HCM 134: FOOD & NUTRITION

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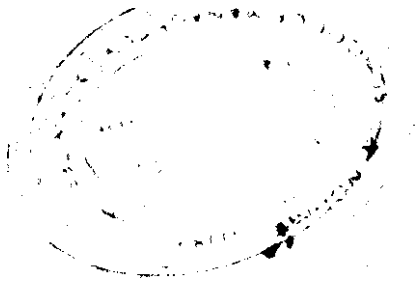

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UNIT 1: FOOD AND NUTRITION — AN OVERVIEW

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1.0 Introduction

This unit is the first unit in the course HCM 106: Food and Nutrition. The unit introduces you to Food and Food Components, nutrition, Importance of Good Nutrition and Uses of Food. The content of this unit forms the basis upon which the other units on components of foods, digestion and metabolism of foods will be based.

2.0 Objectives

At the end of this unit, you should be able to

- Define Food
- Define Nutrition
- List the Components of Foods
- Give the Importance of Good Nutrients
- List the Uses of Foods.

3.0 Main Content

3.1 Meanings of Food

Food has many meanings. For different people, food has different implications. It could be a source of joy, gladness, happiness to many children. To some adults, some foods are symbols of prosperity, pleasure and power. To some children, who are usually forced to eat, food is a source of sadness or rather a sign of sadness. In Nigeria and most African Countries, food is a symbol of friendliness and hospitality.

Foods, as meals, are eaten at certain times of the day. We then have breakfast, lunch and dinner to remove hunger at periodic intervals of the day. In between these meals, people still eat for pleasure.

Certain foods are usually associated with the meals of the day. Breads, eggs, yams, cereals, fruit juices, bacon and sausage are closely associated with breakfast. Pounded yam, Amala. Eba, Semovita, Egusi soup (melon soup), Okro soups, Rice, Beans Fried plantains are often more closely associated with lunch and dinner.

The reactions of people to some foods differ. Many Nigerian Children no matter what they eat will still want to eat cooked garri as part of their provisions to the boarding houses. Even when the children are told of the implication of consumption of garri to their sight, they still show a lot of preference for the consumption of this item. Many children scorn consumption of beans and readily jump at rice.

The types of food eaten by an individual can be affected by age, sex, religious beliefs and many factors depending on the culture of the people involved. Many children, as you learned in this unit, show preference for gan-i, rice, juices, milk, eggs and milk products. They show disdain for some cereals, beans and some foods requiring beluses. Many adults show a lot of preference for pounded yam, amala, eba, and revolt against rice. Elderly people sometimes prefer soft foods that can be easily chewed.

Some religions forbid the eating of certain foods. Eating of pork is forbidden by Islam. Eating of beef is forbidden by Hindus. Some cultures also forbid eating of certain foods. In my place of birth, eating of water yam and products from water yam is forbidden. In some families in Western part of Nigeria, the wives do not eat salt — table salt until many days after the birth of a child.

A culture defines which food is edible or not edible. For instance, grasshopper is eaten in some parts of South West of Nigeria whereas some

people from certain areas of the same South Western part of Nigeria find it difficult to touch grasshoppers.

In some areas of Nigeria, food can be used as a sort of punishment to children. You must have heard some mothers saying that their children would not eat except the children do certain type of work assigned for them.

Fleck (1976) wrote that from the day of birth, foods convey meanings and feelings related for security, protection, love and strength. Pounded yam with egusi soup gives feeling of 'home' to an Ekiti and an ljesha man in Nigeria. To an ljebu man in Nigeria, Ikokore — a food dish from water yam, brings him 'home'. To an lbo man, the service of Apu — a fermented cassava dish, and kola nut makes him feel at 'home'. The service of hamburger and Ice Cream brings an American 'home'.

Some foods have social implications; they reflect the social status of the individuals consuming them. Some people even give more importance or attach more importance to the social implications of these foods than to the nutritive values of the foods.

Food is a basic need of a person. It is one of the physiological needs that are very basic to a person. The quantity and quality of the food that a person consumes must be adequate. When adequate quantity and quality of the foods are eaten, there will be:

- Vitality
- Good health
- Emotional stability
- Resistance against illnesses and diseases
- Enthusiasm for the challenges of life

When either the quantity or the quality of the foods is inadequate, there can be:

- Lack of stamina
- Poor physical appearance
- Tiredness

Lack of enthusiasm
High susceptibility to illnesses and diseases.

Good nutrition makes a lot of difference in the appearance and nutritional well-being of an individual. Children in Nigeria today appear taller, bigger and more beautiful than their parents were at their ages — that is when the

parents were at the ages of these children. This is due to improved nutrition of those children over those of their parents.

There is a need for us to distinguish between food and nutrition. Food conveys the nutrients necessary for well-being of an individual. Sonic foods that are eaten may not contain all these nutrients in the right quantity and quality for the well-being of an individual. This leads us to the terms:

- Well-fed
- Well-nourished

A well nourished person receives adequate quantity and quality of nutrients for good health. A well fed person receives adequate quantity and economic quality of food. The economic quality of food does not imply the nutritive quality of food. You should note that for good nutrition, all nutrients received by the body must be supplied in adequate quantity and proportions required by the body. The lack of a nutrient that is needed in a very minute amount may lead to a more serious health problem than the lack of a nutrient that is required in large amount. We will define nutrition later in this unit.

3.2 Food As Sources of Nutrients

"Give us our daily bread" is the prayer of every human being on a daily basis. Food is important to man because man must eat to live. Food consists of nutrient, derived from both animal and plant sources. The nutrients are mainly organic substances. These nutrients include:

- Water
- Carbohydrates
- Lipids — fats and oils
- Proteins
- Vitamins mineral

The carbohydrates are manufactured in the plants through the process of photosynthesis. In this process the green living parts of the plants, Chlorophyll absorbs sunlight energy.

In the presence of this sunlight energy, water and carbon dioxide are converted to carbohydrates and oxygen.

Some other processes convert carbohydrates to lipids. Nitrifying bacteria introduce nitrogenous matters into the soil. The introduction of inorganic fertilizers also brings nitrogenous matters into the soil. From all these, proteins are manufactured.

Student Assessment Exercise 1.1

1.1.1 Discuss the various implications of Foods, showing clearly the meanings of Food.

3.3 Meanings of Nutrition

There are many definitions of nutrition. Some authors define it as the science of nourishing the body properly or as the analysis of the effect of food on the living organism. Yudekin (1969) defined it as the relationship between man and its food.

The Council of Foods and Nutrition of America Medical Association defined nutrition as the science of food, the nutrients and other substances therein, their action, interaction and balance in relation to health and disease and the processes by which the organism ingests, digests, absorbs, transports, utilizes and excretes food substances.

From all these definitions, nutrition is concerned with what happens to food from the mouth until the nutrients are absorbed and used and waste products finally excreted.

The changes that occur to the food in the mouth, stomach and intestines are important to the nutritionist. The absorption, transportation and utilization of the nutrients are also of concern to the nutritionists.

Also of concern to the nutritionist is what types of foods a person eats, why the person decides to choose the food he or she eats, the nutrients in the food and the nutritive values of the food in terms of supply of energy, promotion of growth, repair of body tissue and regulation of body processes are sources of concern to a nutritionist.

Nutrition has interrelationships with other fields such as chemistry, biochemistry, microbiology, physiology, medicine, and many other fields of human endeavor.

As you learned, the quality and quantity of the nutrients consumed is very important. On the bases of adequacy or inadequacy of the quantity and quality of nutrients consumed, there can be:

- malnutrition
- under nutrition
- over nutrition

Malnutrition is the word used for both excessive intakes of some nutrients. There are some problems associated with both excessive intake and inadequate intake of sonic nutrients. When there is inadequate intake of some nutrients resulting into some health problems, there is under nutrition. When excessive intakes of some health problems- like in the affluent countries, there is over nutrition. Both under nutrition and over nutrition are not good.

3.4 Importance of Good Nutrition

You have learned what malnutrition is. You have also learned the components of malnutrition — under nutrition and over nutrition. Malnutrition has associated costs.

In an attempt to estimate the cost of malnutrition, the United Sates Department of Agriculture once suggested that appropriate nutrition intervention activities can reduce morbidity and mortality from heart disease by 25%, from respiratory and infectious diseases by 20%, from cancer by 20% and from diabetes by 50%.

The enrichment of rice by the addition of thiamin has had remarkable influence in the reduction of incidence of beriberi. The well-being of children at birth including the weights of the children at birth has been attributable to the quality of the nutrition of the mothers during pregnancy. Mothers with good nutrition have been known to bear children judged to have good physical condition at birth.

The iodization of salt has reduced remarkably the incidence of simple goiter in some populations of the World. A program of enriching flour with thiamin, riboflavin, niacin, and iron as well as enriching margarine with vitamin A has resulted into reduction in incidence of rough, dry skin, cracks in the corner of the lips and soft bleeding gums. All these conditions have been found to be as a result of sub-optimal consumption of the nutrients mentioned above. The positive change in the stature of children generally in most Countries of the World has been seriously reformed due to improved nutrition of many population of the World.

Good nutrition in women has been found to have effect on complications during pregnancy with bad nutrition; results have shown reduction in these complications during pregnancy.

3.5 Uses of Foods

You have learned that foods are conveyors of nutrients. The nutrients in the food are water, carbohydrates. proteins, lipids, vitamins and minerals. All these nutrients have uses and functions to the body. Fleck (1976) wrote that the importance of adequate diet could be dramatized when one realizes that his eyes, blood, muscles, bones and teeth — every part of his body — were once food. This summarizes this importance of food and the nutrients therein.

Food provides nutrients for a good diet; the nutrients must be adequate both in quantity and quality. The quality of the diet depends on the amount of the essential nutrients in the food.

The major functions of the nutrients are to:

- Supply energy
- Promote growth and repair body tissues
- Regulate the body processes

Carbohydrates, fat and oils, protein, vitamins, minerals and water perform these functions. According to the classification by Fleck (1976) the following nutrients perform the function given below:

Source of Energy

- Carbohydrates
- Lipid
- Protein

Mineral elements*
Vitamins*

Growth and Maintenance of Tissues

- Protein
  Mineral elements
- Vitamins*

Water*

Regulation of Body Processes

- Proteins
- Mineral elements
- Vitamins
- Water

The Nutrients that play indirect role, since they are necessary to catalyze the use of the three nutrients directly involved.

As you learned in this unit, the amount of the nutrients needed in the diet has no relationship with the importance of the nutrients. Some nutrients needed in minute proportions, may give serious health problems, if they are deficient in the body. It is important that the nutrients are taken in the right proportions. Deficiency of the nutrients may be caused by:

- Increased needs of the nutrient in the body
- Decreased absorption of the nutrients and prolonged deficiency of

protein calorie in children between the ages of 1 and 3 years can lead to kwashiorkor. This child may become pot-bellied, dull, and apathetic and may have Ophthalmic Xerosis. Lack of ascorbic acid in young children may lead to infantile scurry with the child having swollen right thigh and hyper-pigmentation of skin.

The functions of some individual nutrients are influenced by the presence of some other nutrients. For instance the need for thiamin is said to be a function of the amount and kind of carbohydrate in the diet, the supply of Vitamin D affects the absorption of Calcium, indeed the absorption of calcium depends on the availability of Vitamin D. Vitamin E is reported to protect vitamin A. it has also been reported that the nature and amount of fat in the diet affect, the requirement for Vitamin E.

From all these, it can be deduced that any form of manipulation of any diet can lead to changes in the requirement for some nutrients.

Some non-nutritional factors such as use of drugs, exposure to environmental contaminations, physical, emotional and physiological stresses can influence the needs and the requirements of some nutrients. The various functions of the nutrients specific to sonic nutrients will still be discussed when the major nutrients in foods are treated individually.

Student Self Assessment Exercise 2

1.2.1 What are the various uses offitods?

1.2.2 What is nutrition? Of what importance is nutrition?

4.0 Conclusion

The unit treats the meanings of food and nutrition. It also discusses food as sources of nutrients, the importance of good nutrition and the uses of food in the body. Subsequent units will discuss on the important function of nutrients — energy and the various nutrients more extensively.

5.0 Summary

Food has been said to have various implications and to arouse some feelings such as 'feelings of joy, gladness, happiness, prosperity, pleasure and power. The unit gives that different people show different reaction to different foods. The preference for foods has been said to be influenced by age, religious beliefs, sex and cultural factors. Foods have been said to have social implications.

For food to contribute to the good health of an individual, the essential nutrients must be consumed in adequate quality and quantity to ensure vitality, pleasant appearance emotional stability, resistance against diseases and high enthusiasm for the challenges of life.

The unit discusses food as consisting of water, protein, carbohydrates, lipids, vitamins and mineral salts. The unit discusses that for good well being of an individual, these nutrients must be present in adequate quantity and quality.

The unit gives nutrition as the science of food that deals with ingestion and digestion of food absorption transportation and utilization of nutrients by the body. The unit gives malnutrition as consisting of over nutrition and under nutrition.

The unit discusses the importance of good nutrition and functions of nutrients. The functions of nutrients are given as supply of energy, promotion of growth and repair of body tissues regulation of the body processes.

6.0 Tutor Marked Assignment

Discuss the various importance of good nutrition.

Answers to student Self Assessment Exercises

1.1.1 The answers are contained in section 3.1 of this unit.

1.2.1 The various uses of food are contained in section 3.5 of this unit

1.2.2 The various definition of nutrition is given in section 3.3 of this unit. The importance of nutrition is also given in section 3.4 of this unit.

7.0 References and Other Sources

Davidson S. et al L(1975) Human Nutrition and Dietetics. Sixth edition Longman Group Ltd.

Fleck H. (1976) Introduction To Nutrition.Third edition, Macmillan Pub. Co., Inc.,New York

Gultrie H. A. (1979) Introductory Nutrition. Forth edition, The C.V. Mosby Company. St. Louis, London, Toronto.

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UNIT 2: ENERGY

Table of Content

1.0 Introduction

In Unit I, you learned that one of the major functions of food and the nutrients in the food is to supply energy for internal body metabolisms and for physical activities. This unit discusses energy; its forms, the energy

content of food, measurement of energy, the expenditure of energy, the rates of expenditure and the energy requirements of man.

2.0 Objectives

At the end of this unit, you should be able to

- List the forms of Energy
- Calculate the energy content of a given food item with know composition of nutrients
- Measure energy expended
- Discuss the energy requirements of man.

3.0 Main content

3.1 Forms of Energy

There are five forms of energy namely Solar, Chemical, Mechanical, Thermal and Electrical.

In *Unit 1,* you learned that the green living parts of plant manufacture carbohydrate from carbon dioxide and water in the presence of the sunlight energy absorbed by chlorophyll.

It is also known that the plants are able to synthesize carbohydrates, proteins and fats from inorganic substances such as CO2, I-120, NI-I3 and SO4. In food, chemical energy is stored. The chemical energy is used to do the following:

- Perform mechanical work
- For growth
- Maintenance of the body tissue.

There is the conversion of chemical energy to mechanical energy when there is the need to perform mechanical work — that is physical activities.

Out of the energy required for maintenance, 10% is known to be used for internal mechanical work — the beating of the heart and movement of the respiratory muscles. The rest 90% of the energy for maintenance has been found to be used for the osmotic pumps that maintain the differences in the electrolyte concentrations between i ntra and extra cellular fluids for synthesis of protein and other macromolecules (Davidson et al, 1975).

The unit of energy is given in joules, kilojoules, mgajoules and kilocalories A joule of energy is the energy required to move 1 kilogram a meter by a force of 1 Newton (N).

1000 joules equal to 1 kilojoule
100000 kilojoules is equal to 1 megajoule

Kilocalorie has become more familiar in use than joules and kilojoules. 1 kilocalorie has been found to be equal to 4.2 kilojoules.
The rate of expenditure of energy is expressed in kilowatts. One kilowatt is equal to 1 kilojoule per second. Kilojoule is abbreviated as Kj and kilocalorie as Kcal.

Student Assessment Exercise 2.1

2.1.1 Convert the following to kilojoule,
(i) 100 Kcal (ii) 38.5 Kcal
2.1.2 Convert (i) 375 kilojoules to kilocalories
(ii) 10542 kilojoules to kilocalories

3.2 Energy Content of the Food

There is a need to know the energy content of food to know the amount of energy derivable from a portion of food of known composition of nutrients.

To obtain the energy content of food we use bomb calories

The food stuff is placed in a small chamber or bomb and exposed to high pressure of oxygen in the presence of a platinum catalyst. This is ignited by a small electric current. The food stuff in the bomb burns and the heat produced causes a rise in the temperature of the sun-ounding water. From this the heats of combustion of the three major nutrients carbohydrate, protein and fat can be measured.

It has been found that there are slight differences in the heats of combustion of the nutrients in different foods.

In obtaining the heat of combustion of the different nutrients the extent of the oxidation of the individual nutrients is very important. It has been found that in the animal body, the tissue is able to oxidize fat and carbohydrate completely to carbon dioxide and water. However, the oxidation of protein, has been found not to be complete because of the presence urea, uric acid and creatinine Mat are excreted in urine. Urine has been found to contain unoxidized materials. In computing the heat content of protein, there must be correction for the presence of unoxidizable materials in the urine.

1000 joules equal to 1 kilojoule
100000 kilojoules is equal to 1 megajoule

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Generally, the absorption of the nutrients is not also complete. In view of this, there must be allowances made for incomplete absorption of nutrients while computing the energy content of food.

For all these corrections, in computing the energy content of food, 92% of carbohydrates are considered absorbed in the body. The rest passes on as faeces and urine.

The table 2.1 presented here show the heat of combustion and the available energy in the three proximate principles — protein, fat and carbohydrates, in a mixed diet.

