

COMMON VEGETABLES OF THE TRIBALS OF TRIPURA



Tejendra Bhakta

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FOREWORD

Wild edible plants have always attracted the attention of research workers. In different parts of our country the tribal people use a number of wild plants or plant parts, which are locally available. So it will be interesting to know the nutritional status of these plants.

In this work on vegetables used by the tribals of Tripura Dr. Tejendra Bhakta has described about 21 (twenty one) plants or plant parts and their nutritional aspects has also been discussed. This type of work may reveal some non-conventional food plants, which might help to solve the increasing food problem of the future world. Local uses of some of these plants as remedies have an added attraction of this work. I thank the author for his honest attempt.

Retired Reader,

Dr. N. K. Chakraborty

Department of Botany,

M.B.B. College, Agartala.

D. N. Saha
Governor of Tripura



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GOVERNOR OF TRIPURA

MESSAGE

The Book “Common Vegetables of the Tribals of Tripura” Dr. Tejendra Bhakta, Asstt. Professor in Pharmacy, Regional Institute of Pharmaceutical Science and Technology, Agartala, is quite enlightening on biodiversity in Tripura. On the correct, positive and healthy approach to biodiversity depends the sustenance and future existence of mankind.

Nestled in the extreme corner of the North-Eastern Region about 60% of the total geographical area of the State is extensively forested with dense and varied species of forest. Its tropical monsoon climate and loamy and sandy alluvial soils have contributed greatly towards growing of a variety of nutritive and medicinal plants, in abundance, in remote hilly areas of the State. To spotlight on it the author has worked painstakingly to make people aware of the flora of the State, which are so very conducive to both for food as well as for medicinal purpose.

In this book, the author has marked out twentyone variety of plants and their nutritional properties, which would be very helpful to those working in the fields of herbs and plants and ayurvedic medicine and researchers. It would also enable them to select proper food items according to their physiological condition and deficiency disorder in order to sustain and lead good health and vigorous life.

I commend the author for his efforts, the Tripura State Tribal Cultural Research Institute and Museum, Govt. of Tripura for extending their financial assistance in bringing out this book.

D. N. Sahaya
Governor of Tripura.

MESSAGE

I am very much pleased to note that like preceding years, Tripura State Tribal Cultural Research Institute, Govt. of Tripura is going to publish a new scientific plant-based brochure, "Common vegetables of the Tribals of Tripura"—by Dr. Tejendra Bhakta.

This rare work of Dr. Tejendra Bhakta, Asst. Professor, RIPSAT, Agartala on different plant parts is the refined fruit of his good attempt in this respect, wherein he has explained systematically 21 plant products in relation to their nutritional aspect, food preparation techniques, contamination of food, medicinal values, etc. Dr. Bhakta has enlightened the biodiversity of the plants of Tripura and their conservation, and tribal participation in environmental management to maintain happy and healthy life.

In fine, I thank cordially Dr. Bhakta for taking pains for this valuable work and hope that this brochure will be helpful for further research and analytical studies in this field.

J. D. TRIPURA

Director,

Tribal Research & Cultural Institute,
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MESSAGE

The fundamental requirement of a living organism is Oxygen, water and food. In case of a human, in the present context, the basic needs are food, clothings, shelter, drinking water and fuel. Alongwith these factors the provision of education, health services and communication facilities have become necessary inputs for maintaining a healthy society.

The importance of food and its relation to health and power to work, has been established scientifically. Nutritional level of the food is a very important factor we have to consider.

In 1798, Thomas Robert Malthus in his famous article "Essay on the Principle of Population" hypothesised that the rate of growth of population would surpass the growth rate of food production, thereby creating food shortage situation. His hypothesis was proved wrong in the nineteenth and twentieth centuries, because of emergence of Science and Technology. Initially, it was through the expansion irrigation and then through the use of fertilizers, pesticides, fungicides etc. the agricultural production was boosted. At a later stage in the mid twentieth century technological innovations in the field of seeds technology with the invention of high yielding varieties and genetically modified seeds the "Green Revolution" was initiated. But at the end of the twentieth century when the population of the world has already crossed six billion mark, the Malthus Hypothesis needs re-view, under the new circumstances. This large population, specially in Asia and Africa will need huge supply of food materials. The traditional food items are already in short supply. The horizontal expansion of agriculture and vertical increase of productivity of the traditional food items are no longer sufficient to feed this increasing population. Therefore the scientific community all over the world is engaged in finding out alternative, non-traditional food items.

PREFACE

It is known that, for quiet sometimes now, the sea-food of both animal and plant origin has become popular world over. In the recent years, under-water cultivation of sea-weeds and plants (e.g. kelp), in the coastal regions of Japan and China has become quite common. As a result, the possibility to supplement traditional food with non-traditional items having good nutritional values, have become brighter.

In the present publication "Common Vegetables of the Tribals of Tripura" Dr. Tejendra Bhakta, Assistant Professor of Pharmacy, Regional Institute of Pharmaceutical Science and Technology, Agartala, an affiliated institute under Tripura University, has very meticulously examined twenty-one species of vegetables and leaves herbs, consumed by the tribal population of Tripura, alongwith some other cereal food.

The author has tried to study, scientifically, the nutritional value of these food materials (tubers, shoots, fruits, flowers and leaves) including their taxonomy, distribution, varieties, food values, processing and medical values. The bio-chemical analysis of these food items has also been attempted to show the content of carbohydrate, protein, minerals and vitamins in each of them.

In my opinion this book will be a very handy source material for the students, researchers, medical practitioners and social workers. The information accumulated from various sources will definitely be of great help, also, to the dietitians and food technologists.

D. K. Basu

PREFACE

Looking at the indispensability and improving utility of different vegetables, it has become a greater responsibility of the people to be aware about vegetables, their nutritive and medicinal values, which are in use so that the health of an individual is ensured. Keeping in view such aspects initiation has been taken about some plant parts commonly used as vegetables by the tribals of Tripura to explain their nutritive values and related information. The lack of a comprehensive book giving details of the vegetables used by the tribals in a systematic manner has been felt for long. So when the Tribal Research Institute, Govt. of Tripura, Agartala approached to me to perform a project, I gladly accepted the offer without any hesitation. The main purpose of the brochure is to acquaint those who are interested in nutritive and medicinal aspects with the facts and principles of such tribal food habits. This brochure provides a brief outline of some basic aspects of human health, diseases, nutrition etc. and includes detailed information on the nutritive values of some commonly used vegetables by the tribals of Tripura. This brochure also reflects the methods of food preparation technique, pre and post contamination of food during processing. The role of healthy environment and personal hygiene in relation to food contamination are also explained briefly. This booklet might be useful to individuals and institutions in the formulation of balanced diets through a judicious choice suited to their needs. The information contained here will be helpful to serve the needs of home scientists, general public, medical practitioners, public health workers and pediatricians. Care has been exercised to collect valuable suggestions and information from scientists, field workers, literate and illiterate tribal from different communities, and also from other sources like books, bulletins, national and international journals, unpublished mimeographs etc. About 21 (twenty one) vegetables have been discussed in this brochure. Some more vegetables used by the tribals will be discussed in the subsequent volumes.

Finally, I shall consider all my efforts well spent if this brochure directly or even indirectly helps in the selection or awareness of vegetables according to the need of the tribal and other communities of Tripura, India.

1st June, 2002,
Agartala.

Dr. Tejendra Bhakta

ACKNOWLEDGEMENT

To start with, I have the pleasure to sincerely thank Shri M. L. Reang, Director, Tribal Research Institute, Govt. of Tripura, Agartala for his patience in giving me sufficient time to complete the project work.

I then convey my deep gratefulness to Dr. N. K. Chakraborty, ex-Reader, M. B. B. College, Agartala Mr. N. Bhattacharjee, Asst. Controller, Tripura University and Dr. B. B. Goswami, Principal, RIPSAT, Agartala for giving me untiring help and for recommending various suggestions for improvement of my work.

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Dr. Tejendra Bhakta

PREFACE

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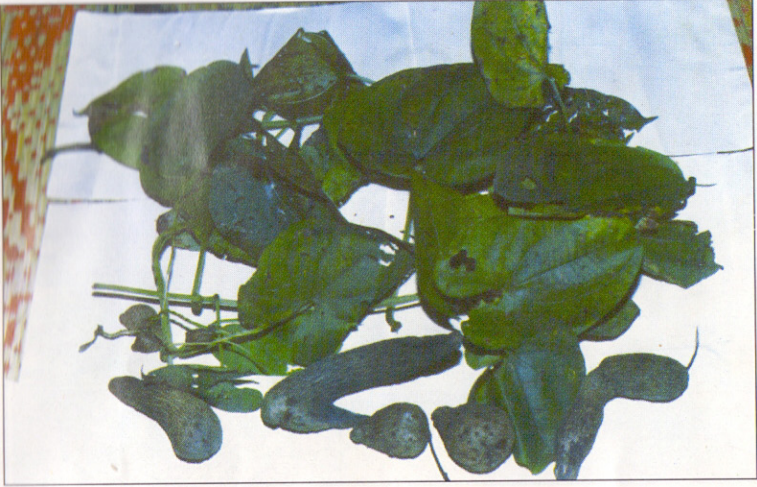
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Tripura is a land-locked small state in the North Eastern Region of India. The state covers an area of 10,477 Sq. Kms. and the shape of the territory is irregular. Out of the total area, about 3552 Sq. Kms. are occupied with dense mixed type of forest. Tripura with its different agro-climatic zone, habitats and forest types has potential of growing plants and other vegetable crops. Numbers of high and low hills, valleys, fountains, lovely lakes and winding rivers enhance the natural beauty of Tripura. The state is covered with an evergreen forests, most deciduous forests, secondary forests, marshy and aquatic habitats offering wide ranging of habitats for growth of all types of plants, vegetables and shrubs etc. whether aquatic or terrestrial shade loving or light demanding. The natural beauty of this state attracts not only the people of Tripura, but the people of other states too. The population of Tripura is heterogeneous which comprises the Bengalees, the Manipuris, the Muslims and the Tribal. The tribal people of mongoloid origin have been living in Tripura from the very early times. The current official list reflects the main tribal groups like Tripuris, Noatias, Jamatias, Reangs, Kukis, Garos, Halams, Santals, Moghs, Chakmas, Oraons, Mundas, Lushais, Khasias, Bhils, Uchais, Lepchas, Bhutias and Chaimals. Tripura has a long historic past of its unique tribal culture and a fascinating folklore. Most of the tribals live comfortably and freely on the hills, hillocks and villages covered by the dense forest. Traditionally they are maintaining symbiotic relationship with the forest, and their food also comprises forest products. The tribals especially women are familiar with the various types of forest products generally available in the dense parts of hills. In the rainy season most of the hills are covered by fast growing vegetation. In this time they collect their favourite edible forest products like different types of **thabolong** (wild yams), **muia** (bamboo shoots), **biring** (*Alpinia* sp.), **gandrui** (*Alocasia odora*), **batema** (*Amorphophallus campanulatus*), **pachok** and **gantha** (*Lasia spinosa*), **muikhonchok** (*Diplazium polypodioides*), **laifang** and **muikhon** (*Musa acuminata*), **mui khumu** (mushroom), **yongchok** (*Parkia javanica*) etc.

Socio-economic conditions of the majority of tribals are below the normal level. Hence they have great demand for these forest resources during the scarcity of food especially in winter season. In this season the majority of tribals of rural areas have to depend on these forest resources. Not only that, sometimes during scarcity of food they make up their economic demand by selling these products in the local market. Tribals are consuming varieties of forest products as a substitute

of rice and food without knowing their nutritive values. It has come to the knowledge from literature survey that these vegetables have a good nutritive values providing rich sources of vitamins and minerals, and fair amount of fat, protein and carbohydrate. With these fresh vegetables, tribals prepare various types of delicious dishes following their traditional methods by using minimum spices and almost without oil. This type of prepared food is very nutritious for health. In spite of socio-economically and educationally undeveloped tribe communities, they are maintaining their stout physique and profound health with these foods. On literature survey it is also reflected that these vegetables have an excellent medicinal activities. By knowing nutritive values and medicinal activities, these vegetables have great demand to the other communities in the local market. It is also noticed that nutritive values of some uncommon favourite vegetables used by the tribals are yet to be determined. Therefore, one should take the initiation to find out the actual food values of these uncommon vegetables for the benefit of tribals and other communities. During field survey another important thing is revealed that shifting of jhum cultivation, poverty, inadequate resources due to over population, illiteracy are the basic sources paving the way for massive deforestation, which threatens the sustenance of the forest base. The basic human needs food, fuel, shelter and employment for a large section of tribals impinge of scarce resources, which ultimately lead to greater poverty.

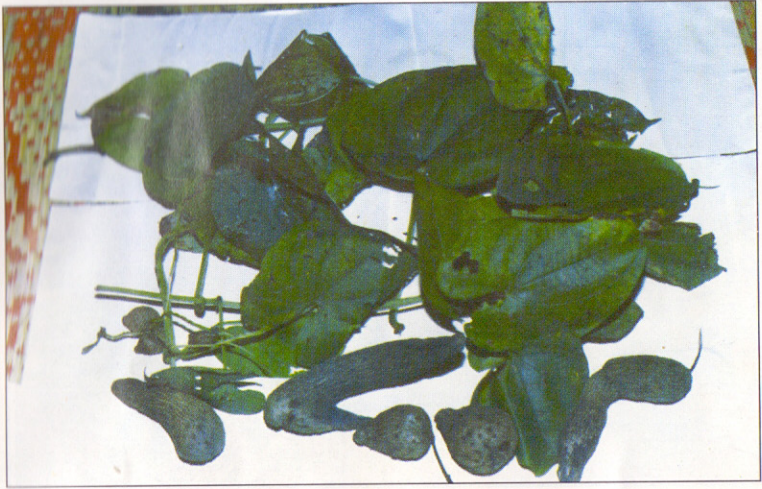
In the subsequent chapters, the importance of health, nutrition and diseases are considered actively. Food is necessary for the normal growth and development of our body. It serves to nourish or build up the tissue or to supply energy to the body. Food habits in different regions depend on the local availability of the food and dietary patterns necessary to sustain the normal health. In this regard the selection of proper foods with full knowledge is essential for sustaining good health and vigorous life. It is very unfortunate to note that in Tripura majority of the people selects their food items without knowing exact nutritive and medicinal values. It is also important to select the proper food items according to the individual's physiological condition and deficiency disorder concern. In this text some vegetables generally consumed by the tribal are summarized with nutritive and medicinal values. Different topics associated with the food value like food processing, food contamination, precaution to check the contamination, personal hygiene, environmental health etc. are explained in the subsequent chapters.



4.1.1a Thaduk buduk tei bwthai (*Dioscorea alata*)



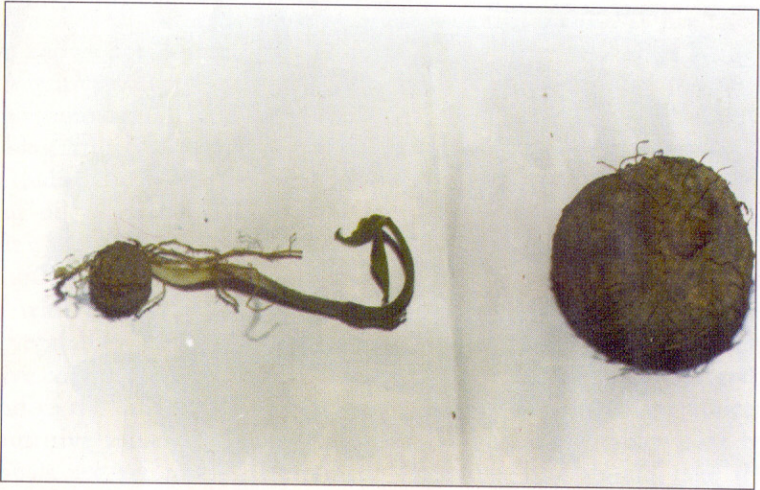
4.1.1b Thaduk (Tubers of *Dioscorea alata*)



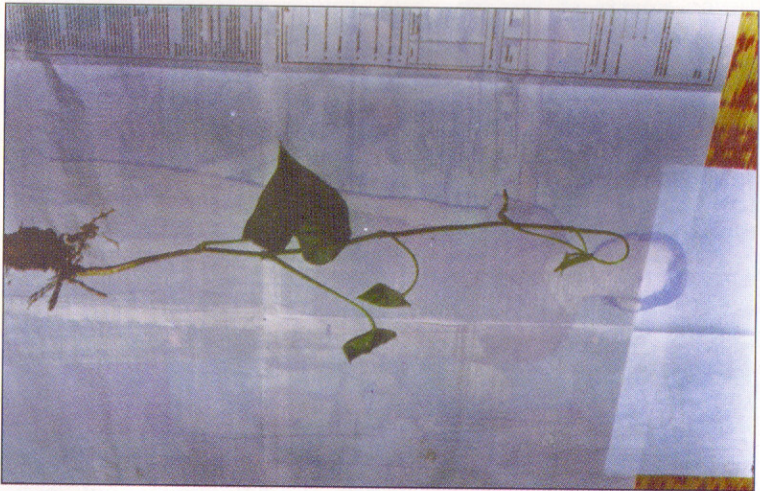
4.1.1a Thaduk buduk tei bwthai (*Dioscorea alata*)



4.1.1b Thaduk (Tubers of *Dioscorea alata*)



4.1.2 Thwngwi tei susunda (*Dioscorea bulbifera*)



4.1.3a Thaktwi waksa bubuk (*Dioscorea esculenta*)



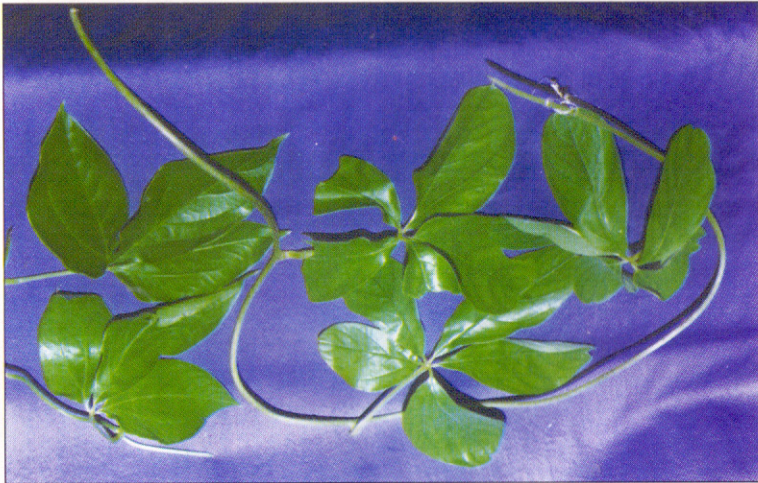
4.1.3b Thaktwi waksa (Tubers of *Dioscorea esculenta*)



4.1.4 Thakun tei thakun buduk (*Dioscorea hamiltonii*)



4.1.5 Thacher tei thacher buduk (*Dioscorea puber*)



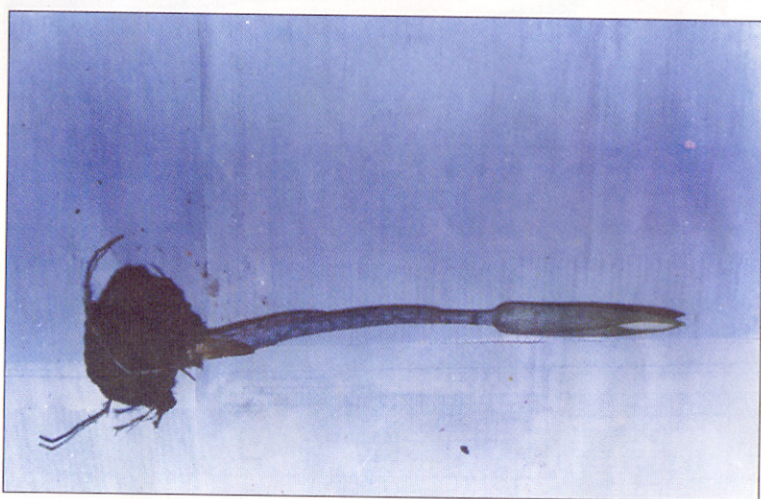
4.1.6 Kwiccha buduk (*Dioscorea pentaphylla*)



4.2 Thaborchuk tei bedek (*Manihot esculenta*)



4.3a Batema bufang (*Amorphophallus campanulatus*)



4.3b Tha muimorong tei bwbar (*Amorphophallus campanulatus*, wild variety)



4.3c Muimorong bufang (*Amorphophallus campanulatus*, wild variety)



4.4a Wathwi muia (*Melocanna baccifera*)



4.4b Wandal muia (*Bambusa tulda*)



4.4c Wasur muia (*Bambusa balcooa*)



4.4d Wamilik muia (*Dendrocalamus hamiltonii*)



4.5.1 Khamka sikam tei bedek (*Solanum torvum*)



4.5.2a Khamka bilati tei bedek (*Solanum indicum*)



4.5.2b Khamka bilati (*Solanum indicum*)



4.6 Muikhon tei bugili (*Musa acuminata*)



4.7 Sajna bedek, bwbar tei bwthai (*Moringa oleifera* – a flowering branch and tender pods)



4.8 Khokleng bedek tei bwthai (*Cajanus cajan* – a fruiting branch)



4.9 Jinga thaktwi tei buduk (*Ipomoea batatas*)



4.10 Komliha (*Ipomoea aquatica*)



4.11 Samsota (*Centella asiatica*)



4.12 Dalo bupham (*Chenopodium album*)



4.13 Mulai tei bwthai (*Raphanus sativas* with fruits)



4.14 Belesho (*Abelmoschus esculentus*)

CONCEPT OF HEALTH, DISEASES AND NUTRITION

1.1 Health

According to Oxford English dictionary, "health" means soundness of body or mind, that condition in which its functions are duly and efficiently discharged. To a psychologist the word "health" means the normal functioning of the mind. The World Health Organization has defined the health as follows: "Health is a state of complete physical, mental and social well being and not merely an absence of disease or infirmity". The above WHO's definition has been criticized as health cannot be defined as "state" at all but must be seen as a process of continuous adjustment to the changing demands of living and changing meanings of life. The WHO's definition describes only three kinds of health namely the physical, the mental and the social health. A few other types of health have also been suggested e.g. spiritual, emotional, vocational, political, socio-economic and philosophical health.

