1 (i)	5000	70.00	1377	110	196	3960
(ii)	5000	70.00	1377	110	196	3960
2 (i)	6000	74.00	1215	117	180	4000
(ii)	6000	74.00	1215	117	180	4000
3 (i)	4500	73.00	1219	175	144	3608
(ii)	4500	73.00	1219	175	144	3608
Ranges	1500	4.00	162	65	52	392

I(1) : Percentage of proximate principles of Guntakalavaraku leaves.

Sample No.	Moisture	On dry weight basis			
		Crude fibre	Total ash	Protein	Ether extractives (gms)
	(gms)	(gms)	(gms)	(gms)	
1 (i)	82.32	8.40	20.40	11.55	5.54
(ii)	82.10	8.70	20.62	11.55	5.50
2 (i)	82.20	9.10	19.80	11.02	6.10
(ii)	82.04	9.00	20.00	11.02	6.04
3 (i)	81.22	8.30	20.71	12.10	6.20
(ii)	81.60	8.70	20.85	12.10	6.13
Ranges	1.10	0.80	1.05	1.08	0.70

I(2) : Percentage of vitamins and minerals of Guntakalavaraku leaves.

Sample No.	Caretene	Vitamin C	Oxalic acid	On dry weight basis		
				Iron	Phosphorous	Calcium
	(µgms)	(mgms)	(mgms)	(mgms)	(mgms)	(mgms)
1 (i)	7,500	49.0	184.0	200	436	2160
(ii)	7,250	49.0	178.2	200	436	2160
2 (i)	6,250	59.5	283.5	225	476	2100
(ii)	6,250	59.5	283.5	225	476	2100
3 (i)	8,000	54.6	292.0	295	400	2080
(ii)	8,000	54.6	292.0	295	400	2080
Ranges	1,750	10.5	113.8	95	76	80

3(1) : Percentage of proximate principles of Ceylon Bacchali leaves.

Sample No.	Moisture	On dry weight basis			
	(gms)	Crude fibre (gms)	Total ash (gms)	Protein (gms)	Ether extractives (gms)
1 (i)	92.43	4.72	21.70	14.70	3.53
(ii)	93.83	4.30	21.60	14.70	3.62
2 (i)	93.34	6.52	21.00	14.20	4.20
(ii)	91.36	6.15	21.20	14.20	4.25
3 (i)	93.30	5.92	21.15	15.05	3.40
(ii)	93.30	5.90	21.70	15.05	3.50
Ranges	2.47	2.22	0.60	0.85	0.85

3(2) : Percentage of vitamins and minerals of Ceylon Bacchali leaves.

Sample No.	Carotene	Vitamin C	Oxalic acid	On dry weight basis		
	(µgms)	(mgms)	(mgms)	Iron (mgms)	Phosphorous (mgms)	Calcium (mgms)
1 (i)	9,000	[illegible]	972.0	280	316	1080
(ii)	9,250	[illegible]	972.0	280	316	1100
2 (i)	8,750	[illegible]	1066.5	285	272	1040
(ii)	8,750	[illegible]	1066.5	285	272	1040
3 (i)	9,750	[illegible]	1107.0	270	280	1400
(ii)	9,999	[illegible]	1107.0	270	280	1400
Ranges	1,249	[illegible]	135.0	15	44	360