Table 2.1 The Heat of Combustion and the Available Energy In the Three Proximate Principles In a Mixed Diet

Nutrients	Heat of Combustion		Loss in Urine		Availability At	Water Factors	
	Kj/gm	Kcal/gm	Kj/gm	Kcal/gni	Percentage	Kj/gm	Kcal/gm
Protein							
Meat	22.4	5.35	5.23	1.25	92	17	4
Egg	23.4	5.58					
Fat							
Butter	38.2	9.12					
Animal Fat	39.2	9.37			95	37	9
Olive oil	39.3	9.38					
Carbohydrate							
Starch	17.2	4.12					
Glucose	15.5	3.69	-	-	99	16	4

Source: Davidson S. et al (1975) Human Nutrition and Dietetics. Sixth edition, Longman Group Ltd., Pg. 19

Columns 1 and 2 show the heat of conlbustion of the nutrients in both kilojoules and kilocalories. Column 3 and 4 show loss of heat through urine. Column 5 shows the percentage availability of the nutrients after allowances have been made for loss in urine and loss through incomplete absorption. Columns 6 and 7 show the At Water fact(is which can be used to calculate the metabolizable energy.

Solution

Nutrients	Amount gm s	Availability Percent	Energy Content (Kcal) Kcal
Carbohydrate	350	346.5	1386
Fat	150	142.5	1282.5
Protein	200	184	736
Total			3404.5

For availability, the weights of protein, fat and carbohydrate and multiplied by 0.92, 0.95 and 0.99 respectively. The availability, was multiplied by 4, 9 and 4 respectively for protein, fat and carbohydrate to obtain energy content of the carbohydrate respectively are the At Water factors.

In obtaining the proximate weight of protein in any food the nitrogen content of the food is usually evaluated. Nitrogen content is about 16% of the protein in the food. If the nitrogen content is obtained, the value is usually multiplied by 6.25 to obtain the value of the protein in the food. The value may appear too low fro milk and milk products, and too high for cereals. For milk 6.4 is used and for cereal 5.7 is used to multiply the nitrogen value in order to obtain the protein content.

In order to obtain the carbohydrate content, we subtract the sum of the weight of water, from protein and mineral salts that the contents of the water, protein, fat and mineral salt will be obtained first before that of carbohydrates. In modern tables of heat of combustion, the content of the monosaccharide is used to express the carbohydrate content. Monosaccharides are the smallest units of the substances that form the carbohydrate. This will be discussed in some subsequent units.

The differences in the composition of different samples of the same food items can lead to differences in the heat content of food items of the same weights. Even with the differences, the tables of food composition are still very useful in dexterities.

Alcohol can also be another source of energy to man (7Kcal/gm). It has been found that all the energy released from alcohol, ethyl alcohol, could be utilized by man.

Cellulose has been found to be a good source of energy to the ruminants for example sheep. The cellulose is broken down by bacteria into simpler form which are transported and metabolized in the cells of the ruminants to release considerable amount of energy. Since man does not possess cellulose, he cannot derive energy from cellulose.

3.3 Measurement of Energy Expenditure

3.3.1 Direct Calorimetry

This is done by putting a man in a chamber in which the total heat evolved can be measured. The measurement was developed by At water and Rose and the At water and Rosa respiratory calorimeter was used for the measurement. The total *energy* expenditure is given as the amount of heat evolved plus the mechanical work performed. Since there is conservation of energy, the total energy expenditure that is the sum of heat produced plus the mechanical work done is equal to the net energy from the food intake that is the total chemical energy in the food minus the energy lost faeces and urine (Davidson S. et al, 1975). You learned that there should be allowance for energy loss through urine and *energy* loss as a result of incomplete absorption of the nutrients. The loss through incomplete absorption of the nutrients is to the faeces.

Since respiration which is the process by which the food or the nutrients are oxidized to release *energy*, the *energy* expenditure of the body has been found to be quantitatively related to the oxygen consumpt;on.

The process of direct calorimetric appears simple in theory. However, it is very difficult and expensive in practice.

3.3.2 Indirect Calorimetry

In this method the oxygen consumption is measured. During respiration, the nutrients are oxidized to release energy. If there is total combustion of the nutrients, then the amount of energy produced either in the body or in the calorimeter must be quantitatively related to oxygen consumption. There is a chemical equation for this. The law of conservation of mass and energy must be obeyed.

From the equation of respiration

Sugar (Glucose) + Oxygen = Carbohydrate + Water + Heat

Chl-Ip06 + 60_2 = 6CO3 + 6H10 = Heat

From the equation, 180gms of sugar will be combusted by 6 x 22.4 litres of oxygen to produce 6 x 22.4 litres of carbon dioxide and 6 x ISgsin of water. You should realize that the molar volume el any gas is the volume occupied by one mole of gas at normal temperature and pressure hence for 6 moles of the gas at the volume of oxygen will be 6 x 22.4 litres.

The heat generated during the reaction has been found to be equivalent to 2.78m.j.

lgm of sugar will then produce

2.78 x 1000000 joules = 15444 joules
= 15.4 Kj
3.69Kcal

Also 1 litre of oxygen gives = 2.78 x 1000Kj
6 x 22.4
= 20.7Kj
4.9Kcal.

the ratio of the carbon dioxide produced to the oxygen consumed is known as respiratory quotient (RQ). The value of RQ for the oxidation of glucose presented above is 1. The RQ is CO/ Expired
02 Consumed

This enables us to determine whether carbohydrate, fat or protein is burnt or not.

This is very useful in certain clinical situations.

The table 2.2 below shows the energy yields forms oxidation of foodstuffs

(Zuntz. 1897)

Table 2.2 Energy Yields from Oxidation of Foodstuffs (Zu0tz1897)

	Oxygen Required	Carbon dioxide	RQ	Energy Developed		Energy Equivalent of O_2 per litre	
	Ml	Ml		Kj	Kcal	Of O_2 Kj	Kcal
Starch	828.8	8288	1.00	17.51	4.183	21.63	5.047
Animal & Fat	2019.2	1427.3	0.77	39.60	4.461	19.62	4.686
Protein	966.1	781.7	0.809	18.59	4.442	19.36	4.600

Source: Davidson S. et al (1975) Human Nutrition and Dietetics Sixth

34 Energy Expenditure by the Body

3.4.1 Energy Expenditure In Mechanical Work

In performing mechanical work, there is the movement of the muscular contractions — both voluntary and involuntary contractions. The voluntary contractions are used to move the different parts of the body while

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Performing mechanical work. The involuntary contractions occur with the muscles of the internal organs of the body. This allows vital processes such as circulation and digestion. The processes occur throughout the life of a man though there is reduction of the *rate* during *sleep.*

For both the voluntary and involuntary contractions, *energy is expended.* It has been found that only 1/4 of the *energy* made available in this regard is used The rest is expended as heat.

3.4.2 Synthesis of Essentials

The cells do a lot of syntheses such as syntheses of fat, protein and some other organic molecules. All these require some energy.

3.4.3 Maintenance of Body Temperature

For the maintenance of the body temperature, some energy is required. During physical activities, the heat produced is used to maintain the body temperature. Since the normal body temperature (37°C) is higher than the normal environmental temperature, those who could not properly maintain their body temperature (babies and old people) should not be exposed to low environmental temperature while at rest.

3.4.4 Energy Expenditure at Rest

It has been found that when a person is resting and when there is no voluntary

muscular contractions going on, the body still expends energy fro the involuntary contractions of the muscles of the internal organs for cell and nerve activity. During the resting period, the heart still pumps blood, respiration still takes place, and there is a lot of the involuntary muscular actions. All these consume energy. The *energy* required at the rest is called basal metabolism. Basal Metabolic Rate (BMR) is determined experimentally and it is the energy below which energy expenditure should not fall throughout the 24 hours of a day. It is the minimum energy requires d by the body. This is measured some 12 hours after *the* last meal while an individual is lying down wearing a light cloth in a comfortably warm room.

There are tables for *the* basal metabolic rates showing standard values for *people* of both sexes and of all ages. However, there are variations betvveen different people of both sexes and of all ages. The basal metabolic rate of a person can *he related* to *the* surface area of that person. It has *been found* to be more related to the lean body mass of a person. The lean body mass of a person is the *weight* of the carcass of the person minus weight of the fatty substances *in* the carcass. The weight of the carcass is the weight of the

person minus the metabolic rate. People living in the tropics have been found to have BMR above 10 percent but below the standards. Age also has effect on the BMR. The BMR has been found to be higher in actively growing children than in the older people.

3.4.5 Specific Dynamic Action

When food is eaten, there is always the release of some heat. The term used to describe this effect of rise in the metabolic rate above the value found when fasting is called Specific Dynamic Action (SDA). SDA is also described as the effect of food which increases the metabolism over the basal level. When food is taken in excess of what is required for immediate energy needs, there will be SDA. With the consumption of protein the rate of metabolism increases by 30 to 40 percent, with fat 4 to 14 percent and with carbohydrates 5 to 7 percent. The heat produced by the SDA of protein has been found to contribute to the maintenance of the body temperature. As a result of the SDA of protein, some people have argued whether those in hot climates should consume less protein, however, it is also discovered that excess protein does not have deleterious effect on the body and in the capacity to perform work at these hot climates.

3•5 Energy Requirements of Man

3.5.1 Dietary Survey

You have learned that man requires energy for physical activities, basal metabolism, and synthesis of some micro molecules in the body and maintenance of body temperature. The energy requirement of the body could be assessed through dietary surveys. From the food intakes he can calculate the energy supplied. The dietary surveys provide good estimates of the energy requirements of the individuals. The dietary survey has these major drawbacks.

a) There could be more food than required and people may tend to eat more than necessary

b) There could also be less food than required and people may not get enough to eat.

With these, dietary surveys may not provide the accurate estimated of the energy requirements of the individuals.

3.5.2 Recommended Intakes of Energy

Many associations and bodies have developed recommended intakes of energy for people of both sexes and different age groups in various occupations depending on the levels of physical activities. There are tables of recommended intakes by USA Foods and Nutritional Board of National Academy of Sciences since 1943 and UK Department of Health and Social Security. There are also recommended intakes for energy by Food and Agricultural Organization and the Department of Health and Social Security (DHSS) United Kingdom.

From the tables, one could have an estimate of the energy required of an individual, though with allowances for some variations.

3.5.2 Variations in the Energy Requirement

Physical The energy requirements of individuals have been found to be dependent on physical activity, body size and composition, age and climate and environment (Davidson S. et al, 1975).

a) Activity

Occupations have been classified as sedentary, moderately active and very active occupations. You have learned that energy is required for both basal metabolism and physical activities. For moderately active occupzttions, it has been found that above half of the energy requirement is for basal metabolism and the other half for physical activity.

b) Body Size and Composition

Since energy intake is used for maintaining body temperature and synthesis of tissue, it is wise to say that the larger the body size the greater the energy requiretnents. Since the body weight is taken as a measure of the body size, the greater the weight the greater the energy required to move the body.

The energy requirement has more relationship with the lean weight.

The more the lean weight the greater the energy required. Women tend to have more of fatty body than men. That is, men have more lean weight than women and require more energy than women of the same body weight.

c) Age

Energy Is Required For Growth and for Synthesis of tissues. The energy requirement has been found to rise from a minimum in young children to a maximum in adolescents. Thereafter, there will be a gradual fall. The energy requirement is related to body weight during growth. At old age, there is

reduction in the metabolic rate hence causing a reduction in the energy requirement.

d) Climate

It appears as if individuals tend to eat more in cold weather than in hot weather. This is probably to maintain the body temperature during the cold weather. In exceptionally hot and cold conditions, physical activities tend to reduce causing a reduction in the energy requirements. Within the tropics, the energy requirements of an individual are above 5 to I() percent lower than the standards, given for places where the mean temperature exceeds 25°C.

è) Pregnancy and Lactation

During pregnancy, there is the need for increase in the energy intake for the growth of the developing embryo. This is also applicable to lactating mothers who will require additional calories intake for the production of milk. During these physiological stages, the mothers require additional caloric intake which invariably increases the requirements of the mothers.

Student Assessment Exercise 2.2

2.2.1 if a food item contains 500gins of carbohydrates, 300gms of protein and 200gms of fat, what is the energy content of the food item to the body if allowances are provided for loss through urine and incomplete absorption of nutrients?

2.2.2 List the factors that cause variations in the energy requirements of individuals.

4.0 Conclusion

This unit discusses the forms of energy, the energy content of food, the measurement of energy expenditure and the energy requirements of the body. The unit gives the basis of obtaining the values of energy requirements of the individuals.

5.0 Summary

The unit gives, chemical, mechanical, solar, thermal and electrical energies as the forms of energy. The unit also slates that the energy content of food can be measured by calorimeter.

The body can be estimated by dietary surveys. The unit finally gives that energy requirements of the individuals are influenced by the level of physical

activity, age, body size and composition, climate and environment. Subsequent units will discuss the various nutrients in the food.

6.0 Tutor Marked Assignment

Discuss the ways in which energy is expended in the body.

Answers to Student Assessment Exercises

2.1.1 (1) 420kj (ii) 161.7kj

2.1.2 (i) 85Kcal (ii) 2510Kcal

2.2.1 500gms of carbohydrate

$$\text{Availability} = \frac{99 \times 500}{100}$$

Energy Content = 495 x 4Kcals = 1980Kcal

300gms of Protein

$$\text{Availability} = \frac{100}{100} \times 95 = 276\text{gms}$$

Energy Content = 276 x 4 = 1104Kcal

200gms of Fat

$$\text{Availability} = \frac{200}{100} \times 95 = 190\text{gms}$$

Energy Content = 190 x 9 = 1710Kcal

Total Energy Content = 1980 + 1104 + 1710 = 4794Kcal

2.2.2 Age, body, size and composition, climate, physical activity, lactation and pregnancy.

7.0 References and Other Sources

Davidson S. et al (1975) Human Nutrition and Dietetics Sixth edition Longman Group Ltd.

Fleck H. (1976) Introduction To Nutrition. Third edition, Macmillan Pub. Co., Inc., New York

Lake B and Inlaternurte M. (1980) Food and Nutrition 1.3u edition, Mills and Boon Ltd., London

UNIT 3: CARBOHYDRATE

Table of Content

1.0 Introduction

The unit of this course discussed the various nutrients in food. One of the nutrients is carbohydrate. Carbohydrate is an energy yielding nutrient, the largest nutrient in the food after water. It has been reported that carbohydrate accounts for about three fourths of the energy in the plants. This unit discusses this nutrient under classification, sources functions, requirement

and consumption.

2.0 Objectives

At the end of this unit, you should be able to:

- List the classes of carbohydrates
- List the sources of carbohydrates
- List the functions of carbohydrates
- Discuss the consumption of carbohydrates.

3.0 Main Content

3.1 Classification of Carbonhydrates

Carbohydrates contain carbon. hydrogen and *oxygen. There are* always two hydrogen to one carbohydrates. *There are three classes of carbonhydrates.* They are:

- Monosaccharides
- Disaccharides
- Polysaccharides

a) Monosaccharides

These are simple sugars. The most important of them are glucose, fructose and galactose. Glucose is also known as grape sugar, dextrose and corn sugar. Fructose is found in fruits and vegetables, honey and sugar *cane.* Fructose is sometimes referred to as laevulose. Galactose is the milk sugar *and ti* is found *in* mild and milk products. All the Monosaccharides are end products *of* digestion of dissacharides and *polysaccharides*

b) Dissacharides

Disacharides are sugars that *yield* two Monosaccharides on hydiolysi, (!: *is when* they are broken down. The most common and important of them are, sucrose, maltose and lactose. *Sucrose* Yields fructose and glucose when *hydrolyzed.* Sucrose is the *cane* sugar and *it 11';),til*
disaccharides fructose and *glucose* in fruit and plant juices.
. It is found in sug.ar cane or sugar bcx2t:;. It is *found* mostly in milk from animals.

Lactose yields a molecule of a gal ctose and *molecule* of plucf,

Maltose consists of two molecules of glucose. It is found in germinating *cereals where* a *specific enzyme reduces* starch to maltose.

c) Polysaccharides

The polysaccharides *yield* more than two m

dig,estion or any Other form of breakdow*n.* *,mple* sugars *during*

The principal forms of polysaccharides are *starch.* dextrin *glycogen* and *cellulose.* Others are insulin, agar, *pectin* and *peptic* substances. This laiter *group* is *of little* or no nutritional importanc*e* to the body.

T

The most important of the polysaccharides to human nutrition is starch. It is found in cereal grains, roots, bulbs and tubers. During ripening of fruits, the

i is i. onveried to glucose.

During ageing of corn, the glucose is also converted to starch. During digestion' the starch is converted first to dextrin from dextrin to maltose and from maltose to glucose.

Dextrin. as) YOU have just seen, is an intermediate product between starch and

sugar,

Gly ∞t's, o _ . , i i12i referred to as animal starch, is the form in which

carbohydrate is stored in man and animal. It is found mostly in the liver with small amounts present in every body cell. Glucose is the end product of the

breakdown of glycogen.