Health of an individual can be influenced by many factors. These factors interact and can promote or deteriorate the health of an individual or a community. The main factors lying within the individual and in the society are heredity, environment, life style, socio-economic conditions and family welfare services. There are also some other contributory factors, which directly or indirectly influence the health e.g. food and agriculture, education, industry, social welfare, rural development, adoption of policies in the economic and social fields that would assist in increasing the standard of living.

1.2 Disease

The term "disease" indicates uneasiness to the body; scientifically, it means, "abnormal functioning" of various organs. The Dorland's Medical Dictionary defines disease as "a definite morbid process

having a characteristic train of symptoms, which may affect the whole body or any of its parts and its cause, pathology and the course may be known or unknown”.

Agent, host and environment are the important factors, which interact with each other to initiate the disease process in human beings. These three causative factors are referred as Epidemiological triad (Fig. 1.1)

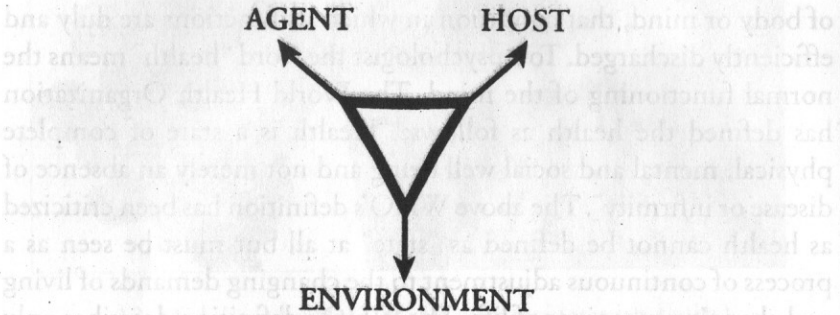


Fig.1.1 Epidemiological triad

The first preliminary cause of a disease is an agent. The disease-agent is a substance of living or non-living things. The disease agent may be of the following categories:

- i. **Biologic agents** : These include micro organisms like bacteria, virus, rickettsiae, fungi, protozoa and helminthes.
- ii. **Nutrient agents** : These agents are present in our diet and include proteins, fats, carbohydrates, vitamins, minerals and water.
- iii. **Physical agents** : These include heat, cold, humidity, radiation, electricity, pressure, sound etc.
- iv. **Chemical agents** : These include urea, bilirubin, cholesterol, prostaglandin (endogenous agents) and pollens, metals, fumes, gases, dust particles, insecticides (exogenous agents).
- v. **Mechanical agents** : Vibrations, chronic friction and other mechanical forces are the examples of these agents.
- vi. **Other factors necessary for health** : These include Hormones (insulin, thyroxin), Neurotransmitters (acetylcholine, dopamine), absence of an organ (thymus, testes), genetic defects (haemophilia).

Physical, biological and psychosocial environment are also considered as an important factor responsible to produce disease in human beings.

1.3 Nutrition

Living organisms require steady supply of food for the maintenance of life and the processes connected with life including growth, movement, reproduction etc. A living organism either synthesizes or collects necessary energy-rich organic molecule, the food from the surrounding environment. The food may be utilized directly or may be converted into simpler products. The way by which food is taken and utilized within the body is called **nutrition** or more precisely "Nutrition" is the combination of processes by which the living organism receives and utilizes the materials necessary for the maintenance of its functions and for the growth and renewal of its components". WHO in 1971 defined nutrition as the science of food and its relationship to health. The organic and inorganic materials, which the living organism collect from nature to perform all the fundamental activities of the body is called **nutrients**. The essential substances like minerals, vitamins and water are collectively called **nutrients**. **Food** means a substance or a mixture of substances which when taken into the body serves to nourish or build up the tissues or to supply energy to the body. Malnutrition plays a very important role in the causation of high infantile, maternal and general mortality rates. Poverty and economic inability are important causes behind malnutrition. Endemic goiter, anaemias, beriberi, night blindness and infections of cutaneous, gastro-intestinal and respiratory origin are found to be more common among undernourished. Gross retardation of growth in children and gross under weight in adults are found common among low income-group communities. The requirement for food is therefore directly related to the specific requirement for the various nutrients. In general the nutritional needs of the human body may be stated as follows :

- i. **Energy need** : The body requires energy for the utilization of the food, the physical activities and the production of heat necessary to maintain body temperature. Carbohydrates, fats

and proteins are the only nutrients that can furnish energy, but these nutrients are utilized in the nutrition process. Nutrition also supplies necessary organic and inorganic materials needed for building the body of an organism. Energy is usually reported in terms of heat energy, and is given in calories.

- ii. **Maintenance and repair need** : Body organs like bones, muscles, teeth and blood cells are constantly replaced. To repair (wear and tear) the different body organs, nutrition is an essential process.
- iii. **Growth need** : Children can grow only when they have nutrients beyond their maintenance and energy requirements. Nutrition supplies the raw materials for proper growth and development of organs.
- iv. **Reproduction and lactation need** : The reproduction and lactation periods might well be considered as periods of growth. Therefore the need is similar to the growth need.
- v. **Regulatory need** : Different processes in the human body are regulated, coordinated constantly and simultaneously. The substances that perform these functions include vitamins, minerals, hormones and enzymes.
- vi. **Protection** : Through nutrition, disease resistance power of the living body develops and hence provides protection from various diseases.

1.4 Energy Value of Nutrients

By considering the composition of different foods and their degrees of absorption by the body it is believed that:

1-gram carbohydrate (as glucose) absorbed by and oxidized in the body yields 3.75 calories.

1-gram fat absorbed by and oxidized in the body yields 9.3 calories.

1-gram protein absorbed by and oxidized in the body yields 4.1 calories.

CHAPTER-II

NUTRIENTS IN FOODS AND CONCEPT OF DIET

2.1 Nutrients

Food is composed of many substances, or nutrients, that are essential for various processes in the body. Almost all foods contain nutrients in varying proportions. All of the nutrients can be obtained from food. On the basis of predominant function, foods are grouped as :

- Energy yielding foods e.g. cereals, sugars, roots, tubers, fats and oils.
- Body building foods e.g. meat, eggs, fish and pulses.
- Protective foods e.g. vegetables, fruits, milk etc.

The following is a list of the important nutrients, which are usually present in food: (i) Carbohydrates, (ii) Proteins, (iii) Fats, (iv) Vitamins, (v) Minerals and (vi) Water.

2.1.1 Carbohydrates

Carbohydrates are the most widely distributed compounds in both plant and animal kingdoms. It is composed of carbon, hydrogen and oxygen. Carbohydrates in the form of glucose act as the main source of energy. Carbohydrates are the body's principal energy food, providing about one half of the calories needed for heat production and muscle action. These compounds can be classified into:

- Monosaccharides** : These carbohydrates contain only one unit of simple sugar, for example, glucose, fructose, ribose etc.
- Disaccharides** : These consist of two monosaccharide units, for example, sucrose, maltose and lactose.
- Polysaccharides** : These complex carbohydrates are made up of large numbers of monosaccharide molecules, for example, starch, glycogen, cellulose and dextrin.

Cellulose is an important component of diet and found in large

quantities in vegetables, fruits and grains. It has no nutritive value but contributes to dietary fibre. The fibre is not digested in the body. It helps in the elimination of intestinal wastes, stimulates peristaltic movements of the intestinal tract by absorbing water and thus adding bulk to the intestinal contents. In this way fibre reduces the tendency for constipation. In addition, fibres also possess cholesterol-lowering activity.

Starch is a long chain polysaccharide, which is found in plant seeds, such as, cereals, pulses, roots and tubers. Plants store the greater part of their food reserves as starch. We consume daily largest proportion of carbohydrate in our diet.

Glycogen is only carbohydrate of animal origin. Hence it is called "animal starch". It is made by the body from glucose and deposited in the liver and muscles.

(a) Dietary Sources

We have abundant supplies of carbohydrates in fruits, vegetables, cereal products and milk. The dietary sources of available carbohydrates have been shown in Table 2.1.

Table No. 2.1 Dietary Sources of Carbohydrates

Type of Carbohydrates	Sources	Product of Digestion	Intake (Grams/Day)
Monosaccharides			
Glucose	Fruits and honey	—	5
Fructose	Fruits and honey	—	5
Mannose	Manna	—	—
Disaccharides			
Sucrose	Sugarcane and sugar beet	Glucose and Fructose	100
Lactose	Milk and milk products	Glucose and galactose	15
Maltose	Malted foods	Glucose	Negligible
Polysaccharides			
Starch	Cereal products, roots-vegetables, beans etc.	Glucose	250
Dextrin	Natural starch	Glucose	Negligible
Glycogen	Meat and liver	Glucose	Negligible

(b) Functions of Carbohydrates

The important functions of carbohydrate are :

1. To provide energy and heat.
2. It is necessary for the synthesis of certain amino acids.
3. If there is an adequate supply of carbohydrate in the diet, proteins do not need to be used to provide energy and heat. Thus, carbohydrates exert a protein sparing action.
4. When carbohydrates are eaten in excess of the body's need, it is converted into fat and is deposited in the fat depots under the skin to give protection against cold.

Certain polysaccharides (e.g. fibres and cellulose present in vegetables and fruits) pass through the alimentary canal almost unchanged. These dietary fibres help in free bowel movements.

2.1.2 Proteins

Proteins are the most essential organic materials of protoplasm made up of carbon, hydrogen, oxygen, nitrogen, sulphur and occasionally phosphorous, iron and other elements. Proteins are probably the most complex materials produced in the nature. The name of protein is derived from the Greek word "Proteios" meaning of prime importance. The name is well chosen because proteins are the basis of protoplasm and are present in the living organisms. Without proteins life would not be possible. Plants synthesize proteins from carbon dioxide, water, nitrates, sulphates and phosphates. Proteins have very high molecular weights ranging from 10,000 to over 50 million. The protein molecule is made up of one or more chains of amino acids bonded together by a peptide linkage, which is formed between the amino group of one acid and the carboxyl group of another. When amino acids combine in this way, the resulting product is known as peptide. All proteins yield amino acids upon complete hydrolysis. Excess protein is not required by the body and is converted into glucose. This glucose is utilized as an energy source within the body.

◆ Amino Acids

Amino acids are the basic components of protein. An amino acid contains a basic amino group ($-\text{NH}_2$), an acidic carboxyl group ($-\text{COOH}$), and a side chain attached to a carbon atom. These are composed of carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorous elements. They are divided into two categories namely essential and non-essential amino acids.

Essential amino acids are those which are required by the body, cannot be synthesized by tissues and they must be supplied in the diet. Absence of these amino acids in the diet, growth, wear and tear of body organs may be retarded. In human beings following amino acids have been found to be essential: Arginine, valine, histidine, isoleucine, lysine, methionine, leucine, phenylalanine, tryptophan and threonine.

Non-essential amino acids are those, which can be synthesized in the body, for example, alanine, glycine, tyrosine, cystine, proline, glutamic acid etc. Essential and non-essential amino acids are equally important for our growth and good health. Experimental research has indicated that the quantities of amino acids needed for the normal growth of children are far greater than the proportion needed for the good health in adults.

(a) Sources of Protein

Proteins are distributed in both animals and plants. Animal proteins are available in milk, egg, fish, poultry etc. Animal proteins contain all the essential amino acids required by the body. Plant proteins are present in pulses, cereals, nuts, beans, oil seeds, soyabean etc. Plant proteins are considered as incomplete proteins as they are deficient in one or more essential amino acids.

(b) Protein requirements

For an Indian adult man and woman the Indian Council of Medical Research (ICMR) has recommended a daily requirement of 1.0 gram protein per kilogram body weight. An extra amount of protein should be provided in conditions like blood loss, burns, proteinuria, surgery, parasitic infections, diabetes etc.

(c) Functions of Protein

The principal functions of proteins in the body are as follows :

1. Building of new tissues in growing stages of life, thus act as building of organism.
2. Maintenance of tissue already built and replacement of regular losses.
3. Helping in the formation of enzymes, antibodies, milk, some hormones and one of the B-Vitamins.
4. Act as regulatory substances for internal water and acid-base balance.
5. Each gram of protein supplies 4.1 calories to the body.

(d) Biological Value of Protein

The quality or ability to support life is the principal matter in judging the protein value of a diet. When a protein contains all the essential amino acids in the proportions needed by the body, it is said to have a high biological value. But if a protein lacks one or more essential amino acids, it is said to be of low biological value.

The proteins of uncooked vegetable foods (especially pulses) are less digestible than those of animal foods. Cooking increases the digestibility of several foods. Thus the nutritive value of a protein depends on its essential amino acid make up and its digestibility.

Food proteins vary greatly in their amino acid composition. Particularly the vegetable proteins are deficient in certain amino acids. For example, cereal is low in lysine and threonine, and most pulses are low in methionine. However with proper planning it is possible for vegetarian to obtain a high-grade protein from mixed diet of cereals, pulses and other vegetables. In other words, various foods, when consumed together in a meal, complement each other and the biological value of protein mixture in the meal is much higher than that of the individual food protein, when eaten separately. The biological values of some dietary proteins in Table 2.2 have indicated that the animal proteins are of higher biological value than the vegetable proteins.

Table No. 2.2 :

Nutritive values of the Proteins of different foodstuffs

Foodstuff	Biological value	Foodstuff	Biological value
Rice	68	Ground nut	55
Wheat	65	Egg	94
Maize	59	Milk	84
Bengal gram	68	Meat	74
Red gram	57	Fish	76

(e) Protein Energy Malnutrition

Protein energy malnutrition is one of the most common nutritional deficiencies in India. It is common among the children during the first few years of life. Babies, who are low in weight at birth, may be at risk. Children may suffer from retardation of growth, and adolescents from thin and lanky bodies. The pregnant women may gain insufficient weight. Clinically the protein energy malnutrition is manifested in two forms namely Kwashiorkor and Marasmus.

Kwashiorkor : It is the most common in children between the ages of one and three years. These types of nutritional deficiencies are common among certain African tribes. It develops when, after prolong breast-feeding, the child is weaned into an inadequate traditional family diet. The diet is such that it is physically impossible for the child to consume the required quantity in order to obtain sufficient protein and energy. The symptoms are oedema, loss of appetite, diarrhoea, general discomfort and apathy associated with gastric infection.

Marasmus : This condition may be due to malabsorption, wrong feeding, metabolic disorders, repeated vomiting, diarrhoea, severe disease of the heart, lungs, kidneys, or urinary tract, or chronic bacterial or parasitic disease. In this disorder, the body weight of the infants is below 75% of that expected for age. The infant looks old, pallid and apathetic, lacks skin fat, and has subnormal temperature.

The other principal features are severe muscle wasting, growth retardation and marked wasting of skin and bones.

The protein energy malnutrition can be treated by adequate diet and health education, and also treating infections.

2.1.3 Fats

Fats belonging to the naturally occurring group of compounds are called **Lipids**. Lipids are constituents of plants and animals. Natural fats are the triesters of glycerol with long-chain fatty acids. These are known as **Triglycerides**. Fats are solid up to 20°C and if they are liquid at that temperature, they are called oils. It is a concentrated source of energy. Fats, along with carbohydrates, supply readily available energy. Most of the body fat is present in the adipose tissue, which constitute 10-15% of the body weight. Some fatty acids are not synthesized in the human body, for example, linoleic, linolenic and arachidonic acids. The vegetable oils are rich in polyunsaturated fatty acids (exception coconut oil and palm oil) while animal fats contain high percent of saturated fatty acids (exception fish oil) but essential for the body, thus they should be taken through diet. These fatty acids are known as **essential fatty acids**. Some oils like ground nut oil, sesame oil or sunflower oil which contain high proportion of polyunsaturated fatty acids do not increase blood cholesterol levels even when consumed in large quantities. But certain fats like butter, ghee, and coconut oil and hydrogenated vegetable fats (Vanaspati) contain a high proportion of saturated fatty acid. These fats cause considerable elevation of blood cholesterol when consumed in large amounts. The presence of excessive amounts of cholesterol in blood causes deposition of cholesterol at the intima (inner layer of arterial wall). Thus there is a patchy thickening and hardening of arterial walls. The coronary arteries supplying blood to the heart are thus affected and coronary heart disease results. The quantity, quality and mode of consumption of fat play an active role to influence the cholesterol content of blood. Generally the daily intake of fat in an adult should be such that it contributes not more than 15 to 20 percent of the calories in the diet. In order to obtain the necessary

amounts of essential fatty acids, the daily fat intake should include at least 15 grams of vegetable oils.

(a) Sources

Fats (oils) are widely distributed both in plants, animals and marine organisms.

1. **Plant sources** : Plants store large quantities of fats in their seeds, roots, and fruits. Cottonseeds, groundnut, coconut, palm, mustard, sesame seed etc. have a high fat content.
2. **Animal sources** : In animals fats are deposited under the skin, and around intestine and kidneys. Thus we have tallow from cattle, sheep and goats, and lard from hogs.
3. **Marine Organisms** : These are obtained from water animals like Salmons, whales, dolphins, seals, herrings and sardines.

(b) Function of Fats

Fats (Oils) have several functions in the body. The principal functions of fat in the body are as follows:

1. **Energy production** : Fat has high energy producing power i.e. calorific value. One gram of fat supplies 9.3 calories to the body.
2. **Reserve Food** : Fats are easily stored for future use. It is the main reserve food of our body.
3. **Protection** : The storage (depot) fat protects or supports the vital organs like the kidneys, the heart and the eyes, and also acts as cushion and packing tissues. Fat beneath the skin protects us against cold.
4. **Regulation of body temperature** : It acts as poor heat conductor and as an insulator. Thus subcutaneous fat helps to regulate the temperature.
5. **As vehicle** : It acts as a vehicle to transport the fat-soluble vitamins like A, D, E and K. These vitamins are also absorbed through fat.
6. **As source of essential fatty acids** : Vegetable oils like groundnut oil, sesame oil, sunflower oil etc. are main source of essential fatty acids. Vegetable oils also act as a good source of vitamin E.

7. **Palatability** : Fats and Oils greatly improve the palatability and acceptability of the foods.
8. **Synthesis of vitamins and hormones** : Various steroidal hormones and vitamin D are synthesized from it.

2.1.4 Vitamins

Besides carbohydrate, protein and fat, vitamins are essential for human beings for nutrition. Dr. Casimir Funk first suggested the word, "vitamin" in 1911. He had isolated an unknown factor from the extract of the husks. Later he used these substances in the treatment of beriberi. These organic compounds are required by the body in small amounts and are essential components in metabolic processes. The man is generally unable to synthesize most of the vitamins in sufficient amount and hence they must be provided by the food. Vitamin can be defined as potent organic compounds, which are found in foods in variable and minute quantity, and must be supplied to the organisms from external source, so that specific physiological functions, vital to life, may go on normally.

The lack of vitamins results definite deficiency disorders which are specific for each particular vitamin. The deficiency state (avitaminosis) is usually observed due to the following reasons :

- (i) Inadequate dietary intake.
- (ii) Reduced absorption from gastro intestinal tract due to prolonged diarrhoea or drug treatment, gastritis and achlorhydria.
- (iii) In obstructive jaundice and other hepatic disorder, vitamin K is not absorbed properly due to lack of bile.
- (iv) If vitamins are not supplied in excess amount during growth, pregnancy, lactation and prolonged illness.

Vitamins are conveniently classified into two groups on the basis of their solubility namely (a) **Fat soluble vitamins** : These include vitamins A, D, E and K and (b) **Water soluble vitamins** : These are vitamin B complex and vitamin C.

The general characteristics of the vitamins are given below :

1. **Distribution** : The vitamins are widely distributed in nature both in the plant and animal kingdoms. Generally all vitamins are synthesized in plants. The animals can manufacture a few only, but they can store all to some extent. Almost all common foodstuffs contain more than one vitamin.
2. **Daily requirement** : The total daily requirement is usually very small as vitamin can perform their work in very low concentration. Well balanced diet provides enough of all vitamins required for normal health. Family eating habits and defective methods of food preparation may result in vitamin deficiencies. The vitamin deficiency is termed as **avitaminosis**. The daily need of any vitamin for an individual is not a fixed quantity. It varies according to the rate of metabolism. During increased metabolism like hyperthyroidism, pregnancy, lactation, growing children etc., the requirement is proportionally more.
3. **Store** : Vitamins can be stored in the body to some extent, for example the fat-soluble vitamins are stored in the liver and the subcutaneous tissue, vitamin C in adrenal cortex etc.
4. **Absorption** : All vitamins are absorbed from alimentary canal. They are not destroyed in the digestive process. Hence all vitamins are effective when administered orally.
5. **Mode of action** : Vitamins help in the functioning of various metabolic enzymes as a coenzyme. Thus vitamins take part in chemical reactions necessary for our survival or growth. The action of a particular vitamin is selective upon one tissue. This specificity explain why the deficiency of a particular vitamin, specially affects some tissue or system and leaving others more or less untouched.
6. **Fate** : Vitamins are partly converted into metabolically inert products and are partly excreted through urine.
7. **Synthesis in the body** : Some vitamins like vit A, D etc. are synthesized in the body from their precursors. For example, vitamin A from pro-vitamin, carotene, and vitamin D on

exposure of skin to ultra-violet radiation from precursors, ergo sterol. Micro organisms in the intestinal tract also synthesize some vitamin B complex.