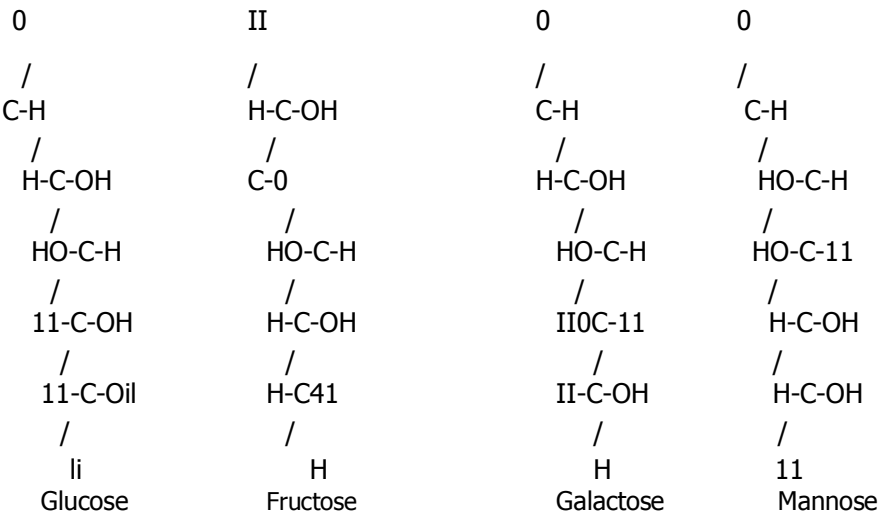
Cellulose is found in plants. It is an insoluble carbohydrate. It provides substantial amount of energy to ruminants since they can be digested by these

ruminants.

Cellulose cannot be digested by man. However, it is good as roughages that are necessary for gastrointestinal health. Cellulose cannot be digested by

man because man lacks cellulose.

It is necessary to show the molecular structures of some of the monosaccharides here so that the differences between them (structurally) may he seen. All the monosaccharides have molecular formula of $C_6H_{12}O_6$.



As you have learned, these monosaccharides will combine together with glycolitic bonds to from dissacharides and polysaccharides.

3.2 Functions of Carbohydrate

a) Source of Energy

Carbohydrate is used mainly as the source of energy in the body. It is the cheapest source of energy in the body. The glucose produced from the breakdown of carbohydrate is the only source of energy to the nervous tissue. Through the process of gluconeogenesis, glucose is produced from part of fat and from some amino acids. With this the nervous tissue can still obtain its need for glucose even without dietary intake of carbohydrate. However, when the glucose *level* in the blood falls below normal, the brain has problem with the supply of glucose — its only energy source. This can lead to symptoms of convulsions.

b) Dietary Essentials

Apart from carbohydrates, fat and protein could be used as a source of energy. You will realize that qeople tend to consume less carbohydrate when the income increases. A diet should not be *completely* free of carbohydrate because recent evidence has shown that a diet of protein and fat, free of carbohydrate produces many undesirable symptoms. It is known that individual on carbohydrate free diet usually develops symptoms that resemble those of starvation. They are found to lose large amounts of sodium, unable to prevent breakdown of body protein, develop ketosis from the accumulation in the blood and urine of abnormal products from metabolism of fat. The individuals also experience dehydration, tiredness and loss of *energy.* Introduction of carbohydrate into such diets has been found to correct all the undesirable symptoms rapidly. This shows that carbohydrate is a dietary essential to the body. Ketosis is the excessive breakdown of protein.

c) It has been found that carbohydrates and some of the products derived from

carbohydrates serve as precursors of some important compounds in the body. Such compounds include nucleic acids and connective tissue matrix.

Student Assessment Exercise 3.1

3.1.1 What are theInactions of carbohvdrate in the body?

3.1.2 List the classes of carbohlyfrate$_s$ *and three examples of each of them.*

3.3 Sources of Carbohydrate

Carbohydrates are mostly found in plants. The most important animal source of carbohydrate is milk — with lactose content. Some small amount of carbohydrate is also found in eggs.

Carbohydrates are found in cereals, roots, tubers, corn, sugar-cane, fruits and vegetable.

The cereals and cereal products have been found to form the largest fraction of the diet of man. These cereal and their products include wheat flour, pastries, bread, cakes, dry cereals and so on.

The many parts of the vegetables such as the root, tuber, leaves, fruits and seeds, contain carbohydrate.

Roots and tubers are also sources of carbohydrate. Yams, potatoes, cocoyams are all rich sources of carbohydrates.

Legumes are also good sources of carbohydrates. In fruits especially the ripe ones provide some amount of carbohydrates. Concentrated sugar such as sugars, syrups, molasses, jams and jellies, beverages, candies and honey are hood sources of carbohydrates.

3.4 Requirements of Carbohydrate

The body can perform its functions even when there is considerable low supply of carbohydrates. Hence it is not possible to establish a dietary standard for carbohydrate. Since the only source of fuel for the brain is from glucose, carbohydrate just be taken so that the brain can get us fuel. Diets that are free from carbohydrate cannot be taken fro long since they are unpalatable and they also lead to low intake of sodium, ketosis — excessive breakdown of protein, involuntary dehydration and some other undesirable metabolic responses. In view of these, the Food and Nutrition Board of the National Research Council of the United States of America recommends an intake of 100gms of carbohydrate a day. Most diets are known to provide more than this figure a day.

3.5 Consumption of Carbohydrates

Carbohydrates are consumed by men for the supply of energy. You have learned that carbohydrate is a high energy yielding nutrient. In the tropics, where the diets of the people are still relatively poor, up to 90 percent of the

energy needs come from carbohydrate source. The diet of the rich in many gintriesCOIh.Ii1I energy source of about 40 percent fro carbohydrate.

TH Hsing carbohydrates are easy to grow; they can be easily stored at room temperature with minimum deterioration. They are iricxl)L e''oarccs of energy. This makes consumption of carbohydrate lOod i.Npensi \ en for the poor people. In Africa, carbohydrate is consumed a lot because it is expensive to afford proteineous foods.

2.3 Protein Sparing Action

You have learned that it is inexpensive to consume carbohydrate and that proteineous lbods are expensive at least in Africa. Protein containing foods are even more expensive than carbohydrate foods any where in the world.

When there is no dietary supply of glycogen into the liver, the process of gluconeogenesis, whereby, protein is destroyed and some of its amino acids converted to glycogen for the use of liver occur. This conversion amounts to a wasteful use of protein physiologically and economically. The energy liberated from this process is less than the energy consumed. In ordertto spare protein of undergoing the process f gluconeogenesis, there is a need to have adequate dietary supply of carbohydrates.

Student Assessment Exercise 2.2

2.2.1 List the various sources of carbohydrate.
2.2.2 Give reasons for a minimum dietary intake of carbohwfrate.

4.0 Conclusion

This unit discusses the classes of carbohydrates, the sources, functions, requirements and consumption of carbohydrates. It also gives an important aspect of carbohydrate in preventing wasteful use of protein in the body.

5.0 Summary

The unit states the classes of carbohydrates as monosacchztrides, disaccharides and polysaccharides and gives the examples of each of these classes.

The functions of carbohydrates are given as a source of energy, a dietary essential and as precursors of some important compounds such as nucleic acids in the body.

The sources of carbohydrate are given as cereals, roots, tubers, concentrated sweets, fruits and vegetables. The unit explains that carbohydrates are inexpensive to demand and they constitute about 90 percent of the energy source in the diets of poor people of the world.

The unit gives the need to supply dietary carbohydrate in order to spare protein of the process of gluconeogenesis that destroys proteins and converts some amino acids to glycogen so that the protein could perform more useful functions of growth and maintenance of body tissues.

6.0 Tutor Marked Assignment

6.1 What are the products of the breakdown of
(i) Maltose, (ii) Sucrose, (iii) Lactose
(iv) Starch
6.2 Discuss the various functions of carbohydrate.

Answers to the Student Assessment Exercise

2.1.1 See Section 3.2 of this unit
2.1.2 See Section 3.1 of this unit
2.2.1 There is a need for minimum dietary intake of carbohydrate to spare protein of ketosis and the process of gluconeogenesis, to prevent inadequate absorption of sodium and some other undesirable metabolic responses.

7.0 Reference and Other Sources.

Davidson S. et al (1975) Human Nutrition and Dietetics. Sixth edition
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Mills and Boon Ltd., London

UNIT 4: LIPIDS

Table of Content

1.0 Introduction

You learned about carbohydrates in unit 3. You have also learned the components of food in unit 1. Lipids become most predominant after water and carbohydrates. They are very visible facts and oils such as butter margarine, vegetable oils. There are also the invisible oils and fats in fibres of meat and in egg yolk, in milk, in grain cereals and in nuts. This unit treats the composition of fats and oils, the physical properties, the sources, the functions in diet, the roles in the body and the dietary requirements of fats and oils.

2.0 Objectives

At the end of this unit, you should be able to

Explain the composition of lipids

List the classes of fats and oils

- Differentiate between fats and oils
- List the roles of Lipids in the body
- List the functions of lipids in diets
- List the sources of fats and oils
- State the requirements of fats and oils.

3.0 Main Content

3.1 Nature, Composition and Physical Properties of Lipids

Some oils and fats are visible — butter, margarine, vegetable oils, salad oils and some fats surrounding meat. Some other oils and fats are finely dispersed in egg yolk and homogenized milk. Some oils are marbled in meat fibres and some in nuts.

Lipids consist of carbon, hydrogen and oxygen atoms just like carbohydrates. This is true with most lipids. Some other lipids in addition to all these atoms contain phosphate and nitrogen containing substances. Some others contain phosphate and carbohydrate- like substances. All these are called phospho-lipids. In the common lipids, the ratio of oxygen to carbon and hydrogen range from 1:7 to 1:3. This is unlike carbohydrate where the ration is 1:2 of energy. For every fat there is a molecule of glycerol shown below

H-C-OH

II-00_0H

H-C-01-1

The glycerol has three hydroxyl (OH) groups. This glycerol is common to all dietary lipids.

The fatty acids with even number of carbon atoms ranging from 4-22 carbon atoms combine with the glycerol to form monoglyceride, diglyceride or triglyceride depending on the numbers of fatty acids that react with the glycerol.

If a fat is monoglyccride, for a diglyceride, we have tow fatty acids linked with the glycerol. Most of the fats are triglyceride with the glycerol. Most of the fats are triglyceride with three fatty acids linked with the glycerol.

H-C-OH	H-C-OH	H - C-0- FA
C-OH	H-C-OH- FA	H-C-O-FA2
1 FC-0- FA	H-C-O-FA2	H-C-0-FA3
Monoglyceride	Diolvcerides	Triglyceride

The FA^{s} represent the fatty acids. When the fatty acids connected with glycerol are not the same, we have mixed glycerides either diglycerides or triglycerides.

The fatty acids have the molecule formula of RCOOH
Where
R represents the hydrocarbon chain

The carboxylic groups of the fatty acids react with the hydroxyl group of the glycerol to form fat (an ester). The reaction is known as esterification.

				z^{0}
H-C-OH	+	RICOOH		H-C-0-C-R1
			I	/^{0}
H-C-OH	+	R,COOH		H-C-0-C-R2+ 31410
				Z°
H-C-OH	+	RiCOOH		H-C-0-C-R3
Glycerol		Fatty Acids		Fat (A Triglyceride)

The properties of Fats and Oils are determined by the

i. Length of chain of the hydrocarbon group of fatty acids
ii. The degree of unsaturation of the hydrocarbon chain
iii. The types of fatty acids that react with the glycerol to form the fats and oil
iv. The order of the fatty acids that is attached to the glycerol.

Most of the food fats contain about eight to ten fatty acids in which some of them are saturated and some unsaturated.

A saturated fatty acid does not possess double bonds between any of its carbon atoms. If there is only one double bond, the fatty acid is monounsaturated. If there is more than one double bond, then we have polyunsaturated fatty acid.

Fats with unsaturated fatty acids are liquid at room temperature and they have low melting point. Those with saturated fatty acids have high melting point and they are solid at room temperature.

The proportions of unsaturated to saturated fatty acids in fats and oils is called P/S ratio. The higher this ratio, the more unsaturated fatty acids are present in the fat and the more likely is for the fat to be in liquid form (oil). Generally animal fats are higher in saturated fatty acids than vegetable fats. The few exceptions are only the chicken fat and fish fat with high P/S ratio.

The length of the hydrocarbon chain in these fatty acids also affects the property of the fats. Fats with short chain fatty acids are likely to be liquid while those ones with long chain fatty acids especially those with saturated chain are likely to be solid. Coconut oil, with large proportion of short chain fatty acids is liquid at room temperature.

The fatty acids in the fats and oils combine with iodine in the proportion to the number of the double bonds in the fat. The reaction of the fats and oils with iodine is used to determine the degree of unsaturation of the fats and oils. The result obtained is called iodine value. The higher the iodine value of the reaction between iodine and a lipid, the greater the degree of unsaturation.

The degree of unsaturation in a lipid has implication for the deteriorative tendency of the fat. If the fat contains large proportion of unsaturated fatty acids, the double bonds to form peroxides which give 'off flavours in some fats.

3.4 Functions of Lipids in Diet

The major functions of Lipids in diet are:

a. Source of Energy
b. Satiety value
c. Carrier of fat soluble vitamins
d. Source of essential fatty acids
e. Precursors of prostaglandins

E Palatability

a. As a source of energy, fat yields of 9 kilocalories of energy per gram of fat. This is more than 4 kilocalories that are yielded by the same weight of protein and carbohydrate. The animals store excess energy in form of fat.

b. Fat has high satiety value since it takes time before it leaves the stomach. The slow rate which fats leave the stomach delays the onset of hunger. This contributes to a feeling of satiety after a meal containing fat.

e. There are some vitamins that are fat soluble. These are vitamins A, D, E, and K. fat therefore, serves as a medium of conveyor for these vitamins. The elimination of fat from diet reduces the intake of these fat soluble vitamins.

d. Fats are the sources of the essential fatty acids discussed before in this unit. The essential fatty acids are linoleic acid, arachidonic and linoleic acids. They play important biological roles as growth and antidermatitis factors.

e. Prostaglandins — substances which stimulate the contraction of smooth muscles in the walls of blood vessels are synthesized from 20-carbon fatty acids. Hence lipids are precursors of these important substances.

f. Palatability: fats contribute to the palatability of our diet. This is very noticeable when fat is used to fry food as a spread, as a base for salad dressing and as a flavour adjusts for vegetable.

3.1 Role of Lipids in the Body

In the body fat is used as a

- Source of Energy

- Body Regulator
- Insulator
- Protector of vital body organs

As a source of energy, you have learned that one gram of fat yields 9 kilocalories of energy. The excess energy is stored in form of fat in the body. The fat is deposited in the adipose tissue of the body.

.As a body regulator, fat helps in regulating the uptake and excretion of nutrients by the cell. The fat underneath the skin serves as insulation material for the body. It protects the body against shock from changes in environmental climate. The fat layer should not be too thick, so as not to slow down the rate of the heat loss during hot weather.

The very thick layer can also slow down physical movement.

The fat deposits around certain vital organs such as kidneys hold these organs in position and protect them from physical shock.

3.2 Dietary Requirements of Lipids

The body required the dietary source of linoleic acid. It has been found that a diet that provides 2% of its calories from linoleic acid will meet the requirement for lipids. Nutritionists have suggested that the provision of 25% to 30% of calories from fat intake is for good health.

The intake of fats that provide more than these values of calories can be injurious to body in view of the prevalence of the cardiovascular diseases resulting from the adverse effects of high fat intake in the diet.

Student Assessment Exercise 4.2

What are the various functions of Fats in the Diet?

4.0 Conclusion

The unit discusses lipids under the following headings.

- Nature, Composition and Physical Properties
- Essential fatty acids
- Food sources
- Functions of fats and oils in Diet
- Roles of Lipids in the body and
- Dietary requirements of Lipids

Fats are synthesized from glycerol and fatty acids where carbon chains vary from 4 to 22 carbon atoms. The fats are useful as sources of energy, protectors of vital body organs, body regulator and as precursors of prostaglandins. Fats also have high satiety value and improve the palatability of diets. Fats are derived from vegetables, nuts, milk, egg yolk and animal sources.

5.0 Summary

Fats are synthesized from glycerol and fatty acids. The length of the carbon chains of the fatty acids, the level of saturation of the fatty acid, the type of the fatty acid and their order determines the properties of the lipids. Liquid

oils at room temperature consist more of unsaturated fatty acids and short chain fatty acids.

Fats and oils are useful in the diets and in the body. Fats serve as a rich source of energy, a body regulator, insulator in the body and precursors of prostaglandins. They also have high satiety value and improve the palatability of diets.

The intake of fat should be controlled to about 25% to 30% of the total calories since this is compatible to hood health. Higher intake of fat could be injurious to the body in view of the implication the higher intakes of fat have for the prevalence of cardiovascular diseases.

6.0 Tutor Marked Assessments

Discuss the Effects of unsaturation on the properties of Lipis.

Answer to Student Assessment Exercise.

4.1 The answers are contained in Section 3.1 of this unit
4.2 The answers are contained in Section 3.4 (a —1) of this unit

7.0 References and Other Sources

Davidson S. eta! (1975) Human Nutrition and Dietetics. Sixth edition Longman Group Ltd.

Fleck H. (1976) Introduction To Nutrition. Third edition, Macmillan Pub. Co., Inc., New York

Gultrie H. A. (1979) Introductory Nutrition. Forth edition, The C.V. Mosby Company. St. Louis, London, Toronto.

Lake B and Inlaternurte M. (1980) Food and Nutrition 13th edition, Mills and Boon Ltd., London

UNIT 5: PROTEINS

TABLE OF CONTENT

1.0 Introduction

You learned about carbohydrates and fats in units 3 and 4. theses are important nutrients in the foods that are used for energy and that perform some other important functions. The other nutrient that can also supply energy (4 kilocalories per gram) promotes growth and maintain the body tissue is Protein. This unit treats Protein, composition, sources, functions, dietary requirements and some other aspects of protein.