A list of vitamins, with their sources, daily requirement and physiological functions is given in Table No. 2.3.

Table No. 2.3 : The Vitamins and their characters

Name	Sources	Daily requirement	Physiological functions
Vitamin A (Retinol ¹ & Retinol ²)	Animal Sources : Fish liver oil, liver, butter, milk, kidney, egg-yolk & fishes. Vegetable sources : Carrots, spinach, mango, tomatoes, ripe papayas etc.	5,000 I.U. for adults & 6,000 - 8,000 I.U. for growing children, during puberty, lactation and pregnancy.	<ul style="list-style-type: none"> ❖ Precursor in the synthesis of light absorbing pigments (Rhodopsin) of the eye. ❖ Controls bone growth. ❖ Maintains integrity of nervous tissue & epithelial tissue. ❖ Essential for normal reproduction and lactation.
Vitamin D (Calciferol)	Animal Sources : Liver, fish liver oil (Cod and halibut), eggs, meat, milk, butter and from exposure of skin to UV radiations.	400-800 I.U. in growing children & during lactation and pregnancy.	<ul style="list-style-type: none"> ❖ Helps in the mineralization of bones. ❖ Regulates metabolism of calcium and phosphorus. ❖ Stimulates growth.
Vitamin E (Tocopherol)	Animal sources : Egg, milk, butter, fish, liver etc. Vegetable sources : Alfa Alfa, spinach, lettuce, soyabean, maize oil and other corns oil.	15-20 mgm.	<ul style="list-style-type: none"> ❖ Acts as a cofactor in electron transport system. ❖ Acts as antioxidant and prevent unwanted oxidation in the body. ❖ Essential for foetal development. ❖ Helps in normal function of muscles.
Vitamin K (Phylloquinone)	Vegetable sources : Alfa Alfa, spinach, tomatoes, other green vegetables and soyabean oil. Animal sources are poor. Pig's liver synthesized by	5 mgm.	<ul style="list-style-type: none"> ❖ Essential in the formation of prothrombin and coagulation factor VIII. ❖ Helps in the phosphorylation process.

Name	Sources	Daily requirement	Physiological functions
Vitamin B ₁ (Thiamine)	bacteria in the gut. Vegetable sources : Beans, yeast, nuts, beet, unpolished cereal, grains, pulses, carrot, turnip, pears, lettuce etc. Animal sources: egg-yolk, liver, meat etc.	0.4 mgm for children & 1.3mgm for adults.	<ul style="list-style-type: none"> ❖ Acts as a coenzyme in carbohydrate metabolism. ❖ Helps in the oxidation of sugar in the tissue and brain. ❖ Helps in the neuro-muscular transmission of impulse.
Vitamin B ₂ (Riboflavin)	Vegetable sources : Germinating seeds, leafy vegetable, yeast, beans, peas, soyabean etc. Animal sources: Milk, egg-white, fish, liver, cheese etc.	1.5 to 1.8 mgm for adults.	<ul style="list-style-type: none"> ❖ Acts as prosthetic group of flavoprotein enzymes used in cellular respiration. ❖ Helps in the maintenance of epithelial and mucosal integrity. ❖ Essential for growth.
Vitamin B ₃ (Pantothenic acid)	Vegetable sources : Yeast, wheat, pea, tomato, and sweet potato. Animal sources: Milk, liver, egg-yolk, meat, kidneys, fish etc.	10 mgm.	<ul style="list-style-type: none"> ❖ Forms coenzyme A, which catalyzes transfer of various carboxylated groups. ❖ Helps in the formation of haemoglobin ❖ Helps in the amino acids and fatty acids metabolism.
Vitamin B ₄ (Choline)	Animal Sources : Egg, liver, fish, meat, butter etc. Vegetable sources: Legumes, green vegetables etc.	Minute.	<ul style="list-style-type: none"> ❖ Promotes growth. ❖ Helps acetylcholine metabolism.
Vitamin B ₅ (Nicotinic acid or Niacin)	Animal sources : Liver, fish, meat, egg and milk. Vegetable sources : Green vegetables, tomatoes, beans,	12-18 mgm for adults.	<ul style="list-style-type: none"> ❖ Acts as co-enzyme of NAD and NADP. ❖ Essential for growth. ❖ Acts as a pellagra preventing factor.
Vitamin B ₆ (Pyridoxine)	wheat, peas etc. Animal sources : Liver, egg-yolk, meat, kidney	2.0 mgm for adults & 0.3 mgm for children.	<ul style="list-style-type: none"> ❖ Helps in metabolism of unsaturated fatty acid and amino acids.

Name	Sources	Daily requirement	Physiological functions
	etc. Vegetable sources: Peas, soyabean, cereals, leafy vegetables etc.		<ul style="list-style-type: none"> ❖ Acts as co-enzyme for transaminases, decarboxylases, deaminases etc. ❖ Helps in the synthesis of fat from proteins and carbohydrates.
Vitamin B ₁₂ (Cyanocobalamin)	Animal Sources : Liver, kidney, egg, milk, mear, fish etc. Vegetables do not contain vit. B ₁₂ .	1 to 1.5mgm for adults & 0.2 mgm for children.	<ul style="list-style-type: none"> ❖ Prevent and cure pernicious anaemia. ❖ Helps in amino acid synthesis. ❖ Essential for formation of blood cells. ❖ Helps in nucleoprotein metabolism.
Vit.M (Folic acid)	Animal sources : Liver, fish, kidney, and egg-yolk. Vegetable sources: Green leafy vegetables, soyabean etc.	50 mgm for adults.	<ul style="list-style-type: none"> ❖ Essential for formation and maturation of red cells. ❖ Used in synthesis of co-enzymes of nucleic acid metabolism.
Vitamin H (Biotin)	Animal sources : Mear, egg-yolk, liver, yeast, and kidney. Vegetable sources: Tomatoes, cereals and molasses.	150-300 mgm.	<ul style="list-style-type: none"> ❖ Essential for growth. ❖ Acts as coenzyme in CO₂ fixation and biosynthesis of pyrimidines and fatty acids. ❖ Maintain epithelial integrity in rats and dogs.
Vitamin C (Ascorbic acid)	Animal sources: Negligible amount. Vegetable sources: Fresh citrus fruits, tomatoes, amlaki, apple, cabbage, cauliflower and leafy vegetables.	100-150 mgm during lactation, pregnancy & adolescence. 75 mgm in average for adults.	<ul style="list-style-type: none"> ❖ Acts as a hydrogen carrier inside the cells. ❖ Helps in the formation of red blood cells. ❖ Helps in the development of matrix and deposition of calcium and phosphate in the bones. ❖ Plays important role in wound repair. ❖ Promotes immunity against infections.

□ Vitamin Deficiency Symptoms □

◆ Vitamin A (Antixerophthalmic factor)

Vitamin A deficiency commonly affects the eyes but extraocular effects can also be noted.

(i) Eye manifestations

Night-blindness (Nyctalopia)

It is the inability to see in dim light or at night. Due to prolonged deficiency of vitamin A the resynthesis of rhodopsin is prevented. This rhodopsin is responsible for vision in dim light. If the vitamin deficiency is allowed to continue night blindness may progress to **xerophthalmia** and **keratomalacia**.

In **xerophthalmia**, the cornea and conjunctiva become dry, red, thickened and wrinkled. Xerophthalmia may progress to **keratomalacia** with consequent keratinisation and degeneration of cornea. Keratomalacia is also called liquification of the cornea. In this condition cornea becomes soften and perforated. This condition is very serious and blindness is usually inevitable. Keratomalacia is one of the major causes of blindness in our country.

(ii) Extraocular manifestation

These include follicular hyperkeratosis, loss of appetite and retardation of growth. Abnormal bone growth is observed in certain parts of vertebral column and skull. The patients become vulnerable for respiratory and intestinal infections.

◆ Vitamin D (Antirachitic factor)

The loss of calcium and phosphate is increased in the faeces due to this vitamin deficiency. This condition results to a fall in their blood concentration and hence not available for bone formation. Due to this reason, the children suffer from **rickets** and adults from **osteomalacia**.

Rickets is characterized by bone deformities in growing children. The bones soften and bend under pressure and there is maldeposition of calcium phosphate. The skull bones show bossing and a gap in the skull, which does not calcify till the age of one and half years. Delays and irregular eruption of teeth occur. Chest is flat, pointed

or depressed. Pelvis is deformed. Legs may bend under pressure, giving deformed locomotion. Rickets develop between 6-18 months of infancy. **Osteomalacia** is a common metabolic disorder of bones especially in women in the reproductive age group or with rapidly recurring deliveries in North India belonging to poorer socio-economic class. This occurs because of the excessive drain of calcium from the mother's body. So pregnant mothers must take plenty of milk, which contains assimilable calcium. The women complain of chronic backache and generalized aches and pains.

◆ **Vitamin E (Antisterilitic factor)**

In women, abortion or miscarriage may occur due to vitamin E deficiency. Other deficiency signs are muscular dystrophies and atrophy of germinal epithelium of genital organs, hepatic necrosis etc. Some physicians use vit. E for heart disease like arteriosclerosis.

◆ **Vitamin K (Antihæmorrhagic factor)**

Vitamin K deficiency produces defective blood coagulation and hæmorrhages. Due to deficiency of this vitamin the prothrombin content of blood is reduced and the blood clotting time is prolonged. This may lead to bleeding disorder.

□ **Vitamin B₁ (Antineuritic factor, Antiberiberi substance)**

The principal deficiency sign of vitamin B₁ is beriberi. The beriberi may be classified as :

- (i) **Dry beriberi** is a nutritional nervous disorder and arises due to consumption of polished rice and refined cereals. In this condition degeneration and demyelination of both sensory and motor nerves occur. The patients complaint of precordial pain, palpitation, numbness in the legs and tenderness in the calf muscles.
- (ii) **Wet beriberi** is a condition where the polyneuritis is accompanied by oedematous swelling of legs. The patients become extreme emaciation. Other signs are loss of appetite, distention of the abdomen, brain and nerves passing in a state of irritation and ultimately paralysis.
- (iii) **Cardiac beriberi** is associated with signs of congestive cardiac

and circulatory failure. The veins of the neck become prominent and there is a rise in systolic blood pressure. Palpitation and breathlessness are common features of this disorder.

- (iv) **Infantile beriberi** is a condition of infants where patients become restless, cries a lot and passes less urine. The lactating mothers observe this disorder due to eating of thiamine deficient diet. Hence the secreting milk of mother contains less amount of thiamine and infants also suffer from lack of thiamine. The symptoms include oedema and tachycardia, and the infant may die within 24 to 48 hours due to circulatory failure. This disorder develops between 2 to 5 months of infancy. Loss of appetite, atony of the gastro intestinal tract, hypochlorhydria etc. are the other deficiency signs of vit. B₁. Heart also becomes weak and enlarged.

◆ Vitamin B₂ (Riboflavin)

Skin and eyes are affected by the vit B₂ deficiency. The following disorders are produced due to the deficiency of this vitamin:

1. **Corneal vascularization:** In this condition a white opacity may develop on the surface of cornea. Eyes become light sensitive (Photophobia) and redness with corneal ulcers. The patient complains of burning sensation in the eyes, disturbed vision and lachrymation.
2. **Angular Stomatitis:** The angles of the mouth are affected with this disorder. It is characterized by heaping up of grayish white epithelium in ridges giving the appearance of fissure at the angles of mouth.
3. **Cheilosis:** This is a condition in which a zone of red, uncovered epithelium appears on the lips. It is often associated with angular stomatitis. Loss of hair, dry and scaly skin, retardation of growth, glossitis are the other deficiency signs of vit. B₂.

◆ Vitamin B₃ (Chick antidermatitis factor, Filtrate factor)

The deficiency of this vitamin causes aching and burning sensation in the feet. These symptoms become more intense and are followed by acute pains. These pains may spread up as far as the knee like an

electric shock, which becomes more at night. In chicks, vit. B₃ deficiency produces dermatitis, fatty liver, degeneration of spinal cord and involution of thymus.

◆ **Vitamin B₄ (Lipotropic factor)**

Deficiency of this vitamin causes haemorrhagic necrosis in kidneys, anaemia and hypoproteinemia in mammalian species. It produces fatty liver in rats.

◆ **Vitamin B₅ (Pellagra-preventing factor)**

The deficiency sign of this vitamin is pellagra. This condition is generally known as the three D's i.e. dermatitis, diarrhoea and dementia. The dermatitis is observed specially on the exposed area of the body. Gradually this area becomes reddish brown, rough, scaly and keratotic. Gastro-intestinal disorders and various forms of mental disorders are also observed.

◆ **Vitamin B₆ (Rat antidermatitis factor)**

In infants the deficiency of vit. B₆ can lead to epileptic type of convulsions due to decreased GABA production. In adults dermatitis, cheilosis, glossitis, angular stomatitis, degeneration of the nerves, reproductive failure, reduced growth and microcytic anaemia have been reported as a result of the deficiency of this vitamin.

◆ **Vitamin B₁₂ (Antipernicious anaemia factor)**

Megaloblastic or macrocytic or pernicious anaemia is produced due to the deficiency of this vitamin. In megaloblastic anaemia the bone marrow contains abnormal blood cells called megaloblast in place of normoblast. These abnormal cells give rise to macrocytes in place of erythrocytes. The life span of macrocytes is short and hence the concentration of haemoglobin and number of red blood cells are further reduced. The anaemia produced due to the deficiency of intrinsic factor resulting in decreased absorption of vit. B₁₂ is known as pernicious anaemia. The deficiency of intrinsic factors is caused by the conditions like malabsorption syndrome, total removal of stomach and atrophy of mucous membrane of stomach.

Vit. B₁₂ deficiency also produces hypoglycaemia, anorexia, mucosal atrophy, inflammation of tongue, mouth etc. and degenerative lesions of the spinal cord.

◆ **Vitamin M(Fermentation residue factor)**

The deficiency of this vitamin results in megaloblastic anaemia, glossitis, cheilosis, disturbances of GIT like diarrhoea, distension and flatulence. Infertility is observed during severe deficiency of this vitamin. Folate deficiency may occur by consuming a poor diet or due to increase demand of folate during pregnancy and lactation.

◆ **Vitamin H (Anti-egg-white-injury factor)**

The deficiency of this vitamin produces dermatitis of skin and mucous membranes, pain in muscles, tiredness, nausea, loss of appetite and rise of blood cholesterol. Deficiency does not occur normally but may be induced either by (i) feeding raw egg-white contains an anti vitamin, avidin able to form a nonabsorbable complex with biotin, (ii) administration of sulpha-drugs which interferes with normal synthesis of this vitamin by micro organisms in the intestine.

◆ **Vitamin C (Antiscorbutic factor)**

The deficiency of this vitamin occurs faster as it is not much stored in the body. Vit.C deficiency causes following disorders.

- (i) **Scurvy** : The main symptoms of this disorder are capillary bleeding, gum bleeding, petichial haemorrhages(under the skin) and the haemorrhages under the periosteum of bones. The gums show erosion of the mucous membrane at their margins leading to bleeding gum.
- (ii) **Malformation of bones and teeth.** There is irregular deposition of bone salts and decrease in the density of long bones. Teeth also show similar changes. This condition increases the brittleness of bones leading to fracture.
- (iii) **Number of red cells and platelets are reduced** which causes anaemia.
- (iv) **Blood clotting and clot retraction are also delayed.**
- (v) **The susceptibility to infections is increased.**
- (vi) **Healing of wound is impaired.**
- (vii) **Reproductive failure is noticed both in male and female.**
- (viii) **Carbohydrate metabolism is irregular.**

2.1.5 Minerals

In addition to the complex organic substances like carbohydrate, protein and fat, our body needs few other things for all body processes. These substances are vitamins, minerals and water. All these substances are necessary for normal functioning of the body and any great changes in their normal concentrations are highly deleterious or fatal. Minerals are required in small quantities. The human body requires about 14 different elements for the health, growth and for the repair of tissues. Some elements namely iron, calcium, phosphorous, sodium, potassium and chloride are found in moderate to large quantities. These elements are known as **major elements**. Beside these iodine, copper, sulfur, magnesium, zinc, manganese, cobalt, fluorine are required in traces. Hence these are called **trace elements**. Some clinically important elements are described as follows :

◆ Calcium

Calcium is the major component of human skeleton. About ninety nine percent of the calcium in the body is found in the bones. It is also the important constituent of the protoplasm of living cells. At birth body contains 25 to 35 g of calcium.

(a) Sources

Vegetable source: Green leafy vegetables, fruits (particularly, sitaphal and dates), cereals, potato etc. **Animal source:** Milk and milk products, fish, whole bone, egg, meat etc. The main food sources of calcium are presented in Table 2.4.

Table No. 2.4 : Sources of Calcium

Food	Calcium mg/100g	Food	Calcium mg/100g
Milk, Cows	120.00	Cheese	790.00
Milk, Buffalo	210.00	Fish, fresh	40.00– 1,600.00
Milk, Goat	170.00	Fish, dry	500.00– 6,000.00
Skimmed Milk Powder	1370.00	Sesame (til) seeds	1,450.00
Whole Milk Powder	950.00	Leafy vegetable, dark green	70.00–400.00
Paneer (Channa)	208.00–480.00		

(b) Functions

1. Calcium helps in the formation of bone and teeth and also for their maintenance.
2. It controls the neuromuscular excitation and the contractility of cardiac, smooth and skeletal muscles.
3. Calcium is essential for coagulation of blood and curdling of milk.
4. Capillary permeability is controlled by calcium.
5. Calcium stimulates some important enzymatic reactions e.g. ATPases, various lipases etc.

(c) Deficiency

Calcium deficiency gives rise to rickets in babies and adolescents. If the ionized calcium concentration is low, tetanic spasms or convulsions may occur. Its deficiency results in osteomalacia in mother.

(d) Daily requirement

The daily allowances of calcium are 400 - 500 mg for an adult. During lactation and pregnancy the requirement is 1,000 mg/day. In infants and children the daily requirement of calcium is 500 to 600mg.

◆ Iron

Iron is the fourth most abundant element in the earth crust after oxygen, silicon and aluminium. A well balanced diet for growing children or for an adult should contain sufficient amount of iron to meet the iron requirement of the body. The adult human body contains about 2 to 6 g of iron, of which the major portion (70%) of body iron is present in haemoglobin and myoglobin. Iron remains in the body as storage iron, transport iron and enzyme iron. Iron is absorbed in the duodenum and upper part of the intestine.

(a) Sources

Animal source : Meat, liver, kidney, egg, fish and poultry. Milk, which is rich in many nutrients, is a particularly poor source of iron.
Vegetable source : Green leafy vegetables, cereals, legumes, nuts,

oilseeds, jaggery and dry fruits. The animal iron (haem iron) is better absorbed than that of vegetables iron (non-haem iron).

The good sources of iron in different foods are shown in Table 2.5.

Table No. 2.5 : Sources of Iron

Food	Iron mg/100g	Food	Iron mg/100g
Leafy vegetables, dark green	5.00-60.00	Eggs, meat, liver	2.00-6.00
Whole wheat flour, rice flakes	10.00-20.00	Other vegetables	2.00-5.00
Rice, jowar, bajra etc.	3.00-6.00	Fruits	1.00-3.00
Dals, pulses, tree nuts	5.00-10.00		

(b) Functions

1. Iron is an essential component for the formation of haemoglobin to fill up RBCs of the blood. Haemoglobin is a combination of an iron containing moiety, 'haem' and the protein 'globin'.
2. Iron helps for cell respiration and for transport of oxygen.
3. It is required to build up chromatin of the nucleus of the protoplasmic cells.
4. Iron is needed for the maintenance of the immune system. The formation of antibodies is decreased with the deficiency of iron in the body.
5. Iron is essential for the development of brain, regulation of body temperature, muscle activity and for the metabolism of catecholamines.

(c) Deficiency

Hypochromic nutritional anaemia occurs due to iron deficiency in the diet. In this condition the haemoglobin concentration falls below normal value of 14.5 g % and the red blood cells decrease in size (microcytic). Apart from anaemia the other deficiency signs are diminished work performance, decreased resistance to infections and cell-mediated immunity.

(d) Iron losses

Natural loss of iron occurs through menstruation, pregnancy, delivery, sweat, urine and bile. Shedding of hair, nails, skin, epithelial cell and mucosal cells also loss some of the iron. An adult losses about 1mg of iron in a day.

(e) Daily requirement

The nutritional expert group of the Indian Council of Medical Research considered the various aspects relating to the availability and utilization of food iron and recommended an allowance of 20 to 30 mg of iron in a balanced diet for an adult. The daily requirement of iron varies with ages and conditions, which is expressed in milligrams/day.

Infants and children : 0.7 to 1.0

Adolescent : 1.8 to 2.4

Adults (male) : 0.9

Adults (female) : Menstruation 2.8; pregnancy 0.8 to 3.5; lactation 2.4; post menopause 0.7.

◆ Phosphorous

Like calcium it is also one of the important elements of the skeleton. An adult man contains about 800 g of phosphorous. Approximately 80% of the total phosphorous in the body is stored in bones and teeth, and the rest is present in the cells as organic phosphates, phospholipids or nucleic acids. Parathyroid and calcitonin hormones control blood phosphorous levels.

(a) Sources

The main source of this element is vegetables, cereals, meat, liver, kidney, milk and cheese.

(b) Functions

1. It is essential for the formation of teeth and bones.
2. It helps in the formation of phospholipids, which is necessary for the structure of cell membranes, both external and internal (endoplasmic reticulum, lysosomes, nuclear membranes).
3. Phosphorous is a component of many enzymes and is involved in transfer and storage of energy (ATP).

4. It plays an important role in muscle contraction and nerve activity.

(c) Deficiency

Unlike calcium deficiency phosphorous causes rickets, osteomalacia etc.

(d) Daily requirement

In adult 1.0 g.

In pregnant women, lactating mother and children 1.5 g.

◆ **Iodine**

An adult human body contains about 50 mg of iodine. Thyroid gland contains a large amount of iodine (0.06%), almost all of which is firmly bound to the protein.

(a) Sources

The principal source of iodine is seafoods, for example, sea fish, sea salt, cod liver oil and seaweeds. The other sources are milk, meat, cereals, vegetables and water.

(b) Functions

1. Iodine is essential for the synthesis of the thyroid hormone, thyroxin (T_4) and triiodothyronine (T_3).
2. Small amount of iodine is required for the growth and development of all human beings.

(c) Deficiency

Deficiency of iodine leads to goiter, a disease characterized by swelling of the thyroid gland in the neck. This disease is found in Alps and Himalayas where water does not contain iodine. Hence peoples are advised to take iodine containing salts and drinking water with low iodine content. The other iodine deficiency disorders include hypothyroidism, mental retardation, spontaneous abortions, cretinism and myxoedema.

(d) Daily requirement

The daily requirement of iodine is 100 – 150 mg.

◆ Fluorine

Fluorine is highly reactive and is found in combined form. Bone contains about 96% fluoride of the body.

(a) Sources

Drinking water, seafood, tea and cheese are the principal dietary sources of fluorine. It is found in traces in water. Drinking water must contain at least 1-2 parts per million (p.p.m.).

(b) Functions

It is essential for the mineralization of bones and for the formation of enamel of teeth. It inhibits formation of caries teeth with cavity. Dental caries is probably caused partly by the excessive consumption of sticky sweet and chocolates, which may promote growth of bacteria, that affect oral hygiene and cause tooth decay. The habit of rinsing the mouth after each meal should be encouraged specially among the children. This may go a long way in preventing dental caries.

(c) Deficiency and excess

It's deficiency causes dental caries. In some areas of Andhra Pradesh and Punjab, the amount of fluorine in drinking water is somewhat high (more than 2 or 3 p.p.m.). Continued consumption of such water leads to a disease known as fluorosis affecting teeth and bones.

(d) Daily requirement

Under Indian conditions the ideal fluorine concentration in drinking water is 0.8 mg/litre.

◆ Copper

A normal adult contains about 100 mg of copper in his body. It is widely distributed in seawater, plants, vegetables, milk, brain, liver etc. Copper is stored in the liver. It is required with iron for the synthesis of haemoglobin. Copper is also a component of enzymes necessary for the formation of melanin pigment. Disturbance of copper metabolism may cause **Wilson's disease**.

In this disease there is a decrease in plasma ceruloplasmin and copper is deposited in the brain, liver, iris of the eye and other tissues of the body. The daily requirement of copper is about 2 mg/day.

◆ Zinc

Zinc is essential for some enzymes like carbonic anhydrase, carboxypeptidase and dehydrogenase. It is involved in the synthesis of insulin and for the proper functions of immune system. This element is found in traces in ordinary articles of diet. Daily requirement is about 12 mg. Deficiency of zinc may cause impaired growth, sexual dysfunction, multiple infections, disorder in taste, alopecia, skin lesions etc.

There are also some other trace elements like chromium, selenium, cobalt, molybdenum, manganese, nickel etc. in the human body. Their exact function and deficiency signs are not clear. Very little information is reported regarding their role.

2.1.6 Water

Water is a second most important substance essential for the survival of living being after the air on this planet. 55 to 70% of our total body weight is made up of the water. This percentage of water is decreased, as men grow older. Thus infants and children have a much higher percentage of body water than adults. Water is a special kind of nutrient. It must be consumed at most frequent intervals and in greater amounts than is true for any other nutrient. Nevertheless, water is often overlooked as a nutrient. This is probably because the body has such a good mechanism for stimulating appropriate water consumption that under normal circumstances healthy people automatically adjust their water intake to meet the needs. The total body water is distributed through two main compartments i.e. intracellular and extracellular.

Water is considered safe if it does not harm the consumer even it is used continuously for prolong periods. Sometimes water is not acceptable because of bad smell or colour or taste though it may be safe for drinking. Hence there is a term "potable" water which is used as acceptable water. Safe and potable water should be free from disease causing micro organisms, harmful chemicals and should not have a bad taste, smell or colour. Pathogenic organisms may be present in the drinking water because of sewage mixing and chemical contamination from industrial wastes. If an animal is contaminating

water it is ultimately the responsibility of human beings, same is true for industrial and sewage contamination. So the most important thing in safe water supply is the human behaviour, which must be modified.

(a) Dietary sources of water

Water derived from food, drinks etc. is exogenous water. Water derived as end product of metabolism is endogenous water. Most food contain high percent of water, including some foods that appear quite dry, such as bread and meat. Melons, celery, and many other fruits and vegetables contain about as much or sometimes more water than milk.

Metabolic breakdown of food for energy is an even less obvious source of water. The end products of the oxidation of energy nutrients are carbondioxide and water. The amount of water produced endogenously i.e. within the body is small as compared to that consumed in the diet.

The amount of water produced by oxidation of energy nutrients depends on the nutrient involved as follows: 100 g fat produce 107ml of water, 100 g carbohydrate produce 56 ml water, 100g protein produce 41 ml of water. If the energy expenditure of a person is 2000 K cal, his endogenous water production would be approximately 230 ml.

(b) Functions

1. Water serves as a solvent and thus helps in digestion.
2. Water is a medium for various biophysical processes like diffusion, filtration, osmosis etc. that helps in absorption, distribution and excretion of various substances such as hormones, digested food and juices. For example, blood, which contains 90 percent water, carries carbondioxide to the lungs, nutrients and oxygen to the cells, and waste nitrogenous materials (urea, uric acid etc.) and salts to the kidneys.
3. Water acts as a lubricant and prevents friction between joints. Moistening of lungs, pleura, pericardium, synovial cavities of joints and other membranous body cavities is done by water.

4. Water is essential for absorption, conduction and distribution of heat in and out of the body. Thus water also helps the heat regulation through sweat, urine, lungs and faeces.
5. It aids in maintenance of shape of the eyeball by filling up of aqueous and vitreous humor.

(c) Recommended intake

The minimum quantity of water for a resting healthy 70 kg adult at moderate environmental temperature and humidity is about 1700 ml to 1800 ml per day. Although this requirement varies widely with variations in characteristics of the person's physical activity and the environment. A normal person can readily excrete excess of water via the urine if intake exceeds the requirement. The food and nutritional board of USA suggests that 1 ml/K cal is a reasonable water allowance for adults under ordinary circumstances. A higher ratio, 1.5 ml/K cal is recommended for healthy infants. Excess water intake helps to maintain normal water content in the body and thus promotes regular bowel movements. Large water consumption may also help to prevent urinary tract infection and kidney stones by increasing the flow of urine.

2.2 Diet

Diet means 'Restricted selection of food'. Dietetics is 'study of Diet and Nutrition'. Nutrition means 'Nourishment'. So dietetics is a scientific study of restricted selection of habitual food. Indirectly it means that everybody should have a specific and systematic thought to our diet. It is necessary to know the nutritive value of different nutrient present in the diet. Imbalanced diet causes malnutrition and deficiency disorder. In this regard 'balanced diet' is recommended as an improved diet.

2.2.1 Balanced diet

A balanced diet is defined as one which contains a variety of foods in such quantities and proportions that the need for energy, amino acids, vitamins, minerals, fats, carbohydrates and other nutrients is adequately met for maintaining health, vitality and general well being

and also makes a provision for extra nutrients to withstand short duration of leanness. This diet provides the safeguard to human beings from nutritional deficiencies. The composition of balanced diet for an adult man and women is given in Tables No. 2.6 & 2.7.

2.2.2 Important Rules and Regulations Related to Diet

1. Eat food, which is beneficial.
2. Eat food in a moderate quantity.
3. Do not eat food whose properties are not known to you.
4. Do not eat food in hurry or when you are having disturbed state of mind, full of tensions, strains and emotional outbreaks. Regain peace of mind and then enjoy food with happy and hearty mood.
5. Wash your hand, feet and mouth with soap and eat food using clean utensils in a clean place, which is well lighted and well ventilated.
6. Fill half quantity of stomach with food, one-fourth quantity with water and liquid substances and keep the remaining one fourth for air.
7. A person who takes only one full meal a day is called practitioner. He takes light breakfast in the morning and leads the healthy and happy life.
8. A person who takes two full meals in a day is called lusty and greedy person who lives mostly to eat and suffers from illness or ill health from time to time.
9. A person who takes full meals more than two times is called a sick person. He is a gluttonous person and lives only to eat. He is always sick and away from health.
10. Do not do exercises immediately after taking food. It is safe to do them three hours after taking food. It is better therefore to do exercise in early morning or in the evening when the stomach is empty.
11. Do not take food immediately after doing exercises but take food one hour after doing them.
12. Do not go to bed immediately after taking supper but two hours after it.

Table No. 2.6 Balanced diets for adult man

Food Items	Sedentary works		Moderate works		Heavy works	
	Veg.● (g)	Non veg. (g)	Veg.● (g)	Non veg. (g)	Veg.● (g)	Non Veg. (g)
Cereals	400	400	475	475	650	650
Pulses	70	55	80	65	80	65
Green leafy vegetables	100	100	125	125	125	125
Other vegetables	75	75	75	75	100	100
Roots and tubers	75	75	100	100	100	100
Fruits	30	30	30	30	30	30
Milk	200	100	200	100	200	100
Fats and Oils	35	40	40	40	50	50
Meat and Fish	-	30	-	30	-	30
Eggs	-	30	-	30	-	30
Sugar and Jaggery	30	30	40	40	55	55
Groundnuts	-	-	-	-	50	50*

* An additional 30 gm of fats and oils can be included in the diet in place of groundnuts

● Vegetarian.

Table No. 2.7 Balanced diets for adult woman

Food Items	Sedentary works		Moderate works		Heavy works		Additional Allowance during	
	Veg. (g)	Non veg. (g)	Veg. (g)	Non veg. (g)	Veg. (g)	Non Veg. (g)	Pregnancy	Lactation
Cereals	300	300	350	350	475	475	50	100
Pulses	60	45	70	55	70	55	-	10
Green leafy vegetables	125	125	125	125	125	125	25	25
Other vegetables	75	75	75	75	100	100	-	-
Roots and tubers	50	50	75	75	100	100	-	-
Fruits	30	30	30	30	30	30	-	-
Milk	200	100	200	100	200	100	125	125
Fats and Oils	30	35	35	40	40	45	-	15
Sugar and Jaggery	30	30	30	30	40	40	10	20
Meat and Fish	-	30	-	30	-	30	-	-
Eggs	-	30	-	30	-	30	-	-
Groundnuts	-	-	-	-	40*	40*	-	-

* An additional 25 gm of fats and oils can be included in the diet in place of groundnuts.

• Vegetarian.

VEGETABLES

Introduction

The green revolution in India ushered in an era of overall prosperity and selfsufficiency with the advancement of Agriculture and Horticulture. India is able not only to meet the demand of food grains and vegetables, but also to export the surplus. India is today the highest producer of several commodities like pulses, fruits, milk etc. and is also one of the leading nations producing rice, wheat, vegetables etc. The country is second in vegetable production after China. The production and productivity of vegetables have recorded impressive growth. Per capita consumption has also increased from 95 g to 175 g per day against 280 g, the recommended dietary requirement per day. Revolution in potato, tomato, cabbage, pea, cucumber, muskmelon, capsicum, cauliflower, watermelon etc. has been achieved. With high yielding varieties and hybrids, improved production technologies, better infrastructure, ensured genuine seed production and supply policies, and participation of all entrepreneurs, India is poised to achieve a revolution in vegetable production to fulfill the target of 220 million tones by the end of 2020 AD. The average increase in production of different crops in India from 1997 to 2000 is shown in Table No.3.1.

Table No. 3.1 : Production of some garden crops in India (in million tons)

Crops	1997-98	1998-99	1999-2000
Fruits	43.26	44.04	45.50
Vegetables	72.70	87.53	90.83
Spices	2.76	2.87	2.91
Coconut	8.75	8.61	8.42
Cashew nut	0.36	0.46	0.52
Others	1.50	1.65	1.75
Total	129.33	145.16	149.93

Despite these glorious achievement, there can be no complacency, in view of food and nutrition security due to unprecedented growth in population, rapid decline in factor productivity, continuous depletion of natural resources, decreasing capital investment (which has declined from 18% in 1980-81 to 9.4% in 1996-97), globalization and liberalization of market. In world food summit held at FAO, ROME in 1996, it was stated that more than 2 billion persons in the world are suffering from silent hunger, arising from deficiency of micronutrients and unfortunately, one third of the hungry are Indians.

In the state of Tripura, although, agriculturists have made some progress in food production there is wide disparity for the distribution and availability of food between the people of plains and hilly regions. Due to unequal distribution and scarcity of food (including vegetables and fruits), the people of hilly regions depend for their food on the forest resources. This situation seems to be the greatest challenge still continuing to threaten the progress in human resources development.

Vegetables including roots and tubers are indispensable for our food and nutritional security. Vegetables and fruits are important to improve the acceptability of a meal, because of the innumerable shades of colour, flavour and texture they contribute. A meal without vegetables and fruits would be very dull indeed. The variety in fruits and vegetables found throughout the world is very large. Many of the same kind of fruits and vegetables are grown in different parts of the world although they may be of different varieties. The vegetable includes those plant parts that are served raw or cooked as a part of a meal. The parts of plants normally used as vegetables include leaves, roots, tubers, bulbs, fruits, seeds (beans and peas), flowers, stems and shoots. The different parts of plant generally used as vegetables in tropics are shown in Table 3.2, where some plant parts are grouped under more than one heading.

Table No. 3.2 : Plant parts used as vegetables in Tripura

Leaves	Roots and Tubers	Bulbs	Fruits	Flowers	Stems and Shoots
Amaranth	Beet	Garlic	Cucumber	Agasti	Amaranth
Cabbage	Carrot	Leek	Brinjal	Broccoli	Colocasia stem
Colocasia	Potato	Onion	Drumstick	Cauliflower	Celery
Fenugreek	Potato (sweet)	-	Capsicum	Drumstick	Lotus stems
Lettuce	Radish	-	Ladies finger	Plantain	Onion stalks
Mustard	Tapioca	-	Kovai	Waterlily	Khol Khol
Radish leaves	Turnip	-	Papaya	-	Plantain stem
Spinach	Yam	-	Tomato All beans All gourds	-	Spinach stalk

3.1 Classification

The vegetables are normally classified into three broad groups :

i. Leafy vegetables, ii. Roots and tubers and iii. Other vegetables.

(i) Leafy vegetables

Many types of leafy vegetables are consumed all over the country as vegetables. The leafy vegetables commonly known as 'sags' includes leaves of colocasia (*muitu-bwlai*), drumstick leaves (*sajna bwlai*), radish (*mulai*), *Centella asiatica* (*samsota*), bathua leaves (*dalo bupham*), *Ipomoea aquatica* (*kamliha bosok*), *Amorphophallus campanulatus* (*muimorong bosok*), methi leaves, mustard, cabbage, lettuce, spinach etc. are used popularly all over the Tripura state. These vegetables have a high water content and very low fat content. They have also a low calorie and protein content. Leafy vegetables are rich sources of vitamin A and C, and minerals, calcium, iron etc., which is shown in Table No 3.3. The carbohydrate content of vegetables is very important, and this is one of the factors often considered in making food groupings. Carbohydrate is present as starch, sugars and cellulose substances. The part of the carbohydrate in the form of

cellulose cannot be digested, but it does contribute to the quantity of bulk, and this aids the digestive processes. Majority of the leafy vegetables are green in colour due to the presence of green coloured pigment, chlorophyll. Chlorophyll is heat sensitive pigment which changes to olive-green on prolong heating. The intensity of the green colour is an indirect indicator of the vitamin A value of the leaves. Therefore, the leafy vegetables provide the good sources of many nutrients, which are essential for growth and maintenance of normal health. Hence care should be taken to encourage cultivation of green leafy vegetables in kitchen gardens and school gardens. The pregnant and nursing women, and children should also be encouraged to consume enough leafy vegetables.

- The retention of vitamin C in leafy vegetables is aided by :
- i. Cutting these just before cooking,
 - ii. Introducing the leafy vegetable in boiling water,
 - iii. Cooking until just done and
 - iv. Serving soon after preparation.

(ii) Roots and Tubers

Some commonly used roots and tubers vegetables are tapioca (thaborchuk), alu, sweet potato (jinga thaktwi), yam (batema), colocasia (thabadia), radish (mulai) and carrots. They are rich in carbohydrates and hence they yield mainly energy. They have lower water content than leaves and other vegetables. These vegetables provide minimum amount of minerals and vitamins except carrot and potato, which are a fair sources of β -carotene and vit. C respectively. Tubers and roots supply a small amount of protein and fat.

(iii) Other vegetables

They do not fall under the category of leafy and root vegetables. The fruits, flowers, beans, stems and shoots are included in this group. Fruits include brinjal, cucumber, tomatoes, ladies finger, drumstick, different types of gourd, pumpkin etc. Flowers include drumstick, cauliflower and many others. All beans such as french

bean, cluster beans etc. and shoots like bamboo shoot (muia) belong to this group.

These vegetables provide variable sources of vitamins and minerals. They have low fat and protein content and have fair amount of calorie value. These vegetables supply fibre, which is essential to add bulk to the diet. It is possible by careful selection to meet the entire nutritional demands of the human body by a diet containing only foods of plant origin. Not only would fruits and vegetables be included in such a diet, but also cereals and legumes. The majority of vegetarians include milk products and eggs in their diets to make it balanced diet.

Vegetable Name	Weight (kg)	Calories	Protein (g)	Fat (g)	Carbohydrate (g)	Fiber (g)	Vitamin A (IU)	Vitamin C (mg)	Iron (mg)	Calcium (mg)
Brinjal	1.0	100	1.0	0.1	20.0	1.0	1000	10	0.5	10
Chili	1.0	100	1.0	0.1	20.0	1.0	1000	10	0.5	10
Okra	1.0	100	1.0	0.1	20.0	1.0	1000	10	0.5	10
Bean	1.0	100	1.0	0.1	20.0	1.0	1000	10	0.5	10
Cluster Bean	1.0	100	1.0	0.1	20.0	1.0	1000	10	0.5	10
Bamboo Shoot	1.0	100	1.0	0.1	20.0	1.0	1000	10	0.5	10
... (faded text)	...	...	...	...	...	...	...	...	...	...

Table 1.1: Nutritional composition of Tribals vegetables (kg, 100 g)

Table No. 3.3 Composition of Leafy vegetables (per 100 g E.P.)

Name	Water (g)	CHO* (g)	Protein (g)	Fat (g)	Calories	Vit. A (I.U)	Vit. C (mg)	Vit. B ₂ (mg)	Iron (mg)	Calcium (mg)
Dark green	-	-	2.4	0.3	22.0	3,560-14,000	70.0	0.19	3.0	166.0
Light green	-	-	1.5	0.1	18.0	126-3,000	5-61	0.08	1.0	55.0
Cabbage	92.0	4.6	1.8	0.1	27.0	1,200	124.0	0.09	1.0	39.0
Lettuce	93.00	2.5	2.1	0.3	21.0	990.0	10.0	0.13	2.0	50.0
Radish leaves	90.00	3.4	2.7	0.6	28.0	18,660.0	103.0	0.16	16.0	310.0
Spinach (palak)	92.0	2.9	2.0	0.7	26.0	5,580.0	28.0	0.26	11.0	73.0
Coriander leaves	86.0	6.3	3.3	0.6	44.0	6,920.0	135.0	0.06	18.0	184.0
Amaranth	86.0	6.1	4.0	0.5	45.0	5,520.0	99.0	0.30	25.0	397.0
Bathua leaves	90.0	2.9	3.7	0.4	30.0	1,740.0	35.0	0.14	4.0	150.0
Methi leaves	86.0	6.0	4.4	0.9	49.0	2,340.0	52.0	0.31	16.0	395.0
Colocasia leaves	83.0	6.8	3.9	1.5	56.0	10,270.0	12.0	0.26	10.0	2.0-7.0
Drumstick leaves	75.0	13.4	6.7	1.7	92.0	1,1300.0	220.0	0.05	7.0	44.0

E. P. * -Edible portion.
CHO* - Carbohydrate.

CHAPTER – IV

DESCRIPTION OF SOME VEGETABLES

Introduction

In the preceding pages, the different types of vegetables and the nutrients present in these vegetables have been described. It has also been mentioned that Tribals of Tripura collect their vegetables from both the house gardens and forest regions almost throughout all the seasons. In this chapter some common vegetables generally consumed by the tribals are selected to describe systematically along with their taxonomy, distribution, varieties, food values, processing and medicinal values. A great deal of information is available concerning the concentration of nutrients and amount of energy released in different vegetables. From the descriptions it also reveals that these vegetables have a good sources of minerals, vitamins, carbohydrates, water and have a less sources of fats and proteins. From these information an individual can be able to select their vegetables according to their calorie need and deficiency signs. In describing vegetables the classification mentioned in the previous chapter is not followed, as same part of plants is present in more than one heading. The names of vegetables in Kokborok used by different communities of tribals are indicated in each item for the convenience of identification.

4.1 THABOLONG

Beng : Ban alu

WILD YAMS

Dioscorea Linn.

(a) Description and Taxonomy

A slender twining annual herbs, distributed throughout the tropical and subtropical regions of the world. Leaves alternate or sometimes opposite, simple or compound, entire or lobed. Flower unisexual, usually dioecious, rarely bisexual and regular. Fruit loculicidal capsule, laterally flattened, almost winged.

Dioscorea consists of the tubers of the several cultivated and wild species. They belong to the family Dioscoreaceae and genus *Dioscorea*, which contain about 250 species. All species, however, do not produce edible roots. Rhizome of some variety is hard while some other is soft. Size, shape and number of tubers can vary according to the species. Some species produce large cylindrical tubers penetrating deep into the ground, while other varieties produce small or large tubers close to the soil surface. Sometimes 1-2 tubers are produced at the base of the plant while in other cases cluster of tubers are observed.