2.0 Objectives

At the end of this unit, you should be able to:

- Explain the chemical composition of protein
- Differentiate between essential and nonessential amino acids
- List some sources of protein
- List some functions of protein
- Define some determinants of the quality of protein
- Explain the Denaturation of protein

3.0 Main Content

3.1 Chemical Composition

Proteins are complex organic substances that are made of amino acids. They are about twenty different naturally occurring amino acids that are used for the synthesis of proteins. The structural formula of an amino acid is given as

COP"
I
H-- C --R

NH2

The are. a carboxyl group (COON), a hydrogen atom, an amino group (NH_2) and an amino acid radical (R) attached to a carbon atom. The difference in amino acids is brought about by the difference in the amino acid radical (R). The other components of a carboxyl group, a hydrogen atom and an amino group are the same with all amino acids.

The amino acid radical (R) varies from a single hydrogen (H) atom found in glycine, the simplex amino acid, to a longer carbon chains of 1 to 7 carbon atoms. The amino acid radicals are even in form of benzyl ring in some aromatic amino acids such as tyrosine and phenyalanine. Some amino acid radicals such as in cysteine and methionine also contain sulphur, some amino acids contain a second nitrogen atom and they are called dibasic amino acids. Included in this arc tryplophan, lysine, histidine and arginine.

The nitrogen of the amino group is a very important characteristic factor n proteins since it is not found i[: other nutrients. It varies from 15% to 18% of the amino n=acid molecule. It is 159 in milk protein, 16% in wheat, 17% in cereals and 18% in nuts. In *e:* Hialing the content of protein in the body, nitrogen determination is done.

There is a need for you to leant the 11:10,':. of these naturally occurring amino acids. Some of the amino acids are (indispensable) while the others are non-essential (dispensable). t.r. ey*m.al amino acid cannot he synthesized by the body at a rate suffieie: •H. the needs for growth and maintenance. There must be the dietary r of those amino acids to meet the needs of the body. Nine of the t\\ • mmtrally occurring amino acids are essential. The non-essential amino (ein be synthesized in the body if there is adequate supply of nitrogen to the 1:ixly.

The naturally occurring amino acids are listed below.

a. Essential Amino Acids

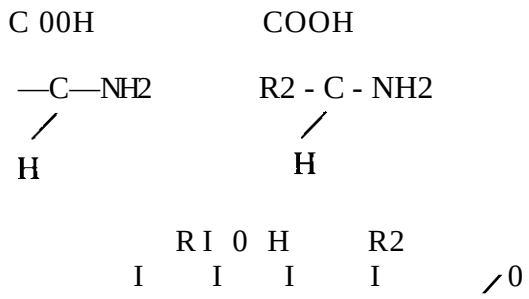
Leusine, isoleucine, lysine, methionine, phenyalanine, threoneine, tryptophan, valine and histidine.

b. The non-essential amino acids are glycine, alaninie, arginine, aspartic acid, asparagines, glutamine, glutamic acid, cystieine, praline, scrine, tyrosine.

c. There are some related compounds that are sometimes classified as amino acids. They are:
Cystine, thyroxin, norleucine, hydroxyl-glutamic acid, hydroxylysine and hydroxyl-proline.

Glysine has been found to be essential for chicks and arginine to be essential for birds and rats.

In the synthesis of protein, the amino group of an amino acid reacts with the carboxyl group of another amino acid to form a peptide bond.



The properties of the protein are determined by the types of the amino acid it contains and the sequence of these amino acids. The types and the sequence of the amino acids in the protein also determines the three dimensional configuration of protein which determines both the enzymatic and catalytic activities of a protein.

32 Sources of Protein

Proteins are from both the plant and animal sources. Animal proteins are superior to plant proteins in form of their amino acids composition and digestibility. The animal proteins have more essential amino acids than the plant proteins.

The animal sources are meat and meat products, milk and mild products, eggs, fish. Some plant sources are beans, peanuts, whole wheat bread, soyabeans and so on.

The toxic substances in soybean and peanuts do not allow eating of these foods raw. They must be detoxified before they can be consumed. There is an antiryptic factor in soybean which must be destroyed at high temperature before the soybean and its protein can be useful in the body.

Student Assessment Exercise 5.1
Discus the chemical composition of protein tend distinguish between essential and non-essential amino acids.

3.3 Functions of Protein

Proteins are used for

a. Promoting growth and maintenance of the body tissues
b. Formation of essential compounds in the body
c. Maintenance of body neutrality
d. Stimulation of antibody formation
e. Transportation of nutrients

a. Protein prompts growth and maintains the body tissues. When some tissues are worn out, proteins are used to build new tissues.

b. The enzymes that are responsible for digestion are proteineous. The hormones, insulin, thyroxin and adrenaline are all proteins. These are used for regulations in the body.

Heomoglobin that carries oxygen to the cells for respiration
is also protein. In the dotting of blood, prothrombin and thromboplastin that are used are all proteins.

c. Since amino acids contain both basic and acid groups that is, they are amphoteric they help in maintaining body neutrality. Their presence in the body therefore helps to prevent accumulation of too much acid and base which could interfere with normal body functioning.

cl. the antibodies that are responsible in combating infection in the body are proteineous. Enzymes, proteineous in nature, are responsible for the detoxification of poisionous materials in the body. Protein depletion in the body affects the resistance of the body against infection and reduces the ability of the body to detoxify poisionous materials.

e. In the transportation of nutrients from intestine across the intestinal walls to the blood, from blood to the tissues and across the cell membrane into the cell, protein plays an essential role. Most of the carriers of nutrients are proteins. With depletion of proteins in the body, the absorption and transportation of some nutrients will be reduced.

3.4 Denaturation of Protein

Proteins, in their native forms, have three dimensional configurations. These determine the enzymatic and catalytic activities of the proteins. This configuration changes when protein is denatured thereby leading to the loss of the enzymatic and catalytic activities of protein.

The denaturing agents are:

a. Heat
b. Vigorous agitation such as whipping or shaking
c. Organic solvents such as ethanol
d. Ey c.·ssive alkalinity or acidity
e. Salts of heavy metals
1. Alkaloidal agents such as tannic acid and picric acid.

Denaturation of proteins causes the destruction of enzymes. In some food processing the denaturing of enzymes is deliberate to prevent deterioration. Denaturation also leads to coagulation, get formation and curdling. In some processes, all these are desirable.

3•5 Dietary Requirements

There are two ways in which we can estimate the requirements. They are:

a. Minimum amount of protein require to promote growth in children and to maintain nitrogen balance in adults
b. Calculation of losses of nitrogen through urine and faeces on a protein-free diet, after allowances have been given for obligatory losses through skin, sweat and worn out cells. More amount of proteins per kilogram of body

weight is consumed by growing children, pregnant women and lactating mothers. There is no evidence of adverse effects of intake of protein above the minimum requirements. The protein required in the body must be able to meet the body *needs* for growth, maintenance of body tissues, compensate for losses through urine, faeces, worn out tissues and various body secretions and excretions.

3.6 Protein Quality

, The quality of proteins is determined by the types of amino acids, the number and the sequence of amino acids in the protein.

Proteins that contain all the essential amino acids in the required proportions, capable of promoting growth when they are consumed as the sole source of proteins are called complete proteins. These are good quality proteins of proteins of high biological value.

Proteins that contain all the essential amino acids in required proportions and in which at least of the amino acids is not in adequate proportion required to promote growth are called partially complete proteins. The amino acid in which the amount is relatively smaller than required is called the limiting amino acids. Arginine is the limiting amino acid in casein, and methoinme in fish and eggs.

The proteins that are lacking in at least one of the essential amino acids are incomplete proteins. They are of low biological values. Complete proteins contain about 33% essential amino acids and 66% nonessential amino acids. The incomplete proteins contain about 25% essential amino acids. All animal proteins except gelatin, is limited in both tryptophan and lysine, are complete proteins since they lack in one or more essential amino acids.

There are some biological and chemical methods of evaluating the quality of proteins. Some indexes are also used to define the quality of proteins. There area:

a. Biological value

b. Net protein utilization

c. Protein efficiency ratio

d. Chemical scores or amino acid score

a. Biological Value

Biological value measures the amount of protein retained to the amount of protein absorbed. There is the assumption that more proteins will be retained when the essential amino acids are supplied in the quantities that will meet the need for growth. You have learned that nitrogen is lost through urine and . through faeces from unabsorbed nitrogen.

Biological value (By) is given as:

$$\frac{\text{Nitrogen Retained} \times 100}{\text{Nitrogen Absorbed}}$$

When a protein is consumed as the only dietary source of protein (Nitrogen) and in the amounts that are capable of meeting the needs of body for nitrogen, the percentage- nitrogen used for protein synthesis is the biological value of that protein.

The biological value of protein is evaluated by determining the amount of nitrogen in the food intake, in the urinary and faecal excretions of both the test protein and on a protein free diet.

$$BV = \frac{\text{Dietar N- Urinal N - U x Faecal}}{\text{Dietary N - (Faecal N — F0)}} \times 100$$

N means Nitrogen

U_0 --,- Urinary loss of nitrogen in a protein free diet

F_0 = Faecal loss of nitrogen in a protein free diet

Diet with biological value of *70%* and above are considered good enough of supporting growth. This index may apply to single proteins, single foods and combination of proteins in foods.

A table of biological values of some proteins is listed below:

Food	Biological Value
Egg	93
Milk	86
Rice	86
Fish	75
Beef	75
Casein	75
Corn	72
Cotton Seed Flour	60
Peanut Flour	56
Wheat Gluten	44

Source: Guthrie 11. A. (1979) Introductory Nutrition 4th ed., the C V. Mosby

b. Net Protein Utilization

The biological value does not take into account the differences in the digestibility of the proteins. It is only based on the amount of nitrogen absorbed. The net protein utilization however takes into consideration both the nitrogen absorbed and the digestibility of the protein.

Net protein utilization (NPU) is expressed as Biological Value multiplied by Coefficient of digestibility

NPU = 1W x coefficient of digestibility..

c. Protein Efficiency Ratio

Protein efficiency ratio is the simplest method of determg the quality of protein. It requires no chemical analysis. The protein *efficiency* ratio is the weight gain of a growing animal in relation to its protein intake when calories are supplied well and the protein source is fed at an adequate level for a long Period of time (four weeks) to assess the protein in comparison to casein with known protein efficiency ratio (PER) of 2.5 (Gultrie, 1979)

d. Chemical Score (Amino Acid Score)

There are some chemicals scores of determining the quality of protein. The Amino Acid score is *given* as

$$= \frac{\text{ma of amino acid in / m of test otein x 100}}{\text{mg of amino acid in reference protein}}$$

Chemical scores do not take into consideration the imbalances in the amino acids content of a protein and the differences in the absorption of the amino acids.

Student Assessment Exercise 5.2

Winn is the Denaturation of protein? What are the denaturing agents?

4.0 Conclusion

This unit teaches protein, its composition, sources, funclions dietary requirements, Denaturation and determinants of the quality of proteins.

5.0 Summary

In this unit you learned that amino acids combine in polypeptide linkages to form protein. Properties of protein are dependent on the types of amino acids in the protein, also determined are the three dimensional configuration of protein that determines both the enzymatic and catalytic activities of the protein. Heat. vigourous agitations, presence of salts of heavy metals, excessive alkanity and acidity, presence of alkaloidal agents and alcohol could lead to the changes in this three dimensional configuration of protein, thereby causing Denaturation of protein. Animal proteins have been found to have higher quality in terms of digestibility and amino acids contents than vegetable proteins. The quality of protein and the completeness of other wise of protein is determined by the number and amount of the essential amino acids in the proteins. Other measures of the quality of protein are given as Biological Value, Net Protein Utilization, Protein Efficiency Ratio and Amino Acid Score.

6.0 Tutor Marked Assignment

Discuss the various determinations of the quality of proteins.

Answers to Student Assessment Exercise

5.1 See answers in Section 3.1 of this unit
5.2 See the answers in section 3.5 of this unit.

7.0 References and Other Sources

Davidson S. et al (1975) Human Nutrition and Dietetics.
Sixth edition Longman Group Ltd.

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UNIT 6: MINERALS

TABLE OF CONTENT

1.0 Introduction

You learned in Units 3, 4 and 5 about Carbohydrates, Fats and Proteins which are all organic substances. The minerals are inorganic substances drawn from the soil by plants. They are supplied by plants and animals that have already consumed plants.

Though they are inorganic substances, many of them are found as components of complex organic substances in the foods.

This unit treats mineral elements, their functions and macro elements or trace elements that are important consistituents of vital substances in the body and that are used for regulation of some body processes.

2.0 Objectives

At the end of this unit, you should be able to

- Explain the classification and body composition of mineral elements

- List the functions of Mineral elements
- Discuss some macro elements in relation to their importance to the body
- Discuss some micro elements or trace elements in relation to their importance to the body

3.0 Main Content

3.1 Classification and Body Composition of Mineral

Minerals in the body are grouped as

- Macro nutrient elements or Major minerals
- Micro nutrient elements or Trace elements

Macro nutrient element's are minerals that are required in relatively large amounts in the body. These are calcium, phosphorous, potassium, sulfur, sodium, chlorine and magnesium. The major electrolytes of the body water have been identified as sodium, chlorine and potassium.

Those minerals that are present in the body in amounts less than 0.005 percent of the body but are useful to the body are called micro elements or trace elements. These are iron, iodine, zinc, selenium, manganese, copper, fluorine, chromium, cobalt and mohybdenum.

The amounts of mineral that are present in the body are very small, though minerals play significant roles in the body. The mineral elements in the body constitute only about 4 percent of the bodyweight and most of the minerals are in the bones.

3.2 Functions of Minerals

There are mainly two major functions of minerals. They are:

a. Constituents of the body in hard and soft tissues
b. Regulators of some body functions

Calcium, magnesium and phosphorous are important constituents of the bones and teeth. They allow the solid structure of both the bones and teeth. Sodium, chlorine and potassium are important electrolytes in the body fluids.

Iodine in the thyroid gland and its sect et ion thryroxine, magnesium in the muscles and some in the blood, potassium in the muscles and various body organs are involved in the structure of the body.

Minerals are parts of many enzymes and hormones. There are copper and iron in c.), tochrome oxidasc and zinc in carboxypeptidase.

Iron is part of heamoglobin that transport oxygen to the cells and transports carbon dioxide away from the cells.

The minerals act as regulators and they arc necessary to some body functions. For the functioning of the nerves, minerals play important roles. An exchange of sodium and potassium ions facilitates the transmission of a nerve impulse. Altering the concentration of calcium, magnesium, sodium and potassium I the fluids of nerve cells has been found to disrupt the ability of the nerves to transmit impulses.

The neutrality of the body fluids or the acid — base balance is maintained by some minerals that can generate acid and alkali media.

Chlorine, phosphorus and sulphur that are found predominantly in protein foods like eggs, meats and in cereal products, generate acid medium.

Some of the basic — reacting minerals found largely in fruits and vegetables are calcium, iron, magnesium, potassium and sodium.

For cells to function and survive, the neutrality of the body cells must be maintained.

Minerals are involved in the osmotic pressure of the body fluids that have a lot of effects on the movements of nutrients.

Some reactions in the body require sonic levels of acidity and alkalinity. This is facilitated by minerals that generate either acid or alkali medium. Gastric juice in the stomach for digestion of carbohydrate is acidic. For digestion of fat the small intestine. some alh.dine salts are important.

The contraction of muscles depends on the presence of calcium, sodium, potassium and chlorides.

Minerals serve as catalysts in some reactions in the body. In the clotting of blood, calcium is important: in the metabolism of carbohydrates and fats, minerals are part of the catalyzing enzymes. In the synthesis of heamoglobin, mineral is involved. The production of insulin depends on the presence of

zinc. In the absorption of carbohydrate, sodium and magnesium are important. Calcium has been found to facilitate the absorption of Vitamin

B12.

3.4 Macronutrient Elements

3.4.1 Calcium

Calcium is found mostly in bones and teeth. There is more calcium in the body than any other mineral. Calcitnn gives the rigidity and hardness of both bones and teeth. Calcium ions are concerned with all cell functioning. They are involved in the clotting of blood. Calcium tends to be a kind of coordinator among inorganic elements. It plays a corrective role in conditions of excess presence of potassium, magnesium or sodium in the body. Iron is utilized to a better advantage if adequate amount of calcium is

consumed in the diet.

The deficiency of calcium and phosphorous is implicated in rickets in small children. Osteomalacia, the adult rickets, may also be due to deficiency of calcium as well as deficiency of phosphorous and vitamin D.

The deficiency of calcium is also implicated in the occurrence of osteoporosis, the thing of bones in old people. Low level of calcium in blood and fluids in the body may interfere with response of nerves to stimuli.

There is always a dynamic equilibrium between the calcium in the blood and that in the bones. The calcium in the bone dissolves constantly into blood under the influence of the cells called Osteoclasts Lake and Waterworth, 1980). This has been found to allow bone growth in childhood and adolescence. It also provides for maintenance and adjustment of bone shape to meet stresses on the skeleton in the action of the adults.

During growth, the amount of calcium laid down exceeds that which is withdrawn. In adults the calcium withdrawn is equal to the calcium laid

down over a short period of time.

As a result of the urinary excretion of calcium, there is the need for regular dietary intake of calcium. When the dietary intake is not adequate, the amount of calcium laid down in the bones will have problem. This does not result into serious effects in adults. In children, this deficient intake could result into serious problem if the calcification process is affected and if the

cartilages in the skeleton are replaced by bone.

The deficiency of vitamin 1) which regulated this absorption of calcium from food in the intestines into the blood can result into serious problems of

deficiency of calcium. If a pregnant woman suffers deficiency of Vitamin I), it can result into deficiency of calcium, which can later result into osteomalacia in the child after birth. The Food and Agricultural Organization of United Nations (FAO) (1961) made the following recommendations in the intake of calcium.