(b) Distribution

Dioscorea is grown up to the altitude of 8,000-15,000 ft. above the sea level and normally does not grow in warm places. Yams (thabolongs) are cultivated as garden crops by using both tuber tops and aerial tubers (bulbils), but the tuber tops are better for rapid growing than the bulbils. A number of cultivated plants as well as wild varieties of yams are available throughout the state of Tripura. Different wild varieties of yams grow in the forest of Tripura, which is yet to identify and evaluate for their food values. Tribals collect these thabolongs from the dense forest during scarcity.

(c) Varieties

More than 50 species are found in India in which some are cultivated while other varieties are wild. The identification of actual species among the large number of species is very difficult. To overcome this confusion two scientists Prain and Burkill have classified the genus into two broad divisions: (i) those with stems twining to the right and (ii) those with stems twining to the left.

(d) Key to the species

- i. Stem winged twining to the right; leaves ovate.

.....*D. alata*.

- ii. (a) Stem twining to the left; capsule reflexed upwards.

- (b) Leaves simple; ovate; fertile stamens 6.

- (c) Tubers and bulbils small, acrid, warted.

.....*D. bulbifera* var. *bulbifera*.

- (c') Tubers almost absent, bulbils large, smooth

.....*D. bulbifera* var. *sativa*.

- iii. (a) Stem angled but not winged; leaves lanceolate to ovate.
 (b) Tubers long stalked.*D. hamiltonii*.
- iv. (a) Whole plant more or less pubescent for tomentose; stem twining to the right ovary tomentose.
 (b) Leaves simple; ovate.*D. puber*.
- v. (a) Stem twining to the left; capsule reflexed upwards.
 (b) Leaves compound; leaflets 3-5; fertile stamens 3.
*D. pantaphylla*.

A brief outline of some yams commonly used as vegetables by the tribals of Tripura is given below :

4.1.1 THADUK

Beng & Hindi : Chupri alu, khamalu

(*Dioscorea alata* Linn. Syn. *D. atropurpurea* Roxb.;

D. globosa Roxb.; *D. purpurea* Roxb.; *D. rubella* Roxb.)

THE GREATER YAM, ASIATIC YAM

(a) Description

A large climber with winged stems twining to the right. Leaves mostly opposite or rarely alternate, broadly ovate, usually 7-9 nerved at the base. Bulbils globose, ovoid or obpyriform, occasionally elongated or flattened. Tubers roundish or oblong, brown to black in colour, non-poisonous and edible. Tubers may be single or several, cylindrical or clavate and deeply penetrating into the soil.

(b) Distribution

Thaduk (*D. alata*) is the most important species among cultivated yams. It is grown as garden crops in almost every part of Tripura. Thaduk grows abundantly and spontaneously in several tracts and forest areas of Tripura. Tribals freely exploit them in times of scarcity.

(c) Food value

Thaduks (yams) are cultivated for their larger tubers, each even weighing 25 to 30 kg. The small to medium size one is referred as food. They are used as vegetable in the same manner as potato. Thaduks form a cheap source of carbohydrate mainly starch. Analysis of tubers of *D. alata* gave the following values :

Table No. 4.1

Moisture, %	79.60	Fibre, %	0.10
Protein, %	1.30	Calcium, mg/100g	16.00
Fat, %	0.10	Phosphorous, mg/100g	31.00
Carbohydrate, %	18.10	Iron, mg/100g	0.50
Minerals, %	0.80	Energy, K Cal/100g	79.00

(d) Medicinal value

The tuber is considered anthelmintic and useful in leprosy, piles and gonorrhoea.

4.1.2 THWNGWI AND SUSUNDA OR SUSUNDRI

Beng : Banalu, gaicha alu; Hindi : Ratalu, suaralu

(*Dioscorea bulbifera* Linn. Syn. *D. crispata* Roxb.;

D. pulchella Roxb.; *D. sativa* Thunb.; *D. versicolor* Buch.-Ham.)

POTATO YAM, AIR POTATO

(a) Description

An unarmed climber with stem twining to the left. Leaves simple, alternate, broadly ovate-cordate. Bulbils abundant and differ in size and shape. Large bulbils smooth while smaller one warted. Tuber variable, globose or pyriform, usually small and round weighing upto 1 kg. Bulbils black or earth-coloured. Flesh white to lemon-yellow and very mucilaginous.

(b) Distribution

Potato yam is cultivated as a garden crop throughout Tripura. They also grow naturally in the forest. Tribals cultivate this yam surrounding their house mainly for bulbils. For propagation they use bulbils. Potato yams occur in rain forests and is common throughout the North Eastern Region of India ascending up to 6,000 ft. It does not thrive in the drier region.

(c) Food value

Tubers are used as famine food. Bulbils are used as vegetable. They are palatable and possess a flavour similar to that of potato. Hence bulbils are used as substitute of potato. It contains a good amount of carbohydrate and vitamin A. Analysis of tubers gave the following values :

Table No. 4.2

Moisture, %	70.40	Calcium, mg/100g	20.00
Protein, %	2.50	Phosphorous, mg/100g	74.00
Fat, %	0.30	Iron, mg/100g	1.00
Carbohydrate, %	24.40	Niacin, mg/100g	1.20
Minerals, %	1.40	Vitamin C, mg/100g	1.00
Fibre, %	1.00	Carotene, µg/100g	565.00
Energy, K Cal./100g	110.00	Thiamine, mg/100g	0.19
		Riboflavin, mg/100g	0.47

(d) Medicinal value

- (i) Dried and powdered tubers are used as external application for ulcers.
- (ii) Tubers are used in piles, dysentery and syphilis.
- (iii) Bulbils are useful in sores.

4.1.3 THAKTWI WAKSA

Beng : Suthnialu, susnialu

(Dioscorea esculenta Burkill. Syn. *D. aculeata* Linn.;*D. fasciculata* Roxb.; *D. spinosa* Roxb. ex Wall.)

LESSER YAM, KAREN POTATO

(a) Description

A climber with prickly stem twining to the left. Leaves alternate, bulbils absent. Tubers many, produced in bunch or scattered close to the surface of the ground. They may be sausage-shaped, globose or flattened and lobed; skin thin, white or golden-white coloured. Flesh soft, white, sweet edible.

(b) Distribution

The yam is specially concentrated in the hilly forest region. Tribals cultivate the yam in their moist house garden. The forest regions of Tripura like Kamalpur, Kailashahar, Subroom, Belonia, Amarpur etc. are the main places where the tribals cultivate the yam and it also grows naturally. The yam is variable in size and shape under cultivation. Depending on the presence or absence of spines, two varieties are distinguished namely, var. *spinosa* and var. *fasciculata*. The *spinosa*

comprises both cultivated and wild races, but *fasciculata* consists of only cultivated plants.

(c) Food value

The tubers are starchy and contain good amount of carbohydrates. As they are sweet in taste, tribals consume this yam simply by boiling. Analysis of tubers gave the following values :

Table No. 4.3

Moisture, %	82.50	Fibre, %	0.70
Protein, %	1.40	Calcium, mg/100g	24.00
Fat, %	0.10	Phosphorous, mg/100g	24.00
Carbohydrate, %	14.70	Energy, KCal./100g	65.00
Minerals, %	0.60		

4.1.4 THAKUN

(*Dioscorea hamiltonii* Hook. Syn. *D. hookeri* Prain.)

(a) Description

A climber with angled stem twining to the right. Leaves lanceolate to ovate, alternate. Long stalked tubers are so deeply penetrated into the soil that it is very difficult to dig them out. Skin pale brown, flesh white and edible. Bulbils present.

(b) Distribution

The thakun (*D. hamiltonii*) is a native of North Eastern Region of India and is available in the more moist part of Sikkim, Assam, Bengal, Tripura and other states of eastern zone. In the thick or medium forest of Tripura, it grows naturally from their bulbils. In some area, tribals of Tripura cultivate this yam surrounding their house.

(c) Food value

The tuber of thakun (*D. hamiltonii*) is very delicious and is one of the most esteemed yams among the wild yams. Like other yams it is also a good source of carbohydrate. Analysis of the tubers gave the following values :

Table No. 4.4

Moisture, %	66.70	Fibre, %	1.50
Protein, %	1.80	Calcium, mg/100g	52.00
Fat, %	0.20	Phosphorous, mg/100g	49.00
Carbohydrate, %	28.80	Energy K Cal./100g	124.00
Minerals, %	1.00		

4.1.5 THACHER

Beng : Kukuralu; Hindi : Kasa alu

(*Dioscorea puber* Blume. Syn. *D. anguina* Roxb.)

(a) Description

An unarmed climber with stem twining to the right. Leaves large, ovate or elliptic-ovate, opposite. Tubers descending deep into the soil, covered with few rootlets, pale brown skin; flesh lemon yellow. **Bulbils** present.

(b) Distribution

Thacher (*D. puber*) is a wild variety of yam. In the forest region, they grow naturally from bulbils. Tribals of Tripura, especially women collect this yam from the forest during the extreme scarcity of food.

(c) Food value

Unlike other tubers it has a good food value especially carbohydrate content. Analysis of the tubers gave the following values :

Table No. 4.5

Moisture, %	73.40	Fibre, %	1.00
Protein, %	1.50	Calcium, mg/100g	16.00
Fat, %	0.10	Phosphorous, mg/100g	48.00
Carbohydrate, %	23.10	Energy, K Cal./100g	99.00
Minerals, %	0.90		

4.1.6 KWICCHA

(Beng : Suaralu, Jhunjhuna lata; Hindi : Kanta alu, Bhusa alu

(*Dioscorea pentaphylla* Linn. Syn. *D. triphylla* Linn.;

D. jacquemontii Hook.)

(a) Description

A slender, prickly climber with stems twining to the left. **Leaves**

alternate, 3-5 foliate, glabrous or sparsely pubescent beneath; leaflets variable in size and shape, elliptic-lanceolate, acuminate, base usually acute. Bulbils globose or cylindrical, usually plentiful. Tubers almost single, soft, covered with few roots; texture and shape variable; skin brown or pale yellow; flesh pale cream or lemon coloured.

(b) Distribution

This yam is commonly distributed in medium to thick forest. Kwiccha (*D. pentaphyla*) grows naturally in the home-gardens from their bulbils, but the tribals due to their unpleasant taste do not like to take the wild varieties. It occurs throughout the North East India ascending upto 5,500 ft. in the Himalayas.

(c) Varieties

About 16 varieties are recognized in the world. Three well-marked varieties are distinguished in the North East Region based on tuber characters. The first variety includes with soft tubers borne close to the surface of the soil, the second tubers deeply buried and the third variety yields hard tubers. The third variety is nauseous and unpleasant to eat.

(d) Food value

As the species include both poisonous and edible varieties, the tubers should be consumed after repeated boiling and washing. The nutritive values of edible tuber is nearly the same as that of *D. alata*. Analysis of edible tubers gave the following values :

Table No. 4.6

Moisture, %	79.60	Fibre, %	0.90
Protein, %	2.90	Calcium, mg/100g	25.00
Fat, %	0.30	Phosphorous, mg/100g	53.00
Carbohydrate, %	15.50	Energy, K Cal./100g	76.00
Minerals, %	0.80		

(e) Medicinal value

Tubers are used to disperse swellings and as tonic.

In spite of the classification of yams mentioned by the Prain and Burkill, it is very difficult to locate the particular thabolong (yam) according to the Kokborok naming as the different tribal communities of Tripura call the same yam with the different names. Hence, various other thabolongs like thanara, gonga, thalwibok etc. are not described

here due to their lack of proper identification. As dioscorea is a source of diosgenin, which is a raw material for the production of steroidal drugs, nowadays its cultivation has been successfully done by a number of pharmaceutical concerns and government agencies in the different states of India. The cultivation of *Dioscorea floribunda* Mart. in Tripura is going on successfully for the extraction of diosgenin. Because of the increased demand of steroidal drugs obtained from diosgenin during recent years, there has been a worldwide search for alternative sources of diosgenin other than species of *Dioscorea*. Therefore, by implementing the modern technology for the production of quality diosgenin in Tripura, government can earn lot of foreign currency by selling the same.

(f) Processing

The tribals use all types of thabolong mentioned above as food. They make different dishes like berma bwtwi, mui borok, mui awandru and gudok with these yams. Sometimes they simply boil the sweet tasty tubers and take these after sprinkling salt. For use as food, yams should be peeled and boiled properly to eliminate the alkaloids or other poisonous principles if any present in them.

4.2 THABORCHUK

Beng : Simul alu; Hindi : Tikhoor

(*Manihot esculenta* Crantz. Syn. *Manihot utilissima* Pohl.)

CASSAVA, MANIOC, TAPIOCA, YUCA

(a) Description and Taxonomy

A low herbaceous plant, 2-5 m. high, with large cluster of tuberous roots and milky juice. Stem varying in colour from dirty white to brown, marked by numerous scars left by fallen leaves. Leaves alternate palmately lobed, long petioled, pale green in colour. Flowers large, unisexual, both male and female flowers on same inflorescence. Fruit a capsule containing three seeds. Thaborchuk (Tapioca) belongs to the family Euphorbiaceae, genus *Manihot* and species *esculenta*.

(b) Distribution

Thaborchuk is also known as tapioca, cassava, manioc, yuca. The plant is popularly cultivated both by the tribals as well as other communities of Tripura. It is a very favourite food of pigs, cows and

other animals. Generally tribals planted this plant in home yards and beside their house. In Tripura this plant is observed in villages and hilly areas. Tapioca is native of South America and has been introduced later on into Africa, India and other countries of Asia. Tapioca cannot withstand frost and prefers well-drained sandy loam soils. Plant is propagated by cutting. About 15 to 20 cm. long stem are taken by cutting from a mature plants.

(c) Varieties

Two types of cassava are known as 'bitter' and 'sweet' according to the taste of the tuberous root. The bitter one is more commonly cultivated which produces higher yield. In Tripura, sweet type is commonly cultivated. Some of the cassava contains a poisonous glucoside. Boiling eliminates this type of poisonous substances.

(d) Food value

Tapioca is very important food crop by considering its high starch content (80 to 85%) in tuberous root. The important commercial use of tapioca is the production of starch and sago. Both the items are produced on cottage as well as on industrial scale in many tapioca-producing countries including India. Sometimes young leaves of sweet varieties of tapioca plant are eaten as vegetable.

Dehydrated meal prepared from tapioca leaves is superior to alfalfa leaf meal in vitamin A and protein content. Considering the fact, this type of preparation can be used as an ingredient of diary feed mixtures. Analysis of the edible portion of fresh tubers gave the following values:

Table No. 4.7

Moisture, %	59.40	Calcium, mg/100g	50.000
Protein, %	0.70	Phosphorous, mg/100g	40.000
Fat, %	0.20	Iron, mg/100g	0.900
Carbohydrate, %	38.70	Thiamine, mg/100g	0.045
Fibre, %	0.60	Nicotinic acid mg/100g	0.300
Mineral matter, %	1.00	Riboflavin, mg/100g	0.100
Energy, KCal./100g	157.00	Vitamin C, mg/100g	25.000

The starch content of the tuber may vary with the type and

condition of growth. The starch content of the tuber increases with the growth and reaching a maximum value between 8 to 12 months after planting; but after full maturity of tuber, the starch content gradually decreases and the fibre content increases.

(e) Processing

Tribals of Tripura state consider thaborchuk (cassava) as one of the favourite food item among the vegetables. For this they cultivate this for tuberous root and leaves. With tuberous root, tribals make mui chakhwi and mui borok. The worker classes also eat thaborchuk during breakfast with tea after boiling it. The leaves are used as food of fish like grass cup.

In tropical areas, this is often used as a supplementary food for its high carbohydrate content. In Africa, Indonesia and Polynesian Islands, it is consumed like sweet potato, in the form of tubers, chips, flour and sago. The working classes in Kerala, India prepare a delicious dish by using tapioca with fishes. They also consume young tubers of sweet varieties after roasting or boiling. In Philippines, the juice of the tubers is squeezed out and the residue made into small pellets named as "Cassava Rice". This "Cassava Rice" is used as a substitute of rice and maize. Flour or meal made from the tubers is used in making bread and other dishes.

4.3 BATEMA

Beng: Ol; Hindi: Suran, Jimikand.

(*Amorphophallus campanulatus* Blume)

ELEPHANT'S FOOT OR YAM

(a) Description and Taxonomy

A tuberous, stout, indigenous herb, 1.0-1.5 m. in height. Tuber depressed-globose, 20-25 cm. dia., bulbiferous, dark brown, long terete roots. Leaves appearing long after the flowers 30-90 cm. broad, segments spreading. Petioles 60-90 cm. long, stout, warted, dark green. Spadix sessile, columnar, as long as the spathe, appendage usually longer than spathe; flowers unisexual. The herb belongs to the family Araceae, the genus *Amorphophallus* and species *campanulatus*.

(b) Distribution

This plant is widely distributed in interior part as well as town of Tripura. It is cultivated as a pure vegetable in most of the areas, but in our house a large variety of vegetables like cluster bean (*Cyamopsis tetragonoloba* Taub.), yams (*Dioscorea* sp.), chillies (*Capsicum annum* Linn.) etc. are planted along with this crop to provide shade to batema. Both the tribes and non-tribes equally favour these vegetables for the different preparations.

(c) Varieties

The corm is also known as elephant foot or yam. There are two distinct types of yam on the basis of the colour of the flesh: red and white, although other colours like purple, pink, violet and yellowish creamy are also available. On the basis of appearance, two types of yam are distinguished:

- (i) The smooth-surfaced corms which cause irritation of the throat and
- (ii) The daughter corms protruding from the parent corm is non-irritating but gives fewer yields.

Amorphophallus bulbifer Roxb. Bl., a wild variety has been reported in the forest of Tripura. This plant is similar to *Amorphophallus campanulatus* with a large corm. In this plant bulbils are present above the stalks of the foliage leaves. Leaves are trifoliate, segmented with purple edged.

(d) Food value

The elephant's foot is grown for its tubers (batema), which can be stored for long periods. The tender petioles (muimorong bosok) have a very pleasant taste when the leaves are still young and unexpanded. The tribals of Tripura eat these tender petioles of cultivated as well as wild varieties as vegetable. The whole plant (muimorong bufang) are rich in nutrients including minerals. Analysis of the stems and leaves gave the following values (dry basis)

Table No. 4.8

Crude protein, %	15.30	Ash, %	16.20
Ether extr., %	3.30	P ₂ O ₅ , %	1.86
N-free extr., %	50.90	CaO, %	2.13
Crude fibre, %	14.20		

The nutritive analysis of the corms gave the following values :

Table No. 4.9

Moisture, %	78.70	Calcium, mg/100g	50.00
Protein, %	1.20	Phosphorous, mg/100g	34.00
Fat, %	0.10	Iron, mg/100g	0.60
Fibre, %	0.80	Thiamine, mg/100g	0.06
Carbohydrate, %	18.40	Riboflavin, mg/100g	0.07
Starch, %	17.70	Niacin, mg/100g	0.70
Oxalic acid, %	1.30	Carotene, μ g/100g	260.00
Energy, K cal./100g	79.00	Vitamin A, I.U/100g	434.00
Minerals, %	0.80		

The irritant properties of corms are due to the presence of calcium oxalate crystals. This calcium oxalate crystal pierces into the throat and produces an irritating sensation in the mouth. The irritating sensation can be removed after washing properly and boiling in tamarind water. The essential amino acids of the corms are arginine, 11.16; histidine, 1.58; leucine, 5.9; isoleucine, 5.0; lysine, 4.44; methionine, 1.04; phenylalanine, 6.22; threonine, 4.47; tryptophan 0.63; and valine 4.95 g/16g.

(e) Processing

Tribals cook **muimorong bosok** (tender leaves) as **dalo**. They prepare their favourite **mui chakhwi** with corms. **Mosodeng** is also prepared with dry corms (cakes) by using dry fish. Sometimes tribals make **mui borak** and **gudok** by using **muimorong bufang** (tender stem).

(f) Medicinal value

1. The corms are used as carminative and expectorant. The fresh ones increase appetite and taste.
2. The corms are administered internally, particularly in the treatment of dysentery, piles and haemorrhoids.
3. They are applied externally as an irritant to treat acute rheumatism.
4. The active principle of the stem is reported to inhibit the growth of 'bovine strain' of *Mycobacterium tuberculosis*.
5. The roots are used in ophthalmia and applied to boils.
6. The fermented juice of the petioles is used to cure diarrhoea.

4.4 MUIA

Beng : Karul, Bansher-ankur
(Tender shoot of *Bambusa* Schreb.)

(a) Description and Taxonomy

Bamboos are usually a large, woody, perennial grasses or trees. The stems are slender, 25 cm. to 50 cm. in diameter and reach a height of about 40 meters. Bamboos are generally round and smooth. They have hollow internodes and solid nodes. However bamboos of some species are also solid. They have well marked nodes as in green grasses. Leaves are shortly petiolate and sheaths are variously auricled. The leaf blades are often short. They are usually joined at the base with a short stalks by which they are attached to a long sheath. Bamboos are said to flower only once during their life, generally at intervals of 25-50 years and die soon after. It happens only in seasons of great drought so that it has been considered a precursor of famine. Bamboos produce their tender shoots (muia) during the month of April to August, although the production of muia varies from species to species. Different types of muia are available in Tripura like :

- (i) **Hatal muia** : These types of muia are produced after burning the forest during the month of March and April.
- (ii) **Muia rwbam or Ha tolani muia** : It is the underground young shoots of bamboos like Mirtanga (wandal) and other, which grow during the early time of muia production.
- (iii) **Watlai muia or Watreng muia** : Muia comes out from bamboos after one year of jhum cultivation during the last season of muia. These types of muia grow up to the height 1-1.5 m.