Age	Mg per Day
0 - 12 Months (Not breastfed)	500 - 600
1 - 9 Years	400 - 500
10 - 15 years	600 - 700
16 - 19 years	500 - 600
Pregnancy and Lactation	1000 1200

The most important sources of calcium are milk and milk products and cheese. Other sources of calcium are tinned fish, green vegetables (as a moderate source), fortified with bread.

Excessive intake of calcium can result into hypercalceamia. This occurred when fortification of baby foods was done with Vitamin D without restriction.

Student Assessment Exercise 6.1

6.1.1 Discuss the various uses of minerals in the body

6.1.2 Discuss Calcium under the Mowing headings': sources, uses absorption in the body, recommended intakes and deficiency.

3.3.2 Phosphorous

Phosphorus occurs in the body generally with calcium and they contribute to the supportive structures of the body.

Phosphorous is important in chemical reactions with protein, fats and carbohydrates so that the body may have energy.

Phosphorous exists as soluble phosphate ions in blood, lipids, proteins, carbohydrates and energy transfer enzymes.

Many of the 13 Vitamins have been found to b effective only when they combine with the phosphate in the body.

Phosphorous is an important component of nuleic acids and nucleoproteins which are responsible for cell division, reproduction and transmission of heredity traits. Phosphorous has been found to be concerned with brain and nerve metabolism.

Phosphorous combines with calcium to give rigidity to the bones and teeth. Phosphorous forms an important component of enzymes and coenzymes that are responsible for respiration in tissue.

The recommended daily allowances of phosphorous as recommended by the Food and Nutrition Board of United States of America (1974) are given here below

. Recommended Daily Allowances of Phosphorous .

Table 3.3

	Age	Weight (kg)	Height (cm)	Phosphorous (mg)
Infants	0.0 — 0.5	6	60	240
	0.5 — 1	9	71	400
Children	1 — 3	13	86	800
	4 — 6	20	110	800
	7 - 10	30	135	800
Males	11 — 14	114	158	1200
	15 — 18	61	172	1200
	19 — 22	67	172	800
	23 — 50	70	172	800
	51+	70	172	800
Female	11 — 24	114	155	1200
	15 — 18	54	162	1200
	19 — 22	58	162	800
	23 — 50	58	162	800
	51+	58	162	800
Pregnant				1200
Lactating				1200

Source: Fleck H. (1976) Introduction To Nutrition.
Third edition,Macmillan Pub. Co., Inc., New York
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Phosphorous is found in cereals and meats of all kinds, legumes, nuts, eggs, milk and diary products.

Protein rich foods are usually rich in phosphorous.

3.3.3 Potassium

It exists as a cation bound to protein in the body. With sodium potassium influences the osmotic pressure and contributes to the normal I'll equilibrium of body fluids.

Potassium has been found to be related to the other minerals in metabolism. Deficiency of potassium leads to retention of sodium. Deficiency of magnesium also results into depletion of potassium.

Dietary lack ·of potassium does not cause deficiency of potassium. Body potassium may be reduced through fasting, starvation, infectious diarrhea and vomiting, severe protein, calorie malnutrition and diabetic may result into potassium depletion.

3.3.4 Sodium

Sodium exists as cations in intracellular fluids. These cations help to maintain osmotic pressure equilibrium of the fluids and the PH of body fluid volume. Sodium is used for tissue formation, nerve transmission and muscle contraction. Sodium and potassium cations together with anions of phosphates, carbonates and citrates are responsible for alkalinity of the bile and pancreatic juice and they help to stabilize the PH of the blood.

Deficiency of sodium results in "heat fatigue" — muscular weakness, drowsiness and mental confusion. When there is deficiency of sodium, physical exercise can result into muscular cramps.

Sodium is consumed in the food as sodium chloride. 6 to 8gms of sodium chloride is recommended as daily intake of sodium.

Sodium losses may occur during vomiting, renal disease, adrenal insufficiency, diarrhea and profuse sweating (Fleck, 1976). Muscle cramps and low Blood Pressure occur if this loss of sodium is accompanied by loss of water.

3.4 Trace Elements

3.4.2 **Iron**

Unlike those other materials discussed before, it is difficult to absorb iron from food and to *excrete* it through urine. This is to say that the little ion absorbed from food is retained. The iron in the body is in form of haemoglobin and inyoglobin. Therefore, ion is important in the oxidation of food stuffs and release of energy. This is because haemoglobin and

myoglobin are oxygen carrying agents in the body. Iron is also involved in the transfer of electrons.

Some irons, about 1/4 of the iron in the body is stored as ferriten. As only very small proportion of iron is absorbed into the blood stream so also, only very little ion is lost in the body except during injury and menstruation. During the manufacture of new red blood cells in the bone marrow of growing children and pregnant women more iron is absorbed to respond to this increase in need.

The incidence of Anaemia that is, the condition of inadequate haemoglobin which jeopardizes oxygen supply in the cells is as a result of deficiency of iron.

Those who are at the risk of the deficiency of iron are children and adolescents during the period of increase in blood volume, girls and women due to menstruation, women undergoing a succession of pregnancies.

Ascorbic acid favours the absorption of iron. Products of protein digestion are also known to favour the absorption of iron. These are especially those containing sulphydry groups.

The formation of insoluble salts from the reaction of oxyalate and phaytate ions with the free fatty acids present in the intestines reduce the absorption of iron.

A recommendation of 10mg per day of iron for adult men and 12mg for women in child bearing years has been made. The recommendations of iron during adolescent, pregnancy and lactation have been given respectively as 12 and 13mg per day.

Food containing iron stores and haemoglobin of mammalian carcasses are good sources of iron. That is, liver and black sausages are good sources of iron. All flesh foods and eggs also contain useful amount of irons.

3.4.3 Iodine

Iodine is found in the thyroid gland of the body where it is bound as an essential component of thyroxine. A lack of iodine in the body results to Goitre, this leads to low thyroxine level of the blood. The thyroid gland in an attempt to compensate for this deficiency of iodine becomes over stimulated and this leads to the enlargement of the gland. Women and girls are more susceptible to goiter than boys and men.

Cretinism occurs when there is acute deficiency of iron in thyroid secretion in childhood. This leads to retardation of growth in children and development of ape-like appearance.

Iodine is also very important for normal production and lactation. Pigs with lack of iodine have been found to produce young ones without hair.

A sufficient intake of the diet is assured by the use of iodine salt.

Student Assessment Exercise 6.2

Discuss iron on the basis of source, importance and requirement.

4.0 Conclusion

In this unit, you learn the two classes of minerals — macro nutrients and micro nutrient elements. You also learn about the importance of these minerals and their sources.

Macro nutrient elements such as calcium, phosphorus, potassium and sodium and micro nutrient elements such as iron and iodine are discussed.

5.0 Summary

In this unit minerals were discussed under macro nutrient and micro nutrient elements. Minerals have been found to be important constituents of the body's hard and soft tissues and regulator of some body functions.

Macroelements have been found to be those consumed in more than 0.005% of the body weight. The microelements are those present in less than 0.005% of the body weight. Though, minerals are consumed in relatively small amount, their deficiencies could lead to serious health problems.

6.0 Tutor Marked Assignment

Discuss the problems associated with the deficiencies of calcium, phosphorous and ion.

Answers to Student Assessment Exercise

6.1.1 *See* answers in Section 3.2 of this Unit

6.1.2 Answers in Section 3.3.1 of this unit

6.2 Sec answers in Section 3.4.1 of this unit.

7.0 References and Other Sources

Davidson S. et al (1975) Human Nutrition and Dietetics. Sixth editionLongman Group Ltd.

Fleck H. (1976) Introduction To Nutrition. Third edition, Macmillan Pub. Co., Inc., New York

Guthrie H. A. (1979) Introductory Nutrition. Forth edition, The C.V. Mosby Company. St. Louis, London, Toronto.

Lake B and Inlaternurte M. (1980) Food and Nutrition 13th edition, Mills and Boon Ltd., London

UNIT 7: VITAMINS

TABLE OF CONTENT

1.0 Introduction

The previous units treated the Vitamin nutrients in food. These nutrients are carbohydrate, lipids and mineral elements. This unit is treating the last set of nutrients to be discovered. These are vitamins — organic substances needed in small amounts (few micrograms to a maximum of above 30 milligrams) and they perform a specific melcbotic function.

They are supplied from the dietary sources.

This unit treats various vitamins, their functions and the problems associated with their *deficiency.*

2.0 Object ves

At the end of this unit, you should be able to

- List the Classes of Vitamins

- List the Functions of Vitamins
- Discuss the Deficiencies of Vitamins
- Discuss fat soluble vitamins under sources, functions, requirements and deficiencies.
- Discuss some water soluble vitamins under sources, functions requirements and deficiencies.

3.0 Main Content

3.1 Classification of Vitamins

Vitamins are organic substances that are required in small amount — some in few micrograms to a maximum of about 30 milligrams. They perform a specific metabolic function in the body. Some substances that are considered as vitamins for some animals may not be vitamins for some other animals which can synthesize these substances. For instance vitamin C is considered as vitamins for human beings, monkeys and guinea pigs but this vitamin is synthesized by rats, rabbits, dogs and other animals.

The vitamins are manufactured by the plants from the nutrient available to them by the soil. There are eleven water soluble vitamins into vitamin B group and Vitamin C. The Vitamin B group is: Thiamin (B), Inciton, Cholin, Riboflavin (B), Pantothenic acid, Biotin, Pyridoxin (B1), Niacin (I32), Folacin or Folic acid, Cobalanin (Br), Vitamin C or Ascorbic acid is also water soluble.

The fat soluble Vitamins are: Vitamins A, D, E, and K.

There are some compounds that are related to Vitamins, these are precursors (Pro-Vitamins) and Antagonest (Anti-Vitamins). The precursors of vitamins are converted in the body to the active forms of the vitamins. Carotene, the precursor of vitamin A is converted to vitamin A in the intestinal wall. 7-dehydrocholesterol is converted to Vitamin D in the skin and to the active form in the liver and kidney when the body is exposed to the sunlight energy especially early in the morning. Tryplophan is converted to Niacin in the liver.

The anti-vitamins prevent the functioning of the vitamins by refusing to be replaced by the active vitamin in those compounds that will allow the vitamins to perform their roles.

3.2 Functions of Vitamins

The vitamin functions as part of enzymes in the metabolic functions of the body. So the vitamins exist' as Co-enzymes in the body. Some enzymes cannot perform their roles in the body except these co-enzymes exist and combine with the vitamins.

3.3 Deficiencies of Vitamins

The deficiencies in vitamins can arise from the following reasons:

a. Inadequate supply of the vitamins from the diet. The vitamin requirements of people vary. The amount of a vitamin that is sufficient for a person may be insufficient for another person.

b. The failure of the body to absorb vitamins required by the body may cause the deficiency of the vitamins in cells. If a person cannot secrete enough bile, the absorption of fat soluble vitamins will be lower than required. Very rapid passage of food through the intestinal tract may also reduce the absorption of nutrients.

c. Increased need for a vitamin may also precipitate the deficiency of that vitamin if additional intake over and above the original intake is not made.

d. Losses of vitamin through processing of the food may also cause deficiency of the vitamins in the diet consisting the foods.

34 Fat Soluble Vitamins

3.4.1 Vitamin A

Vitamin A occurs in several forms in nature. It occurs as retinol in mammals and saltwater fish: as dehydroretinol in fresh water fish, as pro-vitamins (Precursor) known as Carotenes. Vitamin A is supplied to the body through dietary intake or supplements. Excess amount of vitamin A consumed over the required amount in the body is stored in the liver for future use. For maximum utilization of vitamin A in the body, there must be adequacy in the dietary intake of proteins and vitamin E.

Vitamin A is almost colourless, fat soluble and relative to heat. Exposure to light may destroy vitamin A. Storage of vitamin A is associated with fatty acid most especially pal mitic acid.

Functions of Vitamin A

Vitamin A is used by complex organisms such as human beings for at least three physiological functions namely:

- Vision
- Growth
- Reproduction

For vision, vitamin A is used for the maintenance of the visual pupil for vision in dim light. In other words it prevents night blindness.

For growth, vitamin A plays an important role in the development and maintenance of epithelial tissue and the development of bones.

For reproduction, retinol or its aldehyde derivative (retinaldehyde) is necessary for normal reproduction in rat. Absence of vitamin A causes failure in spermatogenesis in male i.e. manufacturing of sperm and feotal resorption in female.

Other functions of vitamin A include

- The role of vitamin A in the release of proteolYtic enzymes from pacticles in the lysosomes.
- Vitamin A is involved in the stability of cell membrane.
- Deficiency of vitamin A has been found to cause changes in which results in loss of appetite.

Food Sources of Vitamin A

Vitamin A is found in fruits and vegetables such as spinach, carrot, asparagus, peas, cabbage, papaya, watermelon, oranges, banana, and pineapple. They are also found in diary products such as milk, cheese butter and margarine. They are also found in fish, meat, poultry and eggs such as liver, beef, lamb, chicken, calf, pork, egg yolk and whole egg. In milk vitamin A is present in the fat position. In fruits and vegetables, vitamin A is present in form of precursor. Vitamin A is also available in only animal product which the carotene in their foods has been metabolized into vitamin A. the liver of such animal is the storage site of Vitamin A.

Deficiency of Vitamin A

Deficiency of vitamin A only occurs after the reserve *in* the liver has been completely depleted when there is very low dietary intake of the vitamin. Vitamin A deficiency results into

a. Night blindness

b. Changes ill the *eye* with the cornea first affected

c. Respiratory infections

d. Changes in skin with the development of folliculosis, that is development of small bumps near the base of hair follicle that subsequently becomes keratinized

e. Changes in gastro-intestinal tract resulting into disturbances such as diarrhea.

f. Failure of teeth enamel in which the enamel in the teeth disappears as a result of deprivation in vitamin A.

g. There could be loss of sense of smell and taste.

Toxicity in Vitamin A

This is also known as hypervitaminosis of vitamin A. This results in the decreased stability of the membrane structure. It can cause the fragility of bones and also result in increase of calcium in both urine and blood therefore, resulting in low amount of calcium laid down in the bones.

Recommended Allowances for Vitamin A

The recommended allowances for vitamin A have been given as 5000 IU for an adult male per day, 4000 IU for women per day, 5000 IU for pregnant women per day and 6000 IV for a lactating mother per day. There are recommended amounts for people of other age groups in many books on nutrition. The need of vitamin A has been found to vary under different conditions. Performing tiring work in hot weather tends to increase the need for vitamin A.

After removal of he gall bladder in hypothyros m and when there is impairment of intestinal absorption of vitamin A, there is a need of increase in dietary intake of vitamin A.

3.4.2 Vitamin D

This is also a fat soluble vitamin that exists as a cholecalciferol, vitamin D3, in animal sources and' ergosterol. vitamin Di, from vegetable. sources. Previously it is known as sunshine vitamin and rickets preventive factor since it could be used to prevent or cure infants of rickets; if the infants are exposed to sunlight or if they receive their vitamin D from cod-liver oil.

We should I,now that rickets is the condition that is characterized by defective bone formation in which there is inadequate deposition of calcium and phosphorous in the bone.

This results into deformity in the bones of the leg leading to bowing of legs and knock-knees. Rickets is primarily associated with children. The term "adult rickets" that is ()stem-Wilda results in the defect in the bone formation but not necessarily as a result of vitamin D deficiency.

Functions of Vitamin D

It is very useful in the metabolism of calcium as it is associated with the calcification of bones. It also acts to raise the blood calcium levels by fascinating the resorption of bones (Guthrie, 1979).

It is also involved in the metabolism of phosphorous as failure in calcification of bone is often caused by insufficient supply of phosphates. It has been found that the addition of vitamin D to the diet causes an increase in the rate of absorption of phosphates.
Vitamin D, has been found to influence the rate of resorption of amino acid in the kidney tubules.

There is also an antagonistic relationship between vitamin D and hydrocortisone, an hormone of the adrenal gland. It should be noted that the hydrocortisone can suppress the high blood level of calcium that is associated with the excessive intake of vitamin D.

Sources of Vitamin D

Vitamin D is produced majorly by the exposure of the adipose tissue to ultraviolet rays in sunlight. Food sources also provide some relatively small amount of vitamin D. Margarine enriched with vitamin D and egg yolk are important sources of vitamin D. Other sources of vitamin D are fatty fish, butter, dietary supplement in form of fish liver oil fortified in infants and invalids' food.

Requirements of Vitamin E

For pregnant and lactating mothers the requirements has been set as 15 Iii. The recommended intake of vitamin E for adult male has been put at 15 IU per day and for adult female it has been put at 12 IU per day.

Source of Vitamin E

Vitamin E is found mostly in vegetable oils. It is also found in wheat and oil. Normal cooking causes little destruction of vitamin E. Fruits and vegetables are relatively poor sources of vitamin E

3.4.4 Vitamin K

Vitamin K is also a fat soluble vitamin called Anti-hemorrhagic factor. It belongs to the substance known as Quinones. Vitamin K is involved in the synthesis of blood clotting factor.

Vitamin K is derived from green and yellow vegetables and from its synthesis in the body by intestinal vertebra. Prolonged coagulation time and frequent incidence of hemorrhage are the few symptoms of vitamin K deficiency.

Student Assessment Exercise 7.1
Discuss the classification and functions of Vitamins.

3.5 Water Soluble Vitamins

3.5.1 Thiamin (BO

Thiamin occurs in the body mostly as thiamin hydrochloride, a white crystalline water soluble substance that is easily destroyed by heat or oxidation in the presence of alkaline.

Functions of Thiantin

Thiamin is part of the co-enzyme thiamin-pyrophosphate or thiamin diphosphate which is required for the metabolism of carbohydrate.

Rice. enriched with thiamin has been found to eliminate the incidence of beriberi.

Food Sources of Thiamin

Thiamin is found in cereal product providing about one-third of dietary thiamin. Meat, fish and poultry provide a fourth and dairy products a tenth of the available dietary' thiamin. Food sources of thiamin are yeast, pears, pork, - orange drink, whole wheat bread, macaroni and wheat bread.

Deficiency of Thiamin

The deficiency is caused by low dietary intake of thiamin and caloric intake in the diet.

Deficiency of thiamin results into loss of appetite or anorexia, decrease muscle tonus, mental depression and confusion, nystagnus caused by weakness of the cranial nerve and beriberi. There could even be growth retardation in animal if there is deficiency of thiamin.

Requirements of Thiamin

There is always a relationship between the caloric intakes for the thiamin need for all ages. The need for thiamin per day varies from 0.5 to 0.9ing in children. For boys, girls, men and women 1.2mg,, 1.0mg, I.2mg, 0.9mg of thiamin per day respectively are recommended.

3.5.3 Riboflavin

This is known as vitamin Bi and it known as essential for growth and tissue repair in all animals it is relatively resistant to effect of acid, heat and oxidation. Major losses of riboflavin in food can be due to ultra violet or physical rays of sunlight on milk, a major source of riboflavin.

Functions of Riboflavin

Riboflavin has been found to he part of several enzymes and co-enzymes that are involved in a number of metabolisms in the body.

Food Sources of Riboflavin

Milk is the most significant source of riboflavin. Riboflavin is also found in kidney, beef, liver, egg, asparagus and so on. The recommended intake of riboflavin is based on caloric intake as it is set as 0.55mg per 100Kcal during pregnancy additional allowance of 3mg is made during lactation, additional allowance of 5mg is also made per day.

3.5.3 Ascorbic Acid (Vitamin C)

This is a water soluble vitamin that is closely related to monosaccharides. The vitamin is stable to acid but easily destroyed by oxidation, alkali and heat.

It has a molecular formula of C_6H806 which can under go oxidation dehydroascorbic acid (C6H606)•

Ascorbic acid plays a growth promoting function. Ascorbic acid sulphate also has anti-scorbutic properties of Ascorbic acid. Those animals that have the ability to synthesize vitamin C require no dietary intake of vitamin C. in this process, glucose or galactose is converted to Ascorbic acid. Human beings, guinea pigs and some bats rely on dietary supply of vitamin C for their vitamin C requirement since they lack the enzymes to synthesize vitamin C.

During ripening process in plants, there is the accumulation of vitamin C.

Food Sources of Vitamin C

Vitamin C is found mostly from food from plants. Except liver, no animal source supplies significant amount of vitamin C.

Si le of the best sources of vitamin C are citrus fruits and their juices. Tomatoes and cabbage also supply some significant amounts of vitamin C. During processing of foods containing vitamin C care must be taken to prevent loss of vitamin C through leaching and destruction by heat.

Functions of Vitamin C

a. In vitamin C deficiency, there is the failure of formation of collagen

b. Ascorbic acid has been implicated in the changes in tooth structure during the critical stage of tooth formation

c. Vitamin C is necessary for the normal oxidation of large amounts of tyrosine — an amino acid.

d. The presence of vitamin C in the intestinal tract facilitates the absorption of iron and calcium

e. The conversion of the inactive form of folic acid (a vitamin B group) to the active form is catalyzed by ascorbic acid.

Deficiency of Vitamin C

Deficiency of vitamin C leads to scurvy in children and young people more than in adults.

Deficiency of vitamin C may also9 result into weakness, irritability, loss of weight, pains in muscles or joints and gum bleeding.

In deficiency of vitamin. C. wounds do not heal easily. There is the reduced ability to resist generalized infection.

Requirements of Vitamin C

There is no hypervitaminosis of vitamin C as we have in vitamins A and D. the requirements of vitamin C vary from 35mg/day in infant to 45mg/day on adults. For pregnant and lactating mothers 60ing and 80mg are the daily dietary allowances recommended.

Student Assessment Exercise 7.2

Discuss vitamin C under chemical properties, food sources, Junctions, requirements and deficiency.

4.0 Conclusion

This unit treats vitamins and their functions. The unit also shows the classes of vitamins as water soluble and fat soluble vitamins some of the vitamins in the groups are treated under chemical nature, food sources, requirements, functions deficiency and toxicity.

5.0 Summary

The vitamins are classified as fat soluble and water soluble. The fat soluble vitamins are vitamins A, D, E and K. There are eleven water soluble vitamins — the vitamin C and the vitamins B group. The B-group vitamins are given as thiamin (BO, inositol, choline, Riboflavin (B1), pantothenic acid, Biotin, Pyridoxine (B_6), Niacin (B3), Folic acid and cobalmin (B_12).

There is no toxic *effect* of excessive consumption of most vitamins except those of vitamins A and D. These hypervitaminosis A and I) vitamins consumed in very minute amounts in the body. Vitamin 13. Thiamin is an anti-beriberi factor, vitamin C, an antisorbutic factor, Niacin -- Pellagra

preventive factor, vitamin E — anti-sterility factor and vitamin K an anti-hemorrhagic factor.

Some of the vitamin from the two groups are discussed under chemical nature, requirements, food sources, functions, deficiency and toxicity.

6.0 Tutor Marked Assessment

Discuss the following vitamins under functions and

deficiency a. Vitamin A b. Vitamin D

c. Vitamin E

Answers to Student Assessment Exercises

7.1 See Section 3.1 and 3.2 of this unit for answers
7.2 See Section 3.5.3 of this unit for the answers

7.0 References and Other Sources

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UNIT 8: DIGESTION AND ABSORPTION

TABLE OF CONTENT

1.0 Introduction

Units 3 to 7 discussed the various nutrients in the food. Most of these nutrients especially carbohydrates, proteins and fats are complex organic substances that cannot be utilized in the forms they are found in the foods. There is a need to break them down into simpler forms in which the body can absorb and utilize them. This process of breaking them down and absorbing them in for utilization in the cells of the body forms the subject matter of this unit — digestion and absorption.

2.0 Objectives

At the end of this unit, you should be able to:

- Identify the features of the gastrointestinal tract
- Discuss digestion of food in the mouth, stomach and small intestine
- Know the enzymes that are involved in the digestion processes
- Discuss the absorption of amino acids, simple sugars, fatty acids and glycerol.

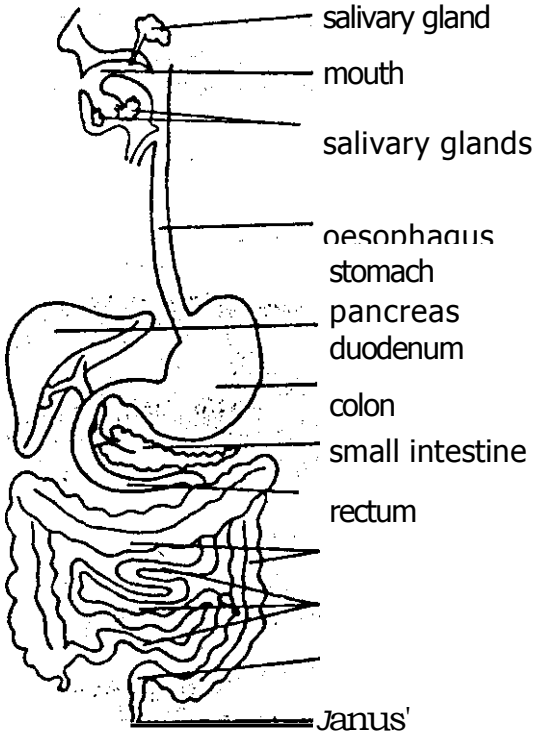
30 Main Content

3.1 The Gastro Intestinal Tract

The gastro-intestinal tract is a tube from the mouth, throat, to the stomach, small intestine and large intestine until it gets to the anus. The different parts of the tract varrin shape, length and internal diameter.

The gastro-intestinal tract is involved in the digestion of the complex food substances of carbohydrate, proteins and fats and oils. It is also involved in the absorption of the products of the digestion of these complex food substances.

Figure 8.1 Diagram of the Gastro-intestinal Tract and those Organs and Glands Concerned with Digestion



Source: Lake B. and Waterworth M, (1980) Foods and Nutrition 13th edition, Mills and Boon Ltd., Brooks Mews,London, Pg. 157

3.2 Digestion

This is the breaking down of complex molecules of carbohydrates, proteins and fat and oil by enzymes into smaller particles that can be absorbed or utilized by the body.

Enzymes are protein in nature and they act as catalysts. They cause chemical changes and remain chemically unchanged after the reaction. The enzymes may have minerals and vitamins ilc; co-enzymes before they can become active.

The digestive enzymes exist in inactive state and factors such as sight, smell of food, hormonal or chemical influence stimulate their secretion.

3.2.1 Digestion In the Mouth

Mastication or chewing of food breaks the large food molecules into small particles thereby creating greater surface area for the action of digestive enzymes. These small particles are then moistened by saliva secreted by the salivary glands.

In the saliva, there is a glycolitic enzyme called ptyalin which converts properly cooked starched into dextrin and maltose. The PH of the mouth varies from 6.4 to 7.3 whereas ptyalin is active between PH of 4 and 9. The food remains in the mouth for a short time to allow proper mastication or chewing of the food before the peristaltic movement of oesophagus allows the movement of the moistened food particles through the cardiac sphincter at the entrance of the stomach.

3.2.2 Digestion in the Stomach

Stomach serves more as a reserver than a digestive organ of food. The period of time the food stays in the stomach varies with the type of the nutrients in the food. Food consisting mainly of carbohydrate stays for a relatively shorter time period than food containing protein and fat. Food containing fat and oil stays longer in the stomach than food containing any other nutrients. This is why diet containing fat and oil has greater satiety value than food containing other nutrients.

The action of ptyalin that starts from the mouth continue in the stomach until the conditions of the stomach becomes highly acidic or basic. In the stomach, gastrin stimulates the secretion of gastric juice at the pyloric region of the stomach (the nearest part to the small intestine).

The gastric juice contains hydrochloric acid, mucin, water and two enzymes. The hydrochloric acid provides the favourable PH for the action of pepsin in the stomach. The PH of the stomach ranges from 1.5 to 4. There is the mechanical mixing of the gastric juice with the food by means of muscular contraction.

The pepsin in the gastric juice, a proteolytic enzyme breaks down protein into proteoses and peptones and from these compounds to polypeptides. Renin that is abundant in babies converts caseins to paracesein. Mucin in the gastric juice protects the wall in the stomach from self digestion in the sense that mucin adheres to the lining of the stomach thereby keeping pepsin away from stomach walls. This action prevents perforation of the tissues of the stomach.

3.2.3 Digestion in the Small Intestine

The highly acidic chyme (liquidified mass of food) from the stomach passes through the pyloric sphincter into the small intestine. As a result of the interaction of hormonal, chemical and the mechanical factors in the intestine, pancreatic juice, bites and intestinal juice are secreted. Pancreatic juice as given by Lake and Waterworth (1980) consists of :

a. Water and inorganic ions Na^{-1-}
   K^{t}, Ca^{2I}, Cl^{-}, $HCO3^{-}$, $HPO4^{-2}$
b. Enzymes, precursor — trypsinogen, chemotrypsinogen and procarboxy-peptilase.

Trypsin from trypsinogen breaks down protein into proteoses to peptones, to polypeptides. Chemotrypsin which is activated by trypsin breaks specific linkages in the polypeptide bond to amino acids. Carboxyl-polypeptilase spilts off amino acids from peptide end having free carboxyl group.

Lipase breaks emulsified fat to fatty acid and glycerol and amylase breaks starch to soluble starch to dextrin to maltose.

Bile salt from bile causes emulsification of fat and aids the absorption of fatty acids and fat soluble vitamins. In view of this, bile salts play an important role in the digestion of fat.

The intestinal juice contains seven enzymes in addition to secretin, an activator of trypsin of the pancreatic juice. The PH of the intestinal tract at this level is about 8.3. the seven enzymes consist of two proteolytic enzymes, an amylopolypeptilase and dipeptilase; lipolytic enzymes, lipase and four glycolitic enzymes amylase, sucrase, lactase and maltase.

Amylopolypeptilase, specifically splits off peptide next to a terminal amino acid with a free amino group. Dispeptilase breaks down polypeptide into amino acids.

Lipase breaks down emulsified fat to fatty acids and glycerol.

Amylase breaks sown starches to dextrin and from dextrin to maltose. Maltase breaks down maltose to two molecules of glucose. Sucrase breaks down sucrose to glucose and fruclose and lactase breaks down lactose to glucose and galatose.

From our discussion so far we have seen that the digestion of food results into the production of amino acids, glucose fructose, galatose, fatty acids and glycerol.

The digestibility of the food is also important for us to consider. Approximately 95c/cof food stuffs are digested and absorbed. While sugars are quickly absorbed, fat remains in the digestive tract for many hours. Animal foods have greater digestibility than the corresponding plant foods.

Table 8.1:Average Percentage of Digestibility of Food by Man When Consumed in Mixed Diet.

Foods	Protein	Fat	Carbohydrate
Animal Foods	97	95	98
Cereals and Breads	85	90	98
Dried Legumes	78	90	97
Vegetables	83	90	95
Fruits	85	90	90
Total Food of Average Diet	92	95	98

Source: Fleck H. (1976) Introduction To Nutrition Third Edition, Macmillan Pub. Co., Inc., New York

Generally, digestibility is greater in fat than protein and in carbohydrate than fat. That is, it is highest in carbohydrates.

3.2.4 Large Intestine

There is no digestion in the large intestine; except that water is absorbed from the waste products in the large intestine to concentrate the feaces. Even the absorption of nutrients does not also take place in the large intestine. The faecal materials contain the unabsorbed food residues containing indigestible

fibres mainly cellulose from fruits and vegetables. It should be noted that these fibres are important roughages for the gastro intestinal health.

Student Assessment Exercise 8.1

Discuss digestion of starch or carbohydrate in the mouth, stomach and small intestine.

3.3 Absorption

Most of the absorption of the products of digestion of carbohydrate, protein and fat and oil takes place in the small intestine by active transport and diffusion.

This occurs particularly in the duodenum and the upper part of jejunum. The absorption takes place in the lining of the small intestine which contains the villi. These villi are fingerlike projections. The epithelial cells of the villi have a brush boarder which increases the absorptive surface of the villi.

The mitochondria that is near the brush boarder area of the villi supply the energy for the transportation of the fructose, galactose, monoglcerides and amino acids are all capillaries of the villi and then into the porter vein.

The absorption of the short chain fatty acids takes place from the endoplasmic membrane and the long chain fatty acids are absorbed into the lymphatics. Many of the cations and anions are absorbed through the small intestinal mucosa. While vitamin A is required for calcium absorption, the presence of vitamin C and E enhance the absorption of iron.

3.4 Utilization

Let us discuss how the nutrients from the digestion of carbohydrates, proteins and fat and oil are utilized in the body.

Amino acids, glucose and fatty acids can all be used for the energy needs of the body and some of these products of digestion are also used for the synthesis of non-essential amino acids, enzymes and hormones. The amino acids absorbed are circulated in the blood for the use of cells for the synthesis of new tissues, for maintenance or repair of body protein and for manufacture of hormones and enzymes.

The liver in its role of controlling human plasma protein makes a lot of demand for amino acids. If after all these functions are still excess amino acids, the amino group containing the nitrogen is detached from the non-

nitrogenous fraction of the amino acids in a process known as "Deamination". The non-nitrogenous fraction, consisting of hydrogen, carbon and oxygen, produced may be used to serve as source of fuel after its conversion to glucose or may be stored as fat in the adipose tissue or may take part in the synthesis of non-essential amino acid. The amino group detached by the process of deamination from the amino acids may be used for the synthesis of non-essential amino acids in a process called "Transamination".

Glucose, galactose and fructose released. from digestion of starches are converted to glucose and later to glycogen when glucose content in the blood is in excess of the immediate needs. The glycogen is the temporary fuel reserve of the blood and this is depleted during exercises. If glucose is in excess of what can be stored as glycogen it will be converted to fat which is stored in the adipose tissue and the excess glucose can also be used for the synthesis of non-nitrogenous part of the non-essential amino acids.

Fatty acids and glycerol form fat digestion are metabolized in separate ways in the body. Glycerol is converted to glucose in the liver and then follows the same metabolism as that of the glucose. Fatty acids may be used by the cells form the circulating blood to form the structure of the cell. In the absence of this the metabolism of fatty acids which occur in the liver may cause its conversion into phospholipids in the presence of choline or methioline. Fatty acids in excess of all these functions are converted into adipose tissue.

Student Assessment Exercise 8.2

Discuss the utilization of the products of digestion of protein, carbohydrate and fat and oil after their absorption in the body.

4.0 Conclusion

In this unit we discuss the components of the gastrointestinal tract, the digestion, of carbohydrate, proteins and fat and oil form the mouth to the stomach and to the small intestine.

The unit also teaches the absorption and utilization of products of the digestion of the carbohydrate, protein and fat and oil in the body.

5.0 Summary

The unit shows the features of the gastro intestinal tract and explains digestion of carbohydrate, protein, fat and oil in the mouth, stomach and small intestine.

he unit shows the various enzymes that are involved in the digestion process. The digestion of starched commences from the mouth by the action of ptyalin in reducing the starches to dextrin and maltose. The digestion of protein and fats commences from the stomach.