The tribals of Tripura popularly eat all kinds of muia. Bamboo belongs to the family Graminae/Poaceae. The genus and species of bamboos are different.

(b) Distribution

In Tripura bamboos are found naturally in evergreen forests both on hills and on the plains. They are also cultivated in many parts of Tripura. Bamboos thrive best in monsoon forests. They reduce into under-shrubs in the temperate regions. At high altitudes they look almost like grasses. They form rich belts of vegetations in well-drained parts of the monsoon regions. Although due to jhum cultivation and

uncontrolled destruction of forests the dense evergreen bamboo forests are now decreasing rapidly.

(c) Varieties

There are about 50 genera and approximately 1,326 species of bamboos generally inhabiting in different temperate regions of the world. More than 58 species of bamboos are available in the North Eastern states. Bamboos can be classified into three groups on the basis of their flowering pattern :

- (i) those that flower annually or nearly so;
- (ii) those that flower gregariously and periodically; and
- (iii) those that flower sporadically or irregularly.

The important bamboos occurring in the Tripura state are : *Dendrocalamus strictus*, *Bambusa affinis*, *Bambusa belcooa*, *Dendrocalamus hamiltonii*, *Dendrocalamus longispathus*, *Melocanna bambusoides*, *Neohouzeaua dullooa*, *Oxytenanthera albociliata*, *Bambusa pallida*, *Bambusa polymorpha*, *Bambusa teres*, *Bambusa tulda*, *Bambusa mutans*, *Dinochloa compactiflora* etc.

The young shoots (muia) of different bamboos available in Tripura which are generally eaten by the tribals of Tripura are :

(i) Wathwi muia

Beng : Muli

Botanical name : *Melocanna baccifera* (Roxb.); Syn. *M. bambusoides* Trin.

(ii) Wanol / Wandal muia

Beng : Mirtanga, Tulda, Matela

Botanical name : *Bambusa tulda* Roxb.

(iii) Wasur muia

Beng : Sil Barak, Borobans.

Botanical name : *Bambusa balcooa* Roxb.

(iv) Wakobor muia

Beng : Bari, Bethua.

Botanical name : *Bambusa polymorpha* Munro.

(v) Watlok muia (rarely taken)

Beng : Dalu

Botanical name : *Neohouzeaua dullooa* A.

(vi) Wamilik muia.

Beng : Ruphai.

Botanical name : *Dendrocalamus hamiltonii*.

(d) Food value

The food value of different bamboo shoots (*muia*) depends on the percentage of the edible portion. This value is about 27 percent. Although the food value of various edible *muia* slightly differ from one species to other, an average food value of *muia* are given below :

Table No. 4.10

Moisture, %	87.10	Calcium, mg/100g	20.00
Protein, %	3.90	Phosphorous, mg/100g	90.00
Carbohydrate, %	7.50	Iron, mg/100g	0.10
Minerals, %	1.40	Niacin, mg/100g	200.00

Majority of edible *muia* contains considerable amount of minerals and carbohydrates. They also release good amount of energy. Analysis of tender shoots of *Bambusa arundinacea* shows the following food values :

Table No. 4.11

Moisture, %	88.80	Sodium, mg/100g	91.00
Protein, %	3.90	Riboflavin, mg/100g	0.19
Fat, %	0.50	Copper, mg/100g	0.19
Carbohydrate, %	5.70	Chlorine mg/100g	76.00
Calcium, mg/100g	20.00	Minerals, %	1.10
Phosphorous, mg/100g	65.00	Niacin, mg/100g	0.20
Iron, mg/100g	0.10	Vitamin C, mg/100g	5.00
Magnesium, mg/100g	32.00	Choline, mg/100g	8.00
Energy, K Cal./100g	43.00	Oxalic acid, mg/100g	2.00
		Thiamine mg/100g	0.08

When we consider the food value of *muia*, the toxic effect should also be considered. Some *muia* of bamboos like *B. vulgaris*, *B. arundinacea*, *D. hamiltonii* etc. contain bitter or acid poisonous substances, taxiphyllin, hydrocyanic acid. These toxic substances can be removed by boiling with water or by maceration with salt water (2%) for several hours.

(e) Processing

Muia (bamboo shoots) are very popular food item not only to the

tribals of Tripura, but also to the other people of North Eastern Region. From the ancient time different literature explained the uses of *muia* both as food as well as medicine. The shoots of *Bambusa polymorpha*, *B. guadua* are sweet and pleasant in taste when it remains under the soil (*ha tolani muia*). Before cooking all kinds of *muia* should be boiled to remove the different toxic principles. The tribals of Tripura prepare different delicious dishes like *gudok*, *mui chakhwi*, *mui borok*, *mui awandru* etc. from various types of bamboo shoots.

(f) Medicinal value

1. A thick transparent watery liquid is obtained from the hollow internodes of the female bamboo, called *Tabashir* in Hindi, *Bansa rochana* in Sanskrit and *wakthwi* in kokborok. This *Tabashir* is composed of silicic acid with traces of iron, calcium, alum, alkalis and organic matter. The *Tabashir* obtained from *Bambusa arundinacea* is largely used as cooling tonic and as an aphrodisiac. It is also useful in asthma, cough, poisoning cases and paralytic complaints.
2. In Ayurveda, the stems and leaves are used in 'Kapha', diseases of blood, leucoderma, wounds, piles and in inflammatory conditions.
3. According to the indigenous system of medicine, the burnt roots are applied to ring worm, bleeding gums and to painful joints.
4. The leaves are good as eye-wash and in fever. The leaves are given to animals during parturition, from a supposition that they cause a more rapid expulsion of the placenta.

4.5 SOLANUM Linn. (Solanaceae)

A large genus of herbs and shrubs, distributed throughout the world. About 58 species are reported from India. Several species of this genus have great economic value. They provide the good sources of food, drugs and fodder. For example, potato, brinjal etc. are consumed as vegetables throughout the years. Several species of *solanum* are found in Tripura state. Out of them, three important vegetables cited here which the tribals of Tripura generally consume: viz., *Khamka sikam*, *Khamka bilati* and *Phantok*.

4.5.1 KHAMKA SIKAM

Beng : Brihati or Gota begun.

(Solanum torvum Swartz.)

(a) Description and Taxonomy

A very common spiny herb or shrub with branches. Leaves simple, ovate, exstipulate. Flower white in colour and bisexual. Fruits green and smooth when unripe but change to yellow or orange-red when ripe. Fruit many seeded. It belongs to the family Solanaceae, genus *Solanum* and species *torvum*.

(b) Distribution

This common herb is distributed throughout the state of Tripura. It is observed on the roadside, backyard of the house and hilly areas. The plant grows naturally from the seeds and can also be propagated by cutting.

(c) Food value

Fruits have a good food value. Fruits provide good energy and vitamins (carotene). It is also a good source of minerals like calcium, phosphorous, iron etc. Analysis of dried fruits gave the following values :

Table No. 4.12

Moisture, %	12.30	Calcium, mg/100g	390.00
Protein, %	8.30	Phosphorous, mg/100g	180.00
Fat, %	1.70	Iron, mg/100g	22.20
Carbohydrate, %	55.00	Carotene, µg/100g	450.00
Minerals, %	5.10	Energy, K Cal/100g	269.00

(d) Processing

Fruits of this plant are cooked and eaten as a vegetable. By using khamka sikam tribals make their various tasty dishes like gudok, chakwi chatang, egwi etc. They also eat this fruit simply by frying it.

(e) Medicinal value

- (i) Leaves are used as haemostatic due to the presence of oil or pectins or both.
- (ii) This plant is useful in the treatment of cough.
- (iii) Root is used in poulticing cracks in the feet.
- (iv) In toothache, the fumes of burning seeds are effective.

4.5.2 KHAMKA / KHAMKA BILATI / KHAMKA BOROK

Beng : Gurkamai, Tit Begun; Hindi : Barhanta

(*Solanum indicum* Linn.)

(a) Description and Taxonomy

A thickly spined common herb or an under shrub, stem much branched, spined almost all parts. Leaves sub-entire, alternate, ovate and lobed. Flowers pale violet. Fruits berry globose smooth, slightly bitter in taste. It belongs to the family Solanaceae, genus *Solanum* and species *indicum*.

(b) Distribution

The herb generally occurs in moderate forest, both in plains and hillocks of Tripura state. As like as *Solanum torvum*, the plant is also found sometimes at the roadside and backyard of the house. It propagates naturally from the seeds.

(c) Food value and Processing

Young fruits and half-ripe fruits are generally preferred by the tribals to make different dishes like khamka sikam. Tribals like this fruit more than khamka sikam. The food value of this herb is almost similar to *Solanum torvum*. Fruits and leaves also contain glycoalkaloids. A steroidal compound, diosgenin has been isolated from the leaves, fruits and stems of this herb. This valuable compound is used to manufacture female contraceptive pills. Some enzymes like carbohydase, maltase, saccharase etc. are present in the fruit.

(d) Medicinal value

- (i) Fruit is used as laxative and digestive.
- (ii) The smoke of burning khamka is useful in toothache.
- (iii) Leaf-extract is used in itching as antibacterial agent.
- (iv) In Africa, this plant is used in ringworm.
- (v) The fruit-extract is used in cough and loss of appetite. The fruit is also effective in rheumatic joint pain.

4.5.3 HUKNI PHANTOK / PHANTOK BOROK

Beng : Jhum Begun; Hindi : Jhum Baingan)

(*Solanum melongena* Linn.)

BRINJAL

(a) Description and Taxonomy

An erect, closely prinkles or sometimes unarmed perennial 0.6-2.4 m. tall herb. Leaves large, elliptic, sub entire, sinuate or lobed. Flowers blue, in small clusters. Fruits various shape and size with thick calyx. Seeds many, discoid. The brinjal belongs to the family Solanaceae and to the genus *Solanum*. It belongs to the species *melongena*.

(b) Distribution

Brinjal is one of the most important vegetables grown not only in every parts of Tripura, but also throughout the country. Although the warm season is the best time for the cultivation of this herb, but it is grown throughout the all seasons. In Tripura, jhum variety is cultivated on the hillock during the jhum cultivation. This plant is grown both in the plains and on the hills. It is a native of India and was first cultivated in this country.

(c) Varieties

Different varieties are grown in Tripura as well as in India. Varieties depend on the shape and colour of fruits and also in the growth habit of the plant. The egg or round-shaped varieties are grouped under var. *esculentum*. The long, slender types are put under var. *serpentinum* and the dwarf early one under var. *depressum*.

(d) Food value

Analysis of the edible portion of fruit gave the following values :

Table No. 4.13

Moisture, %	92.70	Potassium, mg/100g	200.00
Protein, %	1.40	Copper, mg/100g	0.17
Fat, %	0.30	Sulphur, mg/100g	44.00
Carbohydrate, %	4.00	Chlorine, mg/100g	52.00
Minerals, %	0.30	Thiamine, mg/100g	0.04
Fibre, %	1.30	Riboflavin, mg/100g	0.11
Calcium, mg/100g	18.00	Nicotinic acid, mg/100g	0.90
Phosphorous, mg/100g	47.00	Oxalic acid, mg/100g	18.00
Iron, mg/100g	0.90	Vitamin C, mg/100g	12.00
Magnesium, mg/100g	16.00	Vitamin A, I.U./100g	124.00
Sodium, mg/100g	3.00	Calories, K Cal./100g	24.00

The value of brinjals is esteemed as a vegetable due to the availability of this fruits throughout the year. The fully matured fruits have very good nutritive value and are a fairly good source of phosphorous, potassium and vitamin A. Brinjals contain a very good percentage of the vitamin than many other vegetables. The bitter taste of brinjal (jhum variety) and its peel is due to the solasonine.

(c) Processing

Phantok (brinjal) is a very popular vegetable both for the rich and the poor. Brinjals serve the purpose of vegetables during the scarcity of other vegetables. The tribals and other communities consume it in a variety of ways. By using phantok borok tribals make various types of favourite dishes like mui chakhwi, berma butwi, mui borok, chakwi chaprang, mosodeng, and chakhtwi kutung etc. All the communities of Tripura prepare a delicious item called Bharta. To make this item brinjals are burned in hot ashes and the outer layer is peeled. The peeled brinjals are mixed with salt, onion, chillies and mustard oil.

(f) Medicinal value

- (i) White brinjal is said to be good for diabetic patients.
- (ii) Brinjal is recommended in liver disorder.
- (iii) This fruit is reported to stimulate intrahepatic metabolism of cholesterol. Both leaf and fruit produce a marked drop in blood cholesterol level.
- (iv) Extract of the flower is used in asthma.
- (v) Leaves are also used in bronchitis and asthma.

4.6 THAILIK BOLONG

Beng : Ram kala; Hindi : Junglee Kela

(*Musa acuminata* colla.

syn. *Musa cavendishii* Lamb.)

WILD BANANA

(a) Description and Taxonomy

A perennial tree-like herb with pseudostem. Thick stems composed of convolute leaf-sheaths, bearing brown or black marks. Leaves large, wide, oblong and distinct midrib; varying from green to purple. Midrib greenish yellow upper surface and beneath red. Flowers

bisexual, covered by large spathe like bract; about twenty flowers per bract. Fruits bunch compact, shortly pedicelled and prominently beaked fingers. Seeds dull black, tubercular, embedded in pulp. Banana plant belongs to Musaceae family, sub-genus *Musa* and variable species.

(b) Distribution

This wild plant is widely distributed in most of the hilly regions of Tripura. It provides one of the important components of dense evergreen forest in the hillock, hillside and hilltop. This wild variety is also widely distributed over the whole North Eastern Region. The plant is naturally propagated.

(c) Varieties

Musa is the biggest and geographically widespread genus. About 14 species have been reported in India. Two wild varieties have been traced out from India, namely— *Musa acuminata* and *Musa balbisiana*. Both seeded (wild) and seedless (edible) forms of *M. acuminata* occur as normal plants. Nowadays different high yielding edible varieties are obtained through the out crossing of edible and wild forms.

(d) Food value

Banana is one of the favourite fruits and vegetables not only in Tripura, but in India too. By considering its nutritive value it is widely grown as a backyard crop in house. The ripe fruit is a rich source of carbohydrates and a fair of minerals and vitamins, especially B-complex group. The unripe green banana is eaten as vegetable. Starch (20.5%) is the main constituent of the major carbohydrate in green unripe banana. The analytical value of the pulp of unripe banana are as follows :

Table No. 4.14

Moisture, %	60.40-72.40	Non reducing sugars,%	0.50
Protein, %	1.00-1.80	Fat, %	24.50-36.70
Reducing sugars%	0.10-0.20	Ash, %	0.90-1.30

The flowers (**muikhon** in Kokborok; Beng : **mucha**) of banana plants are used as a vegetable. Analysis of the **muikhon** gave the following values :

Table No. 4.15

Moisture, %	90.20	Calcium, mg/100g	0.03
Protein, %	1.50	Phosphorous, mg/100g	0.05
Carbohydrate, %	5.00	Iron, mg/100g	0.10
Fibre, %	1.90	Nicotinic acid, mg/100g	0.60
Mineral matter, %	1.20		

The tender core of the stem (**bugili** in Kokborok; Beng: **chubui**) is eaten after cooking. Analysis of the stem gives the following values:

Table No. 4.16

Moisture, %	88.30	Calcium, mg/100g	25.00
Protein, %	0.50	Phosphorous, mg/100g	10.00
Fat, %	0.10	Iron, mg/100g	1.10
Carbohydrate, %	9.70	Nicotinic acid, mg/100g	0.20
Fibre, %	0.80	Vitamin C, mg/100g	1.00
Mineral matter, %	0.60	Energy, K Cal/100g	51.00

(e) Processing

Almost all the parts of **thailik** like **muikhon** (flower), **bugili** (stem) and green banana (**thailik kwthung**) are popularly eaten after making different tasty dishes by the tribals. The immature tender stem of young banana plant after peeling outermost layers is called **laifang**. The inner mature stem of banana plant after producing fruits obtained by peeling the outermost layers is known as **bugili** or **chubui**. By using **muikhon** and **bugili** tribals make **mui awandru**. They use **muikhon** and **laifang** in the dish of **gudok**. **Muikhon** is also used in **mui chakhwi**. Different dried materials like leaf, stem etc. are used to make **chakhwi** (alkali water). The ripe banana is eaten as fruit.

(f) Medicinal value

- (i) The green banana (**thailik kwthung**) and flower (**muikhon**) are used in combating diarrhoea and dysentery. The fruits promote the healing of intestinal lesions in ulcerative colitis.
- (ii) Ripe banana have mild laxative activity. So they can be eaten during constipation.
- (iii) The cooked flowers and unripe fruits are useful in diabetes. The ripe fruits are considered good in uremia, nephritis, gout, hypertension and cardiac diseases.

- (iv) The ash of the leaves, stem and whole part is considered as anthelmintic. Due to this fact chakhwi prepared from banana leaves is used in different tribal dishes, and believed by the tribals that it is good for health.
- (v) The juice of stem and root are useful in blood disorders and venereal diseases.
- (vi) The juice of the flowers (**muikhon**) mixed with curds is used in dysentery and menorrhagia.

4.7 SEJNA / SAJNA

Beng : Sajina; Hindi : Sainjna, Shajna.

(*Moringa oleifera* Lam.)

Syn. *Moringa pterygosperma* Gaertn.)

DRUM STICK

(a) Description and Taxonomy

A soft-wooded, medium-sized tree. Bark thick, soft, deeply fissured. Leaves usually tri-pinnate, leaflets ovate, slightly rounded at the apex. Flowers white, fragrant. Pods pendulous, greenish, 22.5-50 cm. in length. Seeds trigonous with wings. The tree sheds its leaves in December to January and new leaves appear in February to March. During this time flowers come out and long tender fruits follow these in March to May. This plant belongs to the family Moringaceae. The genus of mostly cultivated drumstick is *Moringa* and species *oleifera*.

(b) Distribution

The plant is often planted in homestead compounds. Frequently, it is grown as a post for fencing. It can grow in almost all types of soils both in plains and hills. The plant can be easily propagated by cutting of stems and planted in moist soil. In Tripura, both at cities and villages, drumstick plants are very popular to all communities. The tree is indigenous to North-West India.

(c) Varieties

Mainly two varieties of drumstick are observed in Tripura namely most common **white-flowers plant** and other somewhat less available variety **red-flowers plant**. Another blue-flowers variety was also observed in earlier day in some area of India, but nowadays this variety

is very rare. Another variety, *chemmurunga* is observed in parts of South India yielding pods with red tips.

(d) Food Value

Every parts of this plant is esteemed either as vegetable or as medicine. Leaves, flowers and tender pods of drumstick provide good food values. Leaves are rich in carotene and ascorbic acid (vit. C). Essential amino acids present in the pod protein are : arginine, 3.6; histidine, 1.1; lysine, 1.5; tryptophan, 0.8; phenyl alanine, 4.3; methionine, 1.4; threonine, 3.9; leucine, 6.5; isoleucine, 4.4 and valine, 5.4 g/16g. Analysis of the kernal of seeds gave the following values: moisture %, 4.0; crude protein %, 38.4; fatty oil %, 34.7; N-free extr. %, 16.4; fibre %, 3.5; and mineral matter %, 3.2. Nutritive analysis of drumstick leaves, pods and flowers gave the following values:

Table No. 4.17

Constituents		Leaves	Pods	Flowers
Moisture, %		75.00	86.90	85.90
Protein, %		6.70	2.50	3.60
Fat, %		1.70	0.10	0.80
Carbohydrate, %		13.40	3.70	7.10
Fibre, %		0.90	4.80	1.30
Mineral matter, %		2.30	2.00	1.30
Energy,	K Cal./100g	92.00	26.00	50.00
Calcium,	mg/100g	44.00	30.00	51.00
Phosphorous,	mg/100g	70.00	110.00	90.00
Iron,	mg/100g	7.00	5.30	-
Nicotinic acid,	mg/100g	0.80	0.20	-
Ascorbic acid (vit. C)	mg/100g	220.00	120.00	-
Tocopherol (vit. E)	mg/100g	7.40	-	-
Carotene,	I.U./100g	11,300.00	184.00	-
Copper,	µg/g	1.10	3.10	-
Iodine,	µg/kg	51.00	18.00	-
Thiamine (vit. B ₁)	µg/100g	210.00	0.05	-

(e) Processing

The tribals of Tripura use *sajna* flowers (*sajna bwbar*), tender leaves (*sajna bosok*), and pods (*bwthai*) as vegetable and incorporate these in different dishes. They prepare *mui chakhwi*, *berma bwtwi* and *mui awandru* by using *sajna bwthai* (pods). The *sajna bosok* (tender leaves) are used as *dalo*. Tribals also use leaves of *sajna* in *mui chakhwi*. The *sajna bwbar* (flower) is popularly used in the preparation of *gudok*, and sometime eat simply by frying it.

(f) Medicinal value

- (i) The leaves are useful in scurvy and catarrhal affections as leaves are rich in vitamin C and vitamin A.
- (ii) A paste of the leaves is used externally for wounds.
- (iii) Flowers are used as tonic, diuretic and cholagogue.
- (iv) The seed oil is used externally for relieving pain of the joint in gout and acute rheumatism.
- (v) The root of the young tree alongwith root bark are ground into paste and applied locally in chronic rheumatism as a poultice.

4.8 KHOKLENG / MUIMASING

Beng : Arhar; Hindi : Tur

[*Cajanus cajan* (Linn.) Millsp. Syn. *Cajanus indicus* Spreng.]

(a) Description and Taxonomy

An erect, annual or perennial hairy herb or shrub; 0.75 to 4.3 m. in height. Leaves trifoliolate with indistinctly gland-dotted beneath. Leaflets oblong-lanceolate, acute & entire. Flowers yellow or yellow-veined with red or purple in colour. Pods 5.0-7.5 cm. long with 3-7 seeded. Seeds vary from yellow and red to brown or black. The plant belongs to the Papilionaceae family, genus *Cajanus* and species *cajan*.

(b) Distribution

The shrub is equally distributed throughout Tripura in plain lands as well as hilly region. This pulse is cultivated in India as an important crop. The crop is highly adaptable to climatic variations and grows both in dry and moist tropics.

(c) Varieties

Two important varieties have been observed under the species. They are *C. cajan* var. *bicolor* Dc. commonly known as arhar, and *C. cajan* var. *flavus* Dc. the common tur. The variety *bicolor* contains dark coloured pods; each bearing 4-5 seeds whereas other variety *flavus* consists of plain pods with 2-3 seeds. The varieties are also categorized depending on the colour of the seed coat and the size of the seed. The most commonly available types of muimasing (arhar) in Tripura are the red and white.

(d) Food value

Muimasing bwchlwi (arhar seed) is generally consumed in the form of dal or when tender, as a vegetable. The seeds contribute significantly to the daily requirements of minerals and vitamin B complex. The green seeds are a good source of phosphorous, potassium, sulphur and carotene. The analysis of tender seed pods show the following nutritive values.

Table No. 4.18

Moisture, %	65.10	Calcium, mg/100g	57.00
Protein, %	9.80	Phosphorous, mg/100g	164.00
Fat, %	1.00	Iron, mg/100g	1.10
Carbohydrate, %	16.90	Magnesium, mg/100g	58.00
Fibre, %	6.20	Sodium, mg/100g	93.00
Minerals, %	1.00	Potassium, mg/100g	463.00
Energy, K Cal./100g	116.00	Copper, mg/100g	0.40
Thiamine, mg/100g	0.32	Sulphur, mg/100g	494.00
Vitamin C, mg/100g	25.00	Chlorine, mg/100g	22.00
Riboflavin, mg/100g	0.33	Choline, mg/100g	72.00
Niacin, mg/100g	3.00	Oxalic acid, mg/100g	16.00
Carotene, µg/100g	469.00		

(e) Processing

Tribals cook the seeds of arhar (muimasing bwchlwi) as mui borok, chakhwi chatang, and mui awandru. Sometimes tender green pods (muimasing kwlwi) are cooked as vegetable.

(f) Medicinal value

(i) A paste of the leaves with salt and water is taken on the empty stomach to cure jaundice.

- (ii) The green leaves are used in disease of mouth.
- (iii) A poultice prepared from the pounded leaves and seeds along with water are used to cure measles by applying topically over the body. It also reduces swelling.
- (iv) The lactating mother to check the secretion of milk uses a paste from seeds and leaves.
- (v) The seed is used in leprosy, bronchitis and piles, and as an anthelmintic.

4.9 JINGA THAKTWI

Beng: Lal alu, ranga alu; Hindi: Mitha alu

(*Ipomoea batatas* [Linn.] Lam.)

(a) Description and Taxonomy

A slender, prostrate, trailing or ascending herb, producing succulent and tuberous roots. Leaves alternate, variable, ovate-cordate, entire and angular. Flowers funnel-shaped, white or purple in colour. Seeds small, black and somewhat flattened. The tubers are grown near to the base of the main stem or at nodes of trailing veins that remain into the soil. Tubers may be of bunched habit when close to the stem or they may be borne on laterals.

In some countries this crop is often known as 'potato' and the potato is called 'white potato' or 'Irish potato'. The sweet potato belongs to the family Convolvulaceae, genus *Ipomoea* and species *batatas*.

(b) Distribution

Sweet potato is cultivated in the plains and the hillocks of Tripura during winter season. It is grown in every district and is available in every parts of Tripura. It is best adopted on light sandy soils.

(c) Varieties

There are near about 100 varieties of sweet potato. The varieties are grouped according to their growth habits. The most common way of grouping the varieties is according to the colour. The colour of the skin may be white, creamy, brown, golden, red and pinkish. The most common local varieties are white and red.

(d) Food value

The chief use of sweet potato is for human consumption,

manufacturing of starch and alcohol. It contains 16 percent starch and 4 percent sugar. The nutritive analysis of Indian sweet potato is given below :

Table No. 4.19

Moisture, %	68.50	Calcium, mg/100g	20.00
Protein, %	1.20	Phosphorous, mg/100g	50.00
Fat, %	0.30	Iron, mg/100g	0.80
Carbohydrate, %	28.20	Potassium, mg/100g	393.00
Fibre, %	0.80	Sodium, mg/100g	9.00
Minerals, %	1.00	Riboflavin, mg/100g	0.04
Energy, K Cal./100g	120.00	Thiamine, mg/100g	0.08
Vitamin A, I.U./100g	10.00	Nicotinic acid, mg/100g	0.70
Vitamin C, mg/100g	24.00		

The food value varies with the type of sweet potato, condition of growth and duration of storage after harvesting. Tender tops (*thaktwi bosok*) and leaves (*thaktwi bwlai*) of the vein are also highly nutritious and are used as a leafy vegetable. Analysis of dried veins gave the following values :

Table No. 4.20

Dry matter, %	90.70	Fibre, %	19.10
Protein, %	12.60	Mineral, %	10.20
Fat, %	3.30	Digestible protein, %	8.90
Total digestible nutrients, %	51.70		

(e) Processing

Tribals prepare *mui borok* with *jinga thaktwi*. The poor tribals also consume these tuberous roots by boiling in water during scarcity of foods.

(f) Medicinal value

- (i) Veins and leaves may be used as antibacterial and fungicidal agents, as they contain antibacterial and fungicidal substances.
- (ii) A paste of roots or leaves is used as an application to scorpion bites.
- (iii) Tops and tender shoots are used in poultices.
- (iv) The root is considered as laxative.

4.10 KOMLIHA

Beng : Kalmisak; Hindi : Kalmisag, karmi

(*Ipomoea aquatica* Forsk. Syn. *Ipomoea reptans* Poir.)

(a) Description and Taxonomy

Annual or biennial, trailing or floating herb with long, hollow stem and rooting at the nodes. Leaves elliptic or ovate-oblong, cordate or hastate at the base. Flowers infundibuliform, white or pale purple in colour. Fruits ovoid and smooth. The herb belongs to the family Convolvulaceae, genus *Ipomoea* and species *aquatica*.

(b) Distribution

The herb is found trailing on moist soil or mud along the margins of streams, fresh water ponds, ditches, marshes and wet rice fields. In almost all market of Tripura local people (both tribes and non-tribes) sale this vegetable popularly.

(c) Varieties

It occurs in both wild and cultivated varieties and is propagated by cutting of stem. The herb may be terrestrial variety and aquatic variety. The terrestrial variety is sweet in taste and later one is bitter or sweet.

(d) Food value

The young terminal shoots and leaves are used as nutritious vegetable. The leaves are the good source of minerals and vitamins, especially carotene. The nutritive analysis of fresh leaves gave the following values :

Table No. 4.21

Moisture, %	90.30	Calcium, mg/100g	110.00
Protein, %	2.90	Phosphorous, mg/100g	46.00
Fat (ether extract), %	0.40	Iron, mg/100g	3.90
Carbohydrate, %	4.30	Vitamin C, mg/100g	137.00
Mineral matter, %	2.10	Riboflavin, µg/100g	120.00
Carotene (vit.A), I.U./100g	3300.00	Nicotinic acid, mg/100g	0.60
Vitamin B ₁ , µg/100g	87.00	Vitamin E, mg/100g	11.80

The whole plant contains (dry basis) :

Table No. 4.22

Dry matter, %	6.90	Carbohydrate, %	41.10
Protein, %	19.60	Fibre, %	20.40
Fat, %	3.40	Ash, %	15.50

(c) Processing

Tribals cook tender terminal shoots (*komliha bosok*) as *dalo*. They also prepare *charchara* which is a common Bengali dish. For this preparation, tender shoots are cut into small pieces and cooked with small fishes along with spices. They consider this preparation as a delicious food item. Tribals also prepare *berma bwtwi*, *mui borok* from this vegetable.

(f) Medicinal value

(i) The juice of the plant is said to employ as an emetic in cases of arsenic or opium poisoning. It is also effective to protect from small pox if taken regularly.

(ii) The herb is used in the treatment of ringworm.

(iii) Poultice prepared from plant is applied in febrile delirium and over matured boils. The boils will burst within a short period of time.

(iv) In Assam, the weed is considered very effective for females who suffer from nervous and general weakness.

(v) The juice of this plant is used to increase the secretion of milk of a lactating mother.

4.11 SAMSOTA

Beng: Thankuni, adamani; Hindi: Brahma-manduki

(*Centella asiatica* Linn. Syn. *Hydrocotyle asiatica* Linn.)

(a) Description and Taxonomy

A slender, perennial herbs growing up to 2 m. long and rooting at the nodes. This creeping herb has a long prostrate coming off from the leaf-axils vertical rootstock. Leaves are fleshy, orbicular-reniform. The leaf surfaces are smooth on the upper and sparsely hairy on the lower. Red, pink or white flowers are in umbels. Each umbel consists of 3-4 flowers. The herb belongs to the family Umbelliferae, genus *Centella* and species *asiatica*.

(b) Distribution

The herb is commonly found in abundance as a weed in crop fields and other waste places of Tripura on moist, sandy or clay soils up to an altitude of 600 m. It is propagated from seeds or from stolons.

(c) Varieties

The plant is frequently confused for *Bacopa monnieri* Wettst., which is sold in the market as **Brahmi**. This confusion, however, has been resolved and it is concluded that **Brahmi** is *Bacopa monnieri* and **Samsota** (thankuni) is *Centella asiatica*. The commercial *Centella* drug is often adulterated with this plant.

(d) Food value

Samsota (thankuni) consists of fresh dried leaves and stems of *Centella asiatica*. This herb is rich in carotenoids, calcium, vitamin B and vitamin C. The nutritive analysis of **Samsota** is given below:

Table No. 4.23

Moisture, %	87.20	Calcium, mg/100g	176.00
Protein, %	1.70	Phosphorous, mg/100g	72.00
Fat, %	0.70	Iron, mg/100g	12.00
Carbohydrate, %	4.80	Niacin, mg/100g	0.80
Crude fibre, %	3.40	Vitamin C, mg/100g	42.00
Energy, K Cal./100g	32.00	Carotene, µg/100g	2400.00

(e) Processing

The tribals eat the whole plants as dalo. Tribals also make various preparations like mui chakhwi, berma bwtwi, mosodeng, mui awandru etc. with this herb.

(f) Medicinal value

- (i) In india, the plant is used as brain tonic to improve memory. It has antianxiety and anti-stress action.
- (ii) The plant showed good therapeutic effects on peptic ulcers and amoebiasis.
- (iii) Syrup of the leaves with ginger and black pepper is taken for cough.
- (iv) For treating leprosy and other skin diseases, it is given as an ointment or dusting powder because of antibacterial properties.

- (v) The plant is used in bronchitis, asthma, kidney troubles and urethritis.
- (vi) Whole plant is eaten either raw or after cooking for hookworm and tapeworm.

4.12 DALO BUPHAM

Beng: Bathusag, Bethuasag; Hindi: Bathua

(*Chenopodium album* Linn.)

(a) Description and Taxonomy

An erect, mealy-white or green or reddish herb growing up to 30 cm. in height. Stems rarely slender and often striped. Leaves variable in size, shape, oblong, rhombic, deltoid or lanceolate, obtuse or acute and entire. Clusters of flower compact or loosely paniced spikes in axils. Seeds orbicular with an acute margin. The herb belongs to the Chenopodiaceae family, genus *Chenopodium* and species *album*.

(b) Distribution

The herb is a very common weed in Tripura during winter in waste places and in the fields of wheat, potato, mustard, gram and other vegetables. It is often sold as winter vegetable in the local market.

(c) Food value

The tender shoots and young plants are eaten as vegetable. The leaves are rich in calcium and vitamin C. Analysis of the leaves gave the following values :

Table No. 4.24

Moisture, %	89.60	Calcium,	mg/100g	150.00
Protein, %	3.70	Phosphorous,	mg/100g	80.00
Fat, %	0.40	Iron,	mg/100g	4.20
Carbohydrate, %	2.90	Niacin,	mg/100g	0.60
Fibre, %	0.80	Vitamin C,	mg/100g	35.00
Minerals, %	2.60	Riboflavin,	mg/100g	0.14
Energy, K cal./100g	30.00	Thiamine,	mg/100g	0.01
Zinc, ppm.	24.00	Carotene,	µg/100g	1740.00
Iodine, ppm.	0.98	Fluorine,	ppm.	6.30
		Vitamin K,	ppm.	250.00

The seeds are considered nutritious and superior to wheat, rice, maize and millets. Analysis of the seeds gave (dry basis) : Protein, 16.8; fat, 8.4; and fibre, 12.8 percent.

(d) Processing

Tribals cook this herb as dalo. They also prepare berma bwtwi with dry fish.

(e) Medicinal value

- (i) The herb is laxative, anthelmintic and cardiotoxic.
- (ii) A decoction of the aerial parts, mixed with alcohol, is rubbed on the body affected by arthritis and rheumatism.
- (iii) The plant is effective in throat troubles, eye diseases and in piles.
- (iv) The juice of this herb is used for treating burns.

4.13 MULAI

Beng: Mula; Hindi: Muli

(*Raphanus sativus* Linn.)

(a) Description and Taxonomy

Radish (Mulai) is an annual or biennial herb and belongs to the Cruciferae family, genus *Raphanus* and species *sativus*. The fleshy edible portion of the root develops from both the primary root and the hypocotyls.

(b) Distribution

This herb came from Central and Western China, and India where it was used as food long before recorded history. Different varieties of radish are distributed in every part of Tripura. Wild varieties are found in the Mediterranean region.

(c) Varieties

Radish (Mulai) varies greatly in size, shape and exterior colour as well as the length of time for which they remain edible. The white and pink colour varieties are very common in Tripura.

(d) Food value

This tuberous root is grown for its fleshy edible roots, which are eaten raw or cooked. The tops of this herb are cooked as leafy vegetables

and are rich in minerals and Vitamins A and C. The nutritive values of radish roots (white and pink), tops and fruits have shown in Table No. 4.25.

(e) Processing

Tuberous roots (mulai), leafy tops (mulai bosok) and fruits of radish (mulai bwthai) are popularly eaten by the tribal people as well as other communities. The tender tops of this herb are taken as dalo. Tribals prepare their varieties type of dishes like mui chakhwi, berma bwtwi, mui borok, mui awandru etc. with these tuberous roots. Mulai bosok (tender leaf) is also eaten as dalo or as fry.

Table No. 4.25

Constituents		Radish roots (white)	Radish roots (pink)	Radish tops	Radish fruits
Moisture, %		94.40	90.80	90.30	90.50
Protein, %		0.70	0.60	2.70	2.30
Fat, %		0.10	0.30	0.60	0.30
Carbohydrate, %		3.40	6.80	3.40	4.70
Fibre, %		0.80	0.60	0.90	1.40
Minerals, %		0.60	0.90	2.10	0.80
Sodium,	mg/100g	33.00	63.50	—	—
Calcium,	mg/100g	35.00	50.00	310.00	80.00
Phosphorous,	mg/100g	22.00	20.00	60.00	100.00
Iron,	mg/100g	0.40	0.50	16.10	2.80
Nicotinic acid,	mg/100g	0.50	0.40	0.30	0.20
Potassium,	mg/100g	138.00	10.00	—	—
Riboflavin,	mg/100g	0.02	0.02	0.16	0.05
Thiamine,	mg/100g	0.06	0.06	0.03	0.07
Oxalic acid,	mg/100g	9.00	20.00	—	—
Vitamin C,	mg/100g	15.00	17.00	103.00	69.00
Vitamin A,	I.U./100g	5.00	5.00	18660.00	50.00

(f) Medicinal value

- (i) The radish is much relished for its pungent flavour and is considered as an appetizer. The pungent flavour of radish has been attributed to the presence of volatile isothiocyanates (mustard oils).

- (ii) Radish preparations are useful in liver and gall bladder troubles.
- (iii) Roots, leaves, flowers and pods are active against Gram-positive bacteria. The seeds are also reported to contain a broad-spectrum antibiotic, named machrolysin, active against *Mycobacterium tuberculosis*.
- (iv) The roots are said to be useful in urinary complaints and piles.
- (v) The juice of fresh leaves is used as diuretic and laxative.
- (vi) The seeds are said to be peptic, expectorant, diuretic and carminative.

4.14 MUIRIMI / BELESHO

Beng: Dheras; Hindi: Bhindi

[*Abelmoschus esculentus* (Linn.)

Syn. *Hibiscus esculentus* Linn.]

OKRA OR LADY'S FINGER

(a) Description and Taxonomy

An annual herb with a tall, erect stem, 3-7 ft. high, covered with hairs. Leaves cordate, 3-5 lobed, coarsely toothed; petioles 15 cm. long, hairy. Flowers yellow with purple center. Fruits pyramidal-oblong, 6-8 ribbed, 7.9 by 2.5-3.2 cm., green in colour. Seeds many, rounded, hairy. It belongs to the family Malvaceae and genus *Abelmoschus*. The okra belongs to species *esculentus*.

(b) Distribution

Lady's finger is grown as a favourite garden crop or home yard plant throughout the Tripura. It is seldom cultivated as a field crop. In the Tripura state, two sowings are done – one in early spring for the summer crop and the other in late summer for the rainy season crop. The okra is a warm-season vegetable and thrives on all kinds of soils. The seed of okra will not germinate below 20° C.

(c) Varieties

The plant is considered to be African or Asian in origin. There is a large number of varieties of okra and they may be classified according to the height of the plants as – (I) tall, (II) medium-tall and (III) dwarf. The varieties are further classified according to pod quality, some varieties are with prominent ridges, some may have slight spines, some are deep green in colour, some light green.

(d) Food value

The okra is cultivated throughout India for its immature fruits, which are valued for its edible pods. The tribals of Tripura use tender pods as vegetable. When ripe, the black or brown-white eyed seeds are sometimes roasted and used as a substitute for coffee. The tender pods are rich in pectin and mucilage than mature pods. The following is the nutritive value of fresh pods.

Table No. 4.26

Moisture, %	88.00	Calcium, mg/100g	0.09
Protein, %	2.20	Phosphorous, mg/100g	0.08
Fat, %	0.20	Iron, mg/100g	1.50
Carbohydrate, %	7.70	Potassium, mg/100g	220.00
Fibre, %	1.20	Magnesium, mg/100g	38.00
Energy, K Cal./100g	35.00	Riboflavin, mg/100g	0.07
Niacin, mg/100g	1.10	Thiamine, mg/100g	0.08
Vitamin A, I.U./100g	740.00	Sulphur, mg/100g	14.00
Ascorbic acid, mg/100g	30.00		

(e) Processing

The young tender pods (belesho kwlwi) are edible. The pods are roasted and taken by the tribals as food. They prepare berma bwtwi with belesho. It is also used as fry or as boiled.

(f) Medicinal value

- (i) Immature capsules are employed in the form of a decoction as an emollient, demulcent and diuretic in catarrhal affections, dysuria and gonorrhoea.
- (ii) The leaves are employed externally as emollient poultice.
- (iii) The seeds are stimulant, cordial and antispasmodic.
- (iv) The mucilage from the fruits and seeds is useful in gonorrhoea and irritation of the genito-urinary system.

FOOD PREPARATION TECHNIQUES AND POSSIBLE CONTAMINATION

5.1 Food preparation

As food is a basic thing of all living organisms, the preparation technique is an important step to meet the nutritional requirement. Many vegetables may be eaten as raw, while majority needs to cook. Preparation of vegetables and other foods is essential to ensure good nutrition, more palatability and pleasing in appearance so that it becomes edible. Cooking helps to soften food materials and permits complete digestion and absorption rather than results from raw foods. Cooking may also be employed to give desirable flavour and colour of foods, and serves to "pasteurize" those vegetables whose growing and handling conditions might permit transfer of disease-producing microorganisms to the consumer. Therefore the science of food preparation is an important understanding of physical and chemical changes that takes place in food during preparation. Proper study of food processing science helps to know the possible sources of contamination during their collection and preparation.

The method of food preparation is a part of culture of the specific region. Naturally each region adopts their method, which may differ from one region to other. Sometimes their own culture may be influenced by the other neighbouring culture or by the other communities within the same region.

In Tripura different tribal communities live together in different regions. They collect various edible forest products and vegetables from the dense forest as well as from the plains. Tribals cook these vegetables by applying their own special technique of an individual community. Thus with same vegetables it is possible to provide innumerable dishes, which makes eating a pleasure. Although different tribal communities make their unique dishes in various ways, but their basic thing is same in majority of the communities except their naming.

The special characteristics of all the tribal communities in Tripura are to prepare their dishes without oil using minimum spices. They like to boil their foods on burning charcoal, or steam by taking the

vegetables in a hollow-bamboo or by wrapping with some leaves like turmeric. In some preparation they use 'chakhwi' (alkali water) which is prepared by applying their own special method. In most of the dishes tribals use *berma* (*sidal*) or *akran* (other dry fish) to increase the taste. Tribals of Tripura prepare different types of dishes, which are summarized in a brief manner as follows :

5.1.1 Mui Chakhwi

This is a special kind of delicious preparation of different vegetables and dry fish (*akran*) in Chakhwi (alkali water or *kharpani*).

To prepare *chakhwi*, tribals burn dry leaves of bamboo and banana, sesame plant, mustard plant, stem and shoots of bamboo etc. The burnt-ash is taken in a specially prepared basket called *chekhok* in *kokborok*. The basket is hanged from a suitable support and below it a container is kept to collect the extract of ashes. Now water is poured slowly just above the ash so that water bathe the whole ash. This extract is collected in the container, which is known as *chakhwi*.