The digestion process could be summarized as follows:

Site	Enzymes	Reaction
Mouth	Ptyalin (In saliva)	Starch —> Soluble Starch Dextrin —> Maltose
Stomach	Pepsin (In Gastric Juice) Rennin	Protein —> Proteoses Peptones —> Polypeptides Casein ntracesein
Small Intestine	Pancreatic Juice:	
	i. Trypsin	Proteoses —> Peptone —> Polypeptide
	Chymotrypsin	Catalyses break down of peptide —> amino acids.
	Carboxy — Polypeptilas	Splits off amino acid from peptide end having free carboxyl group
	iv. Lipase	Fat —> Fatty acids and glycerol
	v. Amylase	Starch —*Soluble Srarches—>Dextrin —Maltose
	Intestinal Juice	Polypeptides—> Amino Acids
	i. Peptilase	Starch — > Soluble Starched—*Maltose
	ii. Amylase	
	iii. Maltose	Maltose—*Glucose—> + Glucose
	iv. Sucrase	Sucrose —*Glucose + Fructose
	v. Lactase	Lactose —> Glucose + Galactose
		Fat —*Fatty Acids—> + Glycerol.

Absorption of the products of digestion takes place in the small intestine and there is the diffusion of the product in the blood stream while they are drawn by the various cells for the various functions of the nutrients for the digestion.

6.0 Tutor Marked Assignment

Discuss the digestion of protein sand fat in the body.

8.1 See the answers in Sections 3.2.1, 3.2.3 and 3.2.3
8.2 See the answers in sections 3.4 in this unit

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UNIT 9: CEREALS AND CEREAL PRODUCTS

TABLE OF CONTENT

1.0 Introduction

Units 3 to 7 treated the nutrients in foods. Unit 8 treated the digestion absorption and utilization of the products derivable from the complex organic substances of carbohydrate, fats and oil and proteins. This unit and some other subsequent units will treat the major classes of food commodities, their characteristics, functions and products that are made or manufactured from them. This unit therefore treats cereals and cereal products.

2.0 Objectives

At the end of this unit, you should be able to

List the various kinds of cereals
Describe the structure of wheat grain
Discuss the milling of wheat
Describe the composition of wheat flour
Describe the process of bread making
List sonic other products from wheat

3.0 Main Content

3.1 Types of Cereals

Cereals are members of the family Grammineae or cultivated grasses and they *are* one of the *chief* supplier of human food.

In many rural areas of the world cereal has been found to provide more than 70% of the energy in the diet of the people.

The major principal cereals are wheat, rice, maize, millet, oats and rye. We can make flours from all cereals and from the flours we can make cakes and porridge. However, only wheat and ryes are suitable for bread making.

Wheat is grown in most dry climate of the world; rice in most damp tropical climate, maize in southern state of the United States, Italy Yugoslavia, Egypt and many parts of Africa, millet in all climate and on poor soil with limited water supply. We use barley mainly for brewing and it can also be eaten by man and cattle. Grains of cereal of different types have similar chemical composition and nutritive value. They supply energy and some protein of good quality. The supply appreciable amount of calcium and iron, the presence of phytic acid and interferes with the absorption of theses minerals.

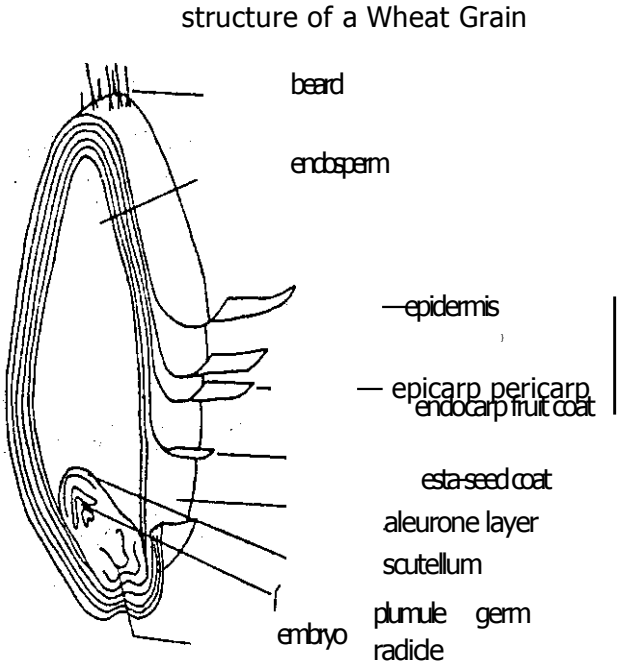
All cereals lack both ascorbic acids and vitamin A except yellow maize that contains some significant amount of the carotene the precursor of vitamin A. All cereal contains appreciable amount of water soluble vitamin B group. From this discussion, it can be realized that in order to prepare a balanced diet from cereals, the cereals must be enriched by animal proteins, minerals, vitamins A and E from meat, milk and fresh green vegetable.

To have a proper understanding of the nutritive value of cereals and the changes the cereals undergo during processing, we need to consider the structure of the cereal grain and the composition of the grain.

3.2 Wheat Flour

3.2.1 Structure of Wheat Grain

Fig. 9.2 Structure of a Wheat Grain



Source:Lake B. and Waterworth M. (1980) Foods and Nutrition, 13th Edition, Mills and Boons Ltd. Brooks Mews, London. Pg. 192

Fig. 9.2 shows the structure of a wheat grain. The outer coverings are pericarp and testa. These are hard and indigestible fibres.

Under the pericarp and testa we have the aleurone layer which contains cells that are rich in protein, these outer layers constitute about 12% of the weight of the grain. The endosperm about 85% of the weight of the grain is composed of both the inner and outer portions.

The germ or the embryo found at the lower end of the grain consists of three pits; the plumule. ridicule and scutellum. While the plumule is the undeveloped shoot, the ridicule is root centre and contains the root bulb, the scutellum or cotyledon grows up to the leaf and consists of several distinct tissues most especially the epithelial layer. The cotyledon secretes the

various enzymes that are required to bring the food stores in the endosperms into soluble and useful state for the developing embryo.

It should be noted that the endosperm stores the food in the wheat and it must make provisions for the developing embryo. In doing this the starch is broken down by diastase to maltose and maltase converts maltose to glucose. The soluble gluten (wheat protein) and other proteins are converted to peptones and amino acids by appropriate proteolytic enzymes.

The nutrients in the grains are distributed as follows:

a. Germ: relatively rich in protein, fat and several of the B vitamins, the cotyledon in the germ contains about fifty times more thiamin than the whole grain.

b. Endorsperm and Aleurone layer: the outer layer of endosperm and the aleurone layer contains higher concentration of protein vitamins and the phatic acids than the inner endosperm. The inner endosperm supplies most of the starch and the protein in the grain.

3.2.2 Milling of Wheat

The milling of wheat grains started with the use of two stones. One resting on the floor and the other one held in the hand. The one resting on the floor is artificial hallowed and the one in the hand shaped to fit it.

The wheat grains are put on the resting stone and the stone in the hand is used to grind the grain.

Advancement in technology has brought about the roller milling process which will be learned in this unit.

Roller Milling Process

This is the process by which the endosperm is separated from the pericarp, testa, aleurone layers and embryo to produce flour. This process consists of the following stages:
Cleaning, conditioning, breakrolling. reduction and bleaching.

a. Cleaning: the cleaning is done to remove sticks, stones, dirt and soils from the ‘theat and this is done by passing the grain through the rubble separator where fans blow off the foreign matters. The grain is then allowed to pass through a disc separator which allows the retention of the wheat grains and the passage of seeds of oats. barley, rye and other foreign seeds.

The wheat grain is then passed over a magnetic separator that removes pieces of iron such as nails which may cause fire outbreak in subsequent processing of wheat. The wheat grain is treated in the "scourer" to remove surface impurities and the fine hairs (bearded) at the pointed end of the grain. The wheat then reaches the washer and the whizzer in which is carried into the machine in a stream of water and removed rapidly at high speed. Here, the wheat grains float and the remaining impurities sink. The wheat is then taken out of the water. Under this condition the wheat is able to take up the correct amount of water for conditioning.

Conditioning: the wetting of the wheat conditions the wheat for break rolling. The conditioning makes the bran tough without affecting the bristle property of the endosperm. Some care should be taken in this process since hard wheat requires longer soaking time than medium and soft wheat. Before breakrolling is done, dry brushing to remove loose particles and slight steaming must be done. Conditioning also improves the baking property of flours.

c. Breakrolling: the milling of the wheat is done by passing the grain through a series of three or more break rolls consisting of a pair of steel rollers with finely fluted surfaces which rotate at different speeds. In the first break roll, the grain splits and the contents are set free. The complete separation of the starchy endosperm from the bran is done by passage through several break rolls; some of the endosperm is unavoidably converted to flour inch is removed by sieving through open wire sieve. This type of flour contains some dirt.

After each break, the endosperm becomes more and more separated from the bran and the starchy endosperm is made to move in opposite direction to a current of air in the purifier or separator. This current of air blows away fine Iluggy particles of hursk which are collected and removed.

d. Reduction: the starchy endosperm known as semulinas and midlings are ground to flour by passage through reduction and grinding rollers. This is then passed through fine sieve. Particles that could not pass through the sieve are then passed through the rollers to grind and the process continues as before.

Flour produced at many different points in the milling system is called "steams" and these streams are blended together to form "straight run" floor.

3.2.3 Composition of Wheat Flour

From our discussion, you learned that wheat is ground to flour before it is used to prepare food. The germ and some varying proportion of the outer layers of the grains are separated from the endosperm and they are regarded as "bran". The proportion of the whole grain that is used to make flour is regarded as the "Extraction Rate". 80% extraction rate flour contains 80% by weight of the whole grain and 20% is discarded as bran. From this discussion we can have low extraction rate and high extraction rate.

The flour with high extraction rate loses little of the aleurone layer and outer endosperm.

The low extraction flours are

a. Whiter than the high extraction flour
h. Bread made from them is more attractive
c. They contain less fat, less phatic acid and they have better baking properties.

However, low extraction flour has less of a group vitamins, less calcium and iron, less protein and less of other trace minerals.

In general, wheat flour consists of about 70% starch from amylase and amylopeptin. Wheat starch is hygroscopic and has high moisture absorbing quality.

Gluten is the characteristic wheat flour protein that gives it its baking properties. It consists of gliadin and glutenin. The presence of gluten in wheat makes wheat flour more suitable for bread making than all other flours.

Wheat flour contains some soluble protein such as albumins, globulins and proteoses.

The water content of lour varies form 11% to 14%, water level above 14% cause bacterial and mould growth and can also result in the development of acidity in flour.

Sucrose, maltose, glucose and fructose are present in the endosperm up to cir . This helps to feed the yeast during bread making.

The sugar of the Hour influencing the bloom of the crust of the bread since it undergoes caranelisation during baking.

The vitamin of the B group namely: Thiamin, nicotinic acid, riboflavin, pantothenic acid, pyridixin are distributed in varying proportion throughout the grains.

The mineral content of flour are mainly phosphates of calcium, magnesium and potassium with traces of iron and magnesium phosphate.

This soluble mineral salt act as yeast food and buffers during fermentation of the dough and they help to stabilize the gluten.

3.2.4 Bleaching and Improving of Flour

Bleaching of the pigment of the wheat endosperm, xantophyll occurs rapidly when flour is exposed to air. Storage also improves the baking qualities of flour.

There are some chemical improves and bleaching agents that are permitted by law. Some permitted improves are ascorbic acid, potassium, bromate and monocalcium phosphate.

Chlorine dioxide acts as a bleaching as well as an improving agent. Benzoyl peroxide is also a permitted bleaching agent.

Cannoned heat treatment has been found to improve the quality of flour. The imi *ro*\ ing of the flour is generally believed to be due to the oxidation of cysteine sulphydryn which is present in wheat gluten.

3.2.5 Fortification of Wheat Flour

Iron, thiamin, nicotinic acid are all used to fortify wheat flour.

0.24mg of thiamin, 1.65mg of iron per 100g of flour have been recommended for fortification of flour.

Students Assessment Exercise 9.1

Discuss the composition of wheat flour

3.3 Bread Making

We make bread from four essential ingredients: flour, water, yeast, salt, sugar, milk and fact though optional are added to improve the quality of bread. Strong flour with gluten content of 14-16g is desirable for bread making. Correct amount of water must he added to the Hour when preparing

the dough. The salt added is used to improve the flavour of the bread, strengthen the gluten and control fermentation. It should be noted that excess salt reduces the activities of the yeast (Denaturation of protein). The fermentation of the dough must be controlled as over-fermentation leads to excessive production of carbon dioxide that destroys the structure of the gluten and causes the collapse of the structure. Inadequate fermentation leads to low volume of bread and production of sticky bread. Baking also must be controlled. We should avoid the dangers of overbaking and underbaking. Overbaking leads to burning of the brown crust and underbaking prevents heating of the starch and formation of brown crust of the bread.

After baking, adequate cooling of the loaves should be done before wrapping to prevent condensation that can facilitate early mould growth.

3.4 Wheat Products

Other wheat products are semolina and pastas, breakfast cereals, macaroni, spaghetti and chapattis.

4.0 Conclusion

In this unit, you learned the various types of cereals. You also learned the structure and composition of wheat grains, the milling of wheat grain, the composition of wheat flour, bleaching and improving of flour, fortification of flour and bread making,. The unit mentioned some other products from wheat.

5.0 Summary

Cereals are defined as members of family of Graminnaea and they provide foods for greater number of people in rural populations of the world. The cereals are wheat, maize, barley, oats, millets, rye, rice. The wheat grain consists of pericarp, testa, aleurone layer, outer and inner endosperm and the germ. The endosperm is the food store of wheat grain. The wheat grain is rich in protein, fat and several of the B Vitamins but devoid of ascorbic acid and Vitamins A and E. The milling process of the wheat involves cleaning, conditioning, breakrolling, reduction and bleaching.

The wheat flour contains 70% starch from ainylose and amylopeptin, gluten the characteristic wheat flour protein that gives the wheat flour its baking quality, soluble protein, albumins, glohins and proteoscs.

Bleaching and improving of the flour can be done by exposure and storage of the flour. Chemical improvers and bleaching agents can also *he* used

Bread is produced from flour, water, yeast and salt though sugar, milk and fat may be added to improve its quality. For bread making, glutin content of 14-16% is desirable. • For good quality of the bread, the ingredients must. be added in correct proportions. Under fermentation and over fermentation should be avoided. Over baking and underbaking should be avoided and adequate cooling of the loaf after baking must be done before wrapping to prevent condensation that can lead to early growth of mould.

6.0 Tutor Marked Assignment

Discuss the roller milling process of wheat and the precautions taken during bread making to enhance the quality of bread.

Answer to Student Assessment Exercise 9.1

See answer in 3.2.1 of this unit

7.0 References and Other Sources

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Gultrie H. A. (1979) Introductory Nutrition. Forth edition,
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UNIT 10: RAISING AGENTS

TABLE OF CONTENT

1.0 Introduction

In some food processes especially in baking, raising agents are used. This is to improve the textural integrity and the consistency of the food. Such agents must be harmless and must not introduce undesirable taste, colour or odour to the food.

This unit therefore, treats the common raising agents used in food preparation and the production of some of these raising agents

2.0 Objectives

At the end of this unit, you should be able to:

- List the types of gases used as raising agents
- Describe both the chemical and the biological production of Carbondioxide
- Describe the production of yeast

3.0 Main Content

3.1 Types of Gases Used as Raising Agents

The types of gases used as raising agents are:

a. Air, introduced mechanically.
b. Water vapour, that is produced by heat on water
c. Carbondioxide that could be produced either chemically or biologically

The most important of these gases used as raising agents is carbondioxide and some of the chemical compound used in the generating of these gases are sodium bicarbonated, monocalcium phosphate, acid sodium, aluminium phosphate and guconodelta lactones. These are some of the permitted agents that are used in the food processing.

Air is mechanically introduced into the food by whisking, beating, sifting and folding. Foods that have foaming properties will be suitable for this method of aeration. This method is used in cake making

Water vapour is also used for the aeration of wet mixture of food that can be subjected to strong heating.

Carbondioxide is used as raising agent when it is deliberately introduced to mixtures especially for mixing bread rolls. This method is not commonly applied.

However, carbondioxide is produced within the mixture by either chemical action or biological actions.

3.2 Chemical Production of Carbondioxide

3.2.1 Reaction Between Acid and Carbonate

All carbonates react with acid to produce salt, water and carbondioxide. In foods some amount of sodium bicarbonate may be made to react with acidic ingredients such as sour milk, vinegar and fruit juice to produce carbondioxide. However, the amount of carbondioxide produced may not be much. To produce greater amount of carbondioxide the bi-carbonate may be reacted with acidic powder such as "cream of tartar" or in the alternative baking powder may be employed.

3.2.2 Baking Powder

There are three major ingredients in baking powder: sodium bi-carbonate, an acid compound and filler.

The filler, usually starch either corn or rice is used to separate carbonate and the acidic compound so as to prevent their premature reaction. The acidic compound, depending on the brand of the baking powder may be tartaric acid, acid potassium-salt of tartaric acid, acid calciumphosphate, acid sodium pyro-phosphate and compound which can hydrolyse to acids such as sodium aluminium phosphate and lactoses.

When water is added to the baking powder, the reaction between the acid component and the sodium bi-carbonate in the production of carbondioxide commences either in cold water or hot water depending on the type of acid components.

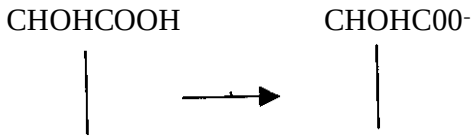
On the basis of these, we have tow types of baking powder, "quick action" baking powder and, "delayed action" baking powder. In quick action baking powder, the acid salts dissolves in cold water and the reaction with carbonate commences. In delayed action baking powder the dissolution of the acid in water and the commencement of carbondioxide are possible during the heating process.