Chakhwi is mixed with vegetables for the preparation of *mui chakhwi*. Vegetables like *muia* (bamboo shoots), *laifang* (young banana stem), *mulai* (radish), *kosoi* (bean), *khokleng* (*arhar*) can be used for *mui chakhwi*. To prepare this dish, vegetables are cut into pieces of moderate size. These vegetables are boiled in *chakhwi* along with *akran* (dry fish), green chillies, common salt etc. Sometimes tribals also use oil or meat of hog (*wahan*) to increase the taste of *mui chakhwi*. Finally the powder of unboiled rice is added as a thickening agent.

Tribals consider this type of food as an easily digestible food, which does not produce any disturbance into the stomach. They also believe that this *mui chakhwi* acts as an anthelmintic and as a washing agent of bowel.

5.1.2 Chakhwi chaprang or Chakhwi Chatang

It is a popular and tasty preparation of the Tripura tribals in which they use previously sun-dried vegetables in *chakhwi* (alkali water) along with flavouring agents. Initially the dried vegetables are soaked in water for sufficient time to soften the same. These soft vegetables and other ingredients like *akran* (dry fish), ground chillies, garlic, salt etc. are boiled in *chakhwi* until the preparation becomes semi-solid in nature. In this dish ginger stem and leaves,

turmeric and other flavouring leaves are also used to increase palatability of the dish. Vegetables used in this dish are **khokleng** (*arhar*), **muia**, **khamka** (*solanum sp.*), **muituyasha** (stem of arum), **mulai** etc. Sometimes tribals dry these vegetables in sun by cutting into suitable slices to use the same during off seasons.

5.1.3 Chakhtwi kuthung

This is a preparation of raw vegetables, **akran** (dry fish), chillies, ginger, salt in **chakhwi** (alkali water). Tribals use all these ingredients as raw and mix with **chakhwi**. They do not use any oil and onion, instead of that they use ginger, **mui ching**, **banta** etc. **Samsota** (*thankuni*), **mulai** can be taken in this way.

5.1.4 Egwi

It is a type of preparation in which tribals put together all vegetables and other ingredients inside the turmeric leaves. For this dish, tribals cut the vegetables into suitable size and mix it with **berma** (*sidal*), onion, chillies and salt. By adding little amount of oil, the mixture is wrapped up with turmeric leaves (**swtwi bwlai**) and is placed inside the burning charcoal for sufficient time. This type of food contains a special flavour absorbing from the turmeric leaves. Small fishes (**aagura**), meat (**wahan**), **khamka** etc. can be eaten in this process.

5.1.5 Hantilai

This is another type of dish where tribals boil all the vegetables with other ingredients in a suitable vessel by covering it with a lid. The sliced vegetables are mixed with **berma**, chillies, salt etc. and is boiled the same until all the ingredients become soft. At the final stage some flavouring agents like **khundrupui**, **tanta** etc. are applied to increase the taste of the dish. When boiling is completed, they mix the ingredients properly and make a semi-solid condition. Vegetables like **muia**, **hukni thaichumu bosolok**, **hukni chakumara bosolok** (tender twig of pumpkin) etc., which are mainly grown during **jhum** cultivation are used in this dish.

5.1.6 Mosodeng

It is a simple tasty dish of charcoal-boiled vegetables along with dry chillies and occasionally with less amount of oil. To make this food, tribals boil the vegetables and dry chillies in the burning charcoal. Sometimes they boil small fish in the same manner to use

it in the dish. After descaling the vegetables (if necessary), they mix all the ingredients like vegetables, chillies, fish, onion, salt and little amount of oil if necessary (in case of brinjal and potato) and make it into a paste form. This type of dish can be prepared with the help of vegetables like batema, phantok, alu, mulai, samsota etc.

5.1.7 Gudok

This is a very popular and delicious kind of dish among the tribals of Tripura. For this special dish, they use hollow internodes of fresh bamboo with one side open. All the vegetables are cut into small fine pieces and is mixed properly with dry fish, green chillies and salt, but without oil. Now the mixture is put inside the hollow bamboo and the open end of the bamboo is closed with banana leaves or turmeric leaves. The filled bamboo is put inside the burning charcoal to boil the ingredients. Finally, a uniform paste is made by repeatedly driving a suitable bamboo stick inside the bamboo. Occasionally tribals prefer to use small fishes like small shrimp (athuk) and other small fishes to increase the taste. Vegetables like mulai, kosoi, gantha, tuber-roots, biring, muikhon are used in single or combined for this dish. With this process, the food value of used vegetables is not deteriorated since the closed hollow bamboo acts as a pressure cooker.

5.1.8 Mui borok

It is a combined preparation of vegetables, berma (*sidal*) or akran (dry fish) along with salt and green chillies. In this process, vegetables are cut into pieces of moderate size. These vegetables are cooked in a suitable vessel with berma or akran, salt and green chillies until the vegetables become soft. Sometimes orai leaves are used as a flavouring agent. Mulai, khokleng (*arhar*), jinga thaktwi (*lalalu*), komliha bosok (*kalmisak*), muia etc. are used in single or combined to prepare this dish.

5.1.9 Berma bwtwi

This is a favourite dish specially made of berma and vegetables. Here the sliced vegetables are boiled with onion or garlic, green chillies, berma, salt and turmeric powder in a suitable vessel until all the ingredients become soft. Vegetables like sajna kwlwi (soft pod), thabadia (*colocasia*), phantok (brinjal), kosoi (bean), biring, thorai (*tara*), kamliha bosok (*kalmisak*), thaipung bwchwlwi (seeds of jack-

fruit), **alu**, **samsota** are used in single or combined to prepare this favourite dish.

5.1.10 Mui awandru

It is a unique and favourite dish of Tripura tribals. To prepare this dish, vegetables are cut into small pieces. These vegetables are boiled in water with **akran** (dry fish), green chillies and salt until all the ingredients become soft. Now the unboiled powder-rice is added to it and is cooked for sometime to make it thick. At the last stage, some flavouring leaves like coriander, **khundrupui**, **banta** are used to increase the palatability. Among the various vegetables **muia**, **khokleng**, **mulai**, **mui khumu** are used in single or combined.

5.1.11 Dalo

To prepare **dalo**, vegetables are washed properly and made into small thin pieces. These vegetables are mixed with garlic, chillies, and salt and is boiled until all the ingredients become soft. Sometimes **kosoi bwchwlwi** (bean seeds) are fried separately and is mixed with **dalo** to increase the taste. Vegetables like tender tops of **mulai**, **samsota**, **dalo bupham**, **komliha bosok**, **mui morong** etc. are used in single or combined to prepare **dalo**.

5.2 Personal hygiene and food contamination

The word 'hygiene' means the science of health and embraces all factors, which contribute to healthful living by preventing disease either in the individual or in the community. When the different measures are applied for the well being of the community as a whole in an organized manner, it is known as public health or community hygiene. It involves different fields of activities like control of communicable diseases, epidemiology, environmental sanitation, industrial hygiene, mental hygiene and health education.

Food may be contaminated during harvesting, storage, handling, preparation and service of boiled food for human consumption. The equipment like utensils, knives, wooden boards, tables, dishes and food ingredients utilized during preparation should be cleaned properly. All vegetables and fruits, which are purchased from market or farm, should be cleaned perfectly if any dust or soil is attached with these vegetables. The dust in vegetables can be the carrier of microorganisms. Therefore all exposed vegetables must be washed with clean water before use. The

person handling the vegetables is to be free from any communicable diseases like colds, respiratory disorders, cuts, boils or any other fungal skin diseases. These diseases can be transmitted with the contaminated vegetables to the healthy person consuming it. The contamination way comes from human hair, nasal discharge and skin, as these agents can also be the source of microorganisms. Hence, person handling the foods must wash hands with detergent before preparation. Sometimes a number of water born diseases like diarrhoea, cholera, amoebic dysentery etc. can be transmitted by use of contaminated food or water. Therefore sanitary handling of food and water is an important step in the preparation of dishes.

The knives, wooden boards, metal and porcelain dishes and utensils should be washed with detergent and clean water. It is better to dip the different equipments in hot water at 80° C for about 20 minutes. This process is safe to destroy the disease-producing microorganisms present with equipments.

In villages and rural areas, people use ash to wash the equipment. After washing they dry the utensils and dishes in the sun. This procedure helps to kill most of the microorganisms with the effect of heat and ultraviolet rays of sun.

5.2.1 Control of insects and rodents

Foods may also be contaminated with insects and rodents like housefly, rats, bandicoots etc. These insects transmit various dangerous diseases like diarrhoea, dysentery, cholera, typhoid, amoebiasis etc. The rodents like rats are hazardous to human health and can transmit plague and typhus (rickettsias).

The food contaminated with insects, insect fragments, rodent excreta etc. is consumed unconsciously which may produce dangerous effect to human health. Therefore it is most essential to prevent the entry of insects and rodents in the cooking and serving areas. The prepared food should always be covered with a suitable lid. Control of insects and rodents plays a vital role to check the contamination of food. By spraying of insecticides like chlorinated hydrocarbons (DDT, aldrin, dieldrin etc.) and the organophosphorous compounds (parathion, malathion, systrex etc.) the insects and rodents can be controlled.

◆ To check the contamination of foods one should follow the points below :

- (i) Use clean and potable water for washing.
- (ii) Remove soil, dust or any other harmful colour adhere to foods.
- (iii) Clean container or utensils used for storage and preparation properly.
- (iv) Check the contamination of food from communicable diseases during handling.
- (v) Personal handling of food should have hygienic habits.
- (vi) Maintain cleanliness of premises.
- (vii) Serve the food with personal hygiene.
- (viii) Dispose food wastes in safe place.
- (ix) Keep the environment healthy and fresh.
- (x) Control insects and rodents from foods.

ENVIRONMENTAL HEALTH

6.1. Environment

Environment has been defined, "as the aggregate of all external conditions and influences effecting the life and development of organisms". The term takes into account all variables, which directly or indirectly infringe on it. These include physical, social, cultural factors and conditions influencing the existence of development of organism. The five factors i.e. air, water, land, fire, flora and fauna are inter-related, inter-dependent, co-evolve and co-adopte. Massive deforestation is one of the prime factors, which threatens the sustenance of all healthy environments. The control of environmental factors in disease causation is called **environmental sanitation**, which means the science of safeguarding health. The term environmental sanitation is now replaced by environmental health.

6.2 Role of Environmental Health in Food Contamination

Environmental health plays a key role in food contamination. Hence everybody should be aware about the environmental health. The health of the people depends primarily upon the social and environmental health under which they live and work. The physician who treats the patients also takes a note of the environmental hazards to health in water, food and physical surroundings as well as his occupation and mode of living. Underlying all these conditions, are the real problems of poverty, illiteracy, malnutrition, poor housing and deeply rooted customs and habits.

In a state like Tripura if everyone is provided with safe drinking water and excreta is disposed off in a sanitary manner, majority of the infectious diseases can be prevented. Environment is most important in the causation of infectious and non-infectious diseases. Tribals living in interior places of Tripura collect their drinking water from artificial lake, canal, pond, river, and sometimes from fountain. This type of water is frequently contaminated with infectious microorganisms. Sometimes the dirty water coming from urinal, latrines, household sullage, bathing places etc. is mixed with drinking water. This dirty

water causes serious hazard to health by providing a source from which infectious agents contaminate the food during processing.

Many common infections of the gut spread from one person to another because of poor hygiene and sanitation. Germs and worms (or their eggs) are passed in thousands in the stools or faeces of the infected persons. These are transmitted to new hosts either by the dirty fingers or by contaminated food or water. Hence personal cleanliness (i.e. hygiene) and public cleanliness (i.e. sanitation) are important in order to prevent the contamination of food and thus transmission of infectious diseases.

In rural areas of Tripura it is very old habit of going to fields for defecation everyday morning and evening. This open field defecation pollutes the fields and flies can disseminate the disease by carrying microorganisms. The food can be contaminated with these microorganisms through the flies. Thus taking this contaminated food can infect the healthy person. It is a social problem and makes the environment unhealthy. It is surprisingly observed that even latrines are constructed but they are not utilized by the villagers. They think that a latrine is a dirty place and should be away from the house. They actually do not know the magnitude and implications of the faecal borne disease. This requires extensive educational activities to bring about a permanent change in the habit of the people. Education may be given through media but more effective is group discussion with them, clearing all doubts, demonstrating them the models etc. If human excreta can be disposed off by a sanitary method there will be tremendous reduction in the occurrence of faecal borne diseases.

6.3 Tribal participation in Environmental Management

The constitution of India in its Fifth and Sixth Schedule confirms the rights of tribals by enunciating various provisions to safeguard their interest. The destruction of forest has resulted in the tribal impoverishment and indebtedness in many cases of land alienation and even their bondage (bonded labour). 90 percent of tribals are below poverty line and involved in the curse of poverty, which extends to all the aspects of life: susceptibility to disease, limited access to service and lack of information. Degradation of forest is caused due to lack of employment and wage earning source and faulty management system. Shifting cultivation has created a disaster in the path of environmental

protection. Degradation of surrounding environment and rigid forest laws has adversely affected food accessibility, livelihood option and quality of life of local indigenous community. Such degradation has often caused periodic phases of hunger, malnutrition, in the absence of supporting means of livelihood for acquiring basics of life. Present plantation policy for the protection of environment has suffered due to aimless policy and lack of proper participation of tribal and other sections of human society. The Tribals participation and implementation of forest laws have been contradicted due to lack of proper realization while framing and implementing the restrictive laws without realizing the socioeconomic base of tribal. It is a matter of great concern that destruction of forest resources and herbal medicinal plants have suffered badly due to lack of participatory approach, effective mechanism of resource mobilization and management. Forest resources and common resources provide safety net to the local indigenous community. Loss of habitat due to drastic reduction of forest base has endangered the climatic condition.

Tribals involvement in policy planning with regard to their symbiotic relationship in forests management would be the primary task of all agencies responsible for conservation of social forestry, which ultimately ensures the environmental protection and eco-management system. Forest conservation becomes imperative, including, preservation, maintenance, utilization, restoration and enhancement of natural environment. Eco-system can be protected by :

- (a) Generating awareness and eco-consciousness among tribals;
- (b) information facilitation and resource mobilization;
- (c) wage earning programme on employment without endangering environment and forest base;
- (d) enhancing horticultural works, cash crops, oil seeds programmes;
- (e) implementing irrigation, land utilization, distribution with effective plantation schemes;
- (f) launching community forest management schemes;
- (g) forming local committees without administrative hurdles and ensuring the objectives of joint forest management;
- (h) generating faith, feeling of ownness by motivating them through inter-personal communication, group meeting and community convergence approach and
- (i) studying on fragile areas and development of institutional framework for environmental protection.

Eco-management group is to be formed in each district to propagate the policy

APPENDIX

GLOSSARY

- Amoebiasis** : is caused by the Protozoan, *Entamoeba histolytica* and results in ulceration of the intestines and occasionally in the formation of abscesses in the liver, lungs, testes or brain. The parasite is spread by food or water contaminated with infected faeces.
- Anthelmintic** : any drug or chemical agent used to destroy parasitic worms (helminthes), including tapeworms, roundworms and flukes, and remove them from the body.
- Asthma** : a condition characterized by paroxysmal attacks of bronchospasm, causing difficulty in breathing. *Bronchial asthma* may be precipitated by exposure to one or more of large range of stimuli, including allergens, exertions, emotions and infections.
- Arthritis** : inflammation of one or more joints, characterized by swelling, warmth, and redness of the overlying skin, pain, and restriction of motion.
- Antispasmodic** : a drug that relieves spasm of smooth muscle.
- Aphrodisiac** : an agent that stimulates sexual excitement.
- Atrophy** : shrinkage of normally developed organ or tissue due to degeneration of cells.
- Anorexia** : loss of appetite.
- Antibody** : a special kind of blood protein that is synthesized in lymphoid tissue in response to the presence of particular antigen the lens.
- Aqueous humor** : the watery fluid that fills the chamber of the eye immediately behind the cornea and in front of the lens.
- Broad-spectrum antibiotics** : are those antibiotics that are active against a wide variety of organisms i.e. gram-positive and gram-negative bacteria.
- Bronchitis** : inflammation of the bronchi. Acute bronchitis is caused by viruses or bacteria and is characterized by coughing the production of mucopurulent sputum, and narrowing of the bronchi due to spasmodic contraction.
- Bradycardia** : slowing of the heart rate to less than 50 beats per minutes.
- Carminative** : a drug that relieves flatulence, used to treat gastric discomfort and colic.
- Cordate leaf** : leaf blade heart-shaped.
- Cheilosis** : swollen cracked bright-red lips. This is very common symptom of many nutritional disorders including Vitamin B₂ deficiency.
- Creatinase** : an enzyme involved in the metabolic break down of creatine to creatinine.
- Cretinism** : a syndrome of mental retardation and coarseness of the skin and

facial features due to lack of thyroid hormone from birth.

Diuretic : a drug that increases the volume of urine produced by promoting the excretion of salts and water from the kidney.

Delirium : an acute disorder of the mental processes accompanying organic brain disease.

Demulcent : a soothing agent that protects the mucous membranes and relieves irritation. Demulcents form a protective film over the membrane.

Dysuria : difficult or painful urination. This is usually associated with urgency and frequency of urination if due to cystitis or urethritis.

Diocious : plants bearing flowers of one sex only i.e. either male or female flowers.

Dementia : a chronic or persistent disorder of behaviour and higher intellectual function due to organic brain diseases.

Dystrophia : a disorder of an organ or tissue, usually muscle, due to impaired nourishment of the effected part.

Expectorant : a drug that enhances the secretion of sputum by the air passages so that it is easier to cough up.

Emetic : an agent that causes vomiting.

Emollient : an agent that soothes and softens the skin.

Elliptical leaf : leaf blade more or less like an ellipse.

Emotional health : Which reflects the feelings. Emotionally ill person may develop anxiety, depression or drug addict.

Fluorosis : the effect of high fluoride intake.

Fungicide : an agent that kills fungi.

Gonorrhoea : a venereal disease caused by the bacterium *Neisseria gonorrhoeae* that affects the genital mucous membranes of either sex.

Gout : a disease in which a defect in uric acid metabolism causes an excess of the acid and its salts (urates) to accumulate in the blood stream and the joints.

Glossitis : inflammation of the tongue.

Glabrous leaf : leaf surface smooth due to complete absence of any hairs or any other outgrowths.

GABA : an amino acid found in the CNS, predominantly in the brain, where it acts as an inhibitory neurotransmitter.

Haemorrhoids (piles) : enlarged (varicose) veins in the wall of the anus (internal haemorrhoids), usually a consequence of prolonged constipation or occasionally diarrhoea.

Haemostatic : an agent that stops or prevents haemorrhage.

Hypochlorhydria : reduced secretion of hydrochloric acid by the stomach.

Hypoproteinaemia : a decrease in the quantity of protein in the blood.

Hypoglycaemia : a deficiency of glucose in the blood-stream.

Haemophilia : a hereditary disorder in which the blood clots very slowly, due to deficiency of the coagulation factors (factor VIII).

Hastate : two pointed basal lobes directed outwards from the leaf blade.

Infundibuliform : funnel-shaped.

Lanceolate leaf : leaf blade lance-shaped.

Laxative : a drug used to stimulate or increase the frequency of bowel evacuation, or to encourage a softer or bulkier stool.

Measles : a highly infectious viral disease that tends to appear in epidemics every 2 to 3 years and mainly affect children.

Menorrhagia : abnormally heavy bleeding at menstruation, which may or may not be associated with abnormally long periods.

Microcytic anaemia : anaemia due to the presence of abnormally small red cells in the blood.

Mental health : a state of balance between the individual and the surrounding world.

Myxoedema : a dry firm waxy swelling of the skin and subcutaneous tissues found in patient, suffering from under activity of the thyroid glands.

Mycobacterium tuberculosis : gram-positive aerobic bacteria that causes tuberculosis.

Nephritis : inflammation of the kidney.

Obtuse : blunt leaf apex.

Oblong leaf : leaf blade wide and long with two margins running parallel.

Orbicular leaf : leaf blade nearly circular.

Ovate leaf : leaf blade egg-shaped.

Ophthalmia : inflammation of the eye, particularly the conjunctiva

Pasteurization : The treatment of milk by heating it to 65°C for 30 minutes, or to 72°C for 15 minutes, followed by rapid cooling, to kill such bacteria as those of tuberculosis and typhoid.

Physical health : a state in which every cell and every organ of the body is functioning properly and perfectly at optimum.

Prostaglandin : one of a group of hormone-like substances present in a wide variety of tissues and body fluids.

Pleura : the covering of the lungs and of the inner surface of the chest wall.

Pericardium : the membrane surrounding the heart.

Polyneuritis : inflammation of the several peripheral nerves.

Rhizome : a thick, fleshy underground modified stem with distinct nodes and internodes growing horizontally, sometimes more or less vertically beneath the surface of the soil.

Rheumatism : any disorder in which aches and pain affect the muscles and joints.

Raniform leaf : leaf blade kidney-shaped.

Syphilis : a chronic venereal disease caused by the bacterium *Treponema pallidum*, resulting in the formation of lesions throughout the body.

Synovial cavity : The cavity around the synovial joint.

Spiritual health : a connecting link between physiology and psychology.

Social Health : a quantity and quality of an individual's interpersonalities and the extent of involvement with the community.

Spadix : modified spike with fleshy rachis and large bract (the spathe) covering the inflorescence.

Spathe : boat-shaped bracts enclosing the spadix inflorescence.

Tachycardia : an increase in the heart rate above normal.

Tripinnate leaf : leaf thrice pinnate; the rachis produces secondary branches, which again produce tertiary branches bearing leaflets.

Uraemia : the presence of excessive amounts of urea and other nitrogenous waste compounds in the blood.

Urethritis : inflammation of the urethra.

Venereal diseases : an infectious disease transmitted by sexual intercourse. The most important are gonorrhoea and syphilis.

Vitreous humour : The transparent jelly-like material that fills the chamber behind the lens of the eye.

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