However, there is greater demand for double action baking powder that allows carbondioxide to be produced in both cold and hot water. Baking powder made from tartaric acid and cream of tartar known as acid potassium salt of tartaric acid are "quick action" baking powder. Whereas, those manufactured fro acid calcium phosphate, sodium aluminium phosphate and lactoses are double action baking powders. It should be remembered that these acids and acids salts ionize and some hydrolysed to hydrogen ions, Fr.

This hydrogen ions combines with bi-carbonate ion (HC63) to form water and carbondioxide, H+ F110 + CO,

Carbondioxide

Tartaric acid in cold water ionizes to tartaric ion and two hydrogen ions (CHOHCOOH), $(CHOHC00)^2$ + 21·-r cream of tartar or acid potassium salt of tartaric acid ionizes to tartrate ion, one hydrogen ion and one potassium ion as follows



I molecule potassium hydrogen tirate | 1 tartrate ion | Ihydroge I potassium ion | ion

Acid Calcium Phosphate (ACP) also hydrolyses to gydrogen ions.

$2CaH_4(PO_4)_2 \rightarrow Ca_3(PO_4)_2 + 4HPO_4^{2-} + 8H$

3 molecules of ACP | 8 hydrogen ions

Acid sodium pyro-phosphate, (ASP) ionizes well at baking temperatures to hydrogen ions as follows:

$Na_2H_2P_2O_7 \rightarrow 2Na^{1-} + P_2O_7^{4-} + 2H^+$

It should be noted that cream of tartar is an expensive ingredient to use because of the production of only one hydrogen ion from the molecule of the compound. Acid calcium phosphate also serves as a flour improver and acid sodium py-o-phosphate is capable of impaction bitter flavours if it is used exclusively as the acid component in the baking powder.

The hydrogen ion produced from these entire reactions combine with bicarbonate ion to produce carbondioxide and water. .

3.2.3 Thermal Decomposition of Carbonate

When carbonates especially sodium bicarbonate and ammonium bicarbonate that are permitted in food processing are heated, there will be production of carbondioxide.

$2NaHCO_3 \xrightarrow{\text{heat}} Na_2CO_3 + H_2O + CO_2$

sodium bicarbonate | sodium carbonate

$NH_4HCO_3 \xrightarrow{\text{heat}} NH_3 \pm H_2O + CO_2$

This method is used in cake making and the use of ammonium bicarbonate is only limited to commercial production of biscuits. The sodium carbonate

residue when heated with sugar gives a strong yellow to brown colours to cake. This alkaline residue also decreases the amount of thiamin in baked foods. For this reason a ot of consideration is being given in favour of biological production of carbondioxide as a raising agent.

3.3 Biological Production of Carbondioxide

The flour contains starch subtrate on which yeast can act during fermentation that is anaerobic respiration. Even when supply of oxygen is during aerobic respiration, carbondioxide can be evolved from the reaction of starch subtrate and oxygen.

In anaerobic respiration that is fermentation glucose as a result of glcolysis is converted to pyruvic acid.

$$C_6H_{12}O_6 \xrightarrow{4\ 1\ 1} 2CH_3COCOOH$$

Pyruvic acid through the process of decarboxylation gives acetydehyde.

$$CH_3COCOOH \xrightarrow{CO,} CH_3CHO$$

Acetyldehyde on reduction gives

$$CH_3CHO \xrightarrow{+/El} C_2HSO_{1-1}$$

From all these reactions we can see that glucose is fermented to give ethanol and carbondioxide and this fermentation is done by yeast. For bread and beer making the yeast, saccharomyces, cerevisiae is used. For fermentation, we have

$$C_6H_{1-1}O_6 \xrightarrow{\text{Fermentation}} C_2H_SO_{11} + 2CO_2$$

In aerobic respiration, the glucose reacts with oxygen to produce carbondioxide, water and energy.

$$C_6H_{12}O_6 + 60, \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$$

The aerobic respiration results into greater energy yield than anaerobic respiration. In all these reactions monosaccharides have been used. In some reactions the yeast can make use of disaccharides such as maltose and of sucrose which are first converted respectively by maltose and sucrose to monosaccharides. It is the monosaccharide that is used for either fermentation or aerobic respiration.

Student Assessment Exercise 10.1

10.1.1 What are raising agents?
10.1.2 How is carbondioxide produced biologically'?

3.4 Consideration for the Yeast and Baking Powder

a Hints on using baking powder

- I. The baking powder must be measure accurately .
- ii. It must be mixed properly with the flour
- iii. Do not slam the oven door in the early stages of cooking
- iv. Insufficient and excess baking powder must be avoided to prevent heavy texture (insufficient) and the collapse of the structure (excess).

b Hints on the use of yeast.

i The yeast must be removed from the refrigerator and used at room temperature

it The liquid for mixing the dough must be at 36°C - 37°C.

iii. We should remember that salt retains the activity of yeast and temperature of over 52°C destroys yeast

iv. The flour bowl and liquid used for mixing should be warm.

v. The yeast dough should be well kneaded to make the dough elastic and to allow the even distribution of yeast

vi. Over-proving and under-proving should be avoided

3.5 Foods that Require the Use of Raising Agent

We use baking powder in sponge puddings, cakes and scones and in suct puddings and dumplings.

We use yeast for the following foods:

Bread dough: rolls, white, brown, whole meal loaves e.t.c

Buns dough: doughnuts, swiss, currant

Croissants, frying batter, Danish pastry.

4.0 Conclusion

The unit treats raising agents and how they are introduced to the food. The unit further extensively treats both chemical and biological productions of carbondioxide that is used as raising agent in bread making and cake.

The raising agent must be harmless and must not impact undesirable colour, taste and odour to the food.

5.0 Summary

The unit gives importance of the raising agent in the textural integrity of food. It also states that air, mechanically introduced, water vapour, produced by heat on water and carbondioxide produced chemically and biologically are gases used for aerating the food substance.

Carbondioxide is considered most commonly used and its production is extensively treated. Reaction of acids with carbonate produces carbondioxide. The use of baking powder in which sodium bicarbonate is made to react with hydrogen ions produced from tartaric acid, cream of tartar and calcium phosphate and acid sodium pyro-phosphate produces carbondioxide.

Carbondioxide is also produced from the thermal decomposition of sodium bicarbonate and aluminium bicarbonate. The biological production of carbondioxide comes from fermentation in which monosaccharides especially glucose is fermented by yeast especially saccharomyces cerevisiea to produce ethanol and carbondioxide.

Aerobic respiration also produces carbondioxide, water and energy.

6.0 Tutor Marked Assignment

Discuss the chemical production of carbondioxide for use as raising agent in food.

10.1.1 See answer in Section 3.1 of this unit
10.1.2 See answer in Section 3.3 of this unit

7.0 References and Other Sources

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UNIT 11: MILK AND MILK PRODUCTS

TABLE OF CONTENT

1.0 Introduction

This unit deals with milk and milk products. Milk has been defined as the sole natural food of the human infant for few months of life (Davidson et al 1975). It is produced by the female mammals. As a result of its importance to mankind and as a result of the quality of the nutrients in it, there is a need to have a discussion of it. This unit therefore treats milk and milk products.

2.0 Objective

At the end of this unit you would be able to:

- Describe the characteristics of fresh milk
- Describe the composition of milk
- Discuss spoilage of milk
- Discuss various armaments on milk
- Distinguish between various milk products

3.0 Main Content

3.0 Characteristics of Fresh Milk

Milk is produced by female mammals including human beings primarily for the feeding of their infants at the early stage of life. It is creamy white liquid containing protein, carbohydrate, fats mineral salts, vitamins and water.

Milk is defined as the most single perfect food. The most significant sources of milk are women, cows and goats. The milk from human being is only used to feed human infants. The milk from cow is also used by infants and adults. Though milk from goats is rich in nutrients, it however contains caproic acid which gives it an undesirable odour. In the milk, there are tint globules that are tinted by by carotene and a small amount of xantophyl. These pugments confers the creamy tint of milk on it. When the milk is allowed to stand for sometime the fat globules that are surrounded by protein wall rises to the surface of the milk to form a layer of cream. The other part of the milk remaining contains the soluble nutrients and it is called skimmed milk.

In milk, we have the "Skim" and the "cream". The cream can be removed by separator or by skimming.

If we allow the milk to stand for some days, Coagulum known as "Curd" is formed at the surface of the milk. The watery liquid under the curd is "whey". Lactic and converts it to lactic acid. This acidic condition of the milk causes the coagulation of the milk protein, case in and the Curd is formed.

Clotting of milk that is used in the preparation of Cheese is brought about by an enzyme called "Renin" contained in rennet. From this discussion, we see that curdling of milk is different from clothing of milk.

3.2 Composition of Milk

Milk consists mostly of water (87.5%) and it also consists solid such as protein, fat, sugar and minerals (about 12.5%). The compositions of human milk have been shown by various studies to be largely independent of the level of nutrition of the mothers. Even with prolonged lactation by Africa women, the composition of their milk appears to be well maintained in quality though the quantity may reduce. The composition of cow milk has been found to vary with the breed of the cow, the stage of lactation and the type of feed. However, the composition of the cow milk has been given by Lake and Waterworth (1980) as:

Water	87 %
Protein	3.4%
Fat	3.60%
Sugar	4.70%
Mineral	0.75%

The human milk contains more sugar and less protein than cow milk. The protein in human milk is about 1.5% while that of cow milk is about 3.5%.

Milk Protein

The milk proteins are mostly casein, lactabumin and lactoglubin. For production of Cheese the casein is used. The casein is used when there is action of rennet on it. There can also be the coagulation of lactabumin at a temperature of 70˚C. You should also remember that the protein in milk envelopes the fat globules so as to stabilize the emulsion.

Milk Fat

The milk fat contains both simple and mixed glycerides, branch chain fatty acids and some fatty acids with odd numbers of carbon from 11 - 19 as well as short chain fatty acids such as brutyric, caproic etc.

The most significant fatty acids is the oleic acid. Apart from this milk fat also contains lecitin and cholesterol.

Milk fat also contains carotenoid which has influence on the colour of the milk. The presence of tocopherol (antioxidant) in the milk influences the keeping quality of the milk by preventing oxidative rancidity.

Milk Sugar

The characteristic milk sugar is lactose which amounts to 40% and 6.2% respectively in cow and human milk. The action of lactic acid bacteria produces lactic acid which impacts the sour taste of butter milk and whey.

Mineral in Milk

These are sodium, Potassium, Calcium, Magnesium and Iron and they exit as Phosphate, Chlroides, Sulphates and Carbonates. The presence of calcium salt and phosphate has positive effect on the presence of Vitamin B in milk. The iron content of milk is low and iron content of cow milk is lower than human mi k.

Vitamins in Milk

Most of the commonly recognized vitamins are found in milk. However, milk contains more fiboflavin•than any other vitamins. Milk fat is a very good source of vitamin A and milk also contins vitamin B. Ascorbic acid in milk is easily oxidized and this is why ascorbic acid is absent in pasteurized milk.

3.3 Spoilage of Milk

Milk is a good source of nutrients for animals, man and even micro-organisms especially bacteria. In view of this, milk is highly susceptible to bacterial spoilage. Some microbial actions of milk are desirable especiall in fermentation for the production of yoghurt and in coagulation of milk for the production of cheese. Some undersirable microbial actions can cause spoilage of milk. Bacterial contaminations of milk are at various stages.

(i) From cow's udder
(ii) Cow's body
(iii) From the atmospheric air
(iv) From the milker

The milk of the udder of a very healthy cow may even not be completely sterile hence, milk of diseased animal should be avoided to prevent microbial contamination from the udder.

There can also be microbial contamination of micro-organisms from the body of the cow and from the atmospheric air . during milking of the cow, the milker and the utensils used should be clean to prevent microbial contamination. The micro-organisms found in milk are:

a. Lactic acid bacteria, streptococcus lactis
b. Baccilus coli

All these micro-organisms are used to ferment sugar.

a. Casein digesting bacteria
b. Bacteria that cause colour changes
c. Pathogenic bateria that can cause food poisoning.

In view of these, there must be sanitary conditions for the processing of milk and milk products.

3.4 Treatment of Milk

Milk during processing is subjected to various treatments:

a. Pasteurization
b. Sterilisation
c. Homogenization

Pasteurization: is done at temperature below 100°C to destroy the pathogenic and the spoilage organisms without affecting the quality attributes of the milk. Pasteurization is a heat treatment and the temperature must be below 100°C. There could be low temperature long time and high temperature short time methods of pasteurization being holder's method and flash pasteurization respectively. The temperature of the holder's method is between 63°C -65°C and the heat treatment is about 30 minutes. For flash method, the temperature is about 72°C for about 15 minutes. Heat resistant micro-organisms can survive pasteurization method hence, milk can be further subjected to sterilization.

Sterilization: Sterilization destroys the organisms more completely than pasteurization and sterilization is done in the autoclave at temperature higher than 100°C (121°C) for about 30-40 minutes.

Homogenization of Milk: For the production of a number of milk products, there is need for homogenization of milk. Homogenization casuses the breaking down of fat globules, makes the milk to be uniform and prevents the separation of the cream, the skim. Homogenization can be affected by forcing the milk through a tiny valve under pressure.

Pasteurization and sterilization have some adverse effect on milk. In pasteurization about 10% of thiamin and vitamin B 12 and 10-20% of ascorbic acid are destroyed.

Sterilization also causes the destruction fo about 50% ascorbic acid, 30% thiamin and almost all the riboflavin. Sterilization also causes the reduction of some biological values of milk protein.

Student Assessment Exercise 11.1

14/111, is milk highly susceptible to microbial contaminations?

3.5 Milk Products

Some of the milk products are cream, ice-cream, skimmed milk, butter milk, condensed milk, both sweetened and unsweetened, spray-dried milk, butter, cheese, yoghurt and fermented milk.

However, these products can be subdivided into:

a. Soured and fermented milk
b. Evaporated and condensed milk

3.5.1 Soured and Fermented Milk

In some countries, milk is drunk soured or curdled. The bacteria used for this are lactobacillus, acidophilus found in man Lactobacillus bifibus found in alimentary tract of infant and bulgaricus found in cow. These bacteria act on lactose in milk and cause the formation of lactic acid. Yoghurt, a soured milk contains all the protein, fat and vitamins of the original milk.

Curd: curds are prepared when fresh milk is inoculated with rennet to cause the clotting of the milk protein.

Whey: This is the liquid that is separated from the clot when curd is made, that is the liquid remaining after the curd has been removed and it contains most of the lactose in the original milk and a little of lactolbumin.

Cream: The cream contains all the fat, about one-third to half of the protein and lactose in the milk.

3.5.2 Evaporated and Condensed Milk

Evaporated milk is produced by the partial removal of water from milk or skimmed milk. We should note that skimmed milk is the whole milk minus the cream.

Condensed milk is produced by removing water from either the milk or the skimmed milk and by adding some sugar to the product.

Skimmed Milk: This is the whole milk minus the butter or the cream. We should note that milk contains the cream and the skim. Skimmed milk is the by-product of the butter industry. It is readily dried. It contains most of the protein and almost all the calcium in the original milk. It also contain the B group vitamins. It is a very good food.

Cheese: Cheese is produced by the action of rennet on the milk protein. The milk may or may not be soured first before rennet is introduced. The whole process involves the clotting of milk by relect at a temperature of about 30°C. The clot formed contains almost all the protein in the milk and many other nutrients. Since we have been told that protein in the milk envelopes the fat globules, the clot also contains fat. The clot is gently removed from the and slat is added to it. We should note that after the clot is formed, the watery liquid left is know as "whey". The clot is pressed to remove moisture and to form a firm cake. The cheese is then put in cheese bags and kept in a cool room so that it can undergo ripening. During ripening bacteria and mould fermentation occurs. The products of the fermentation are responsible for the characteristic texture and flavour of cheese.

Student Assessment Exercise 11.2

*Discuss the production of curd, *skimmed milk and cheese.*

4.0 Conclusion

In this unit, the characteristics of fresh milk, composition of milk treatment of milk, spoilage and milk products are discussed. Some subsequent units will still build on this unit by discussing some other classes of food.

5.0 Summary

Milk is defined as a creamy white liquid produced by the female mammals for the feeding of their infants at the early months of their lives. This milk can be obtained from female human being, cow and goat. The milk from female human being are mainly used for the feeding of their infants and the composition of human milk is relatively stable irrespective of the period of lactation and the level of nutrition.

The milk from cow varies in composition depending on the breed, the period of lactation and the feed.

Human milk has greater percentage of sugar than cow milk and less percentage of protein than cow milk.

Milk is considered to be a perfect food since it contains almost all the nutrients needed by the body. In view of this high nutritional quality of milk, milk encourages microbial growth. Some microbial actions leading to formation of curd and production of cheese are desirable. Some other microbial actions by the pathogenic organism brought about by

contamination through the udder of the cow, body of the cow, atmospheric pollution and the milker are undesirable.

Milk undergoes some treatments, either to destroy the micro-organisms and or to maintain the keeping quality. This treatments are pasteurization and sterilization to destroy micro-organisms. Homogenization is also done to improve the consistency and the textural integrity of milk.

Milk can be processed into fermented or soured milk or evaporated and condensed milk. some of the examples of fermented or soured milk are Yoghurt, curd and whey and some the evaporated milk or condensed milk are evaporated milk, skimmed milk and cheese.

6.0 Tutor Marked Assignment

Discuss causes of milk spoilage and pasteurization and sterilization of milk.

Answers to Students Assessment Exercise

11.1 Milk is highly susceptible to microbial contamination because of the various nutrients contained in milk as discussed in this unit.

11.2 See the answer in section 3.5 of this unit

7.0 Reference and other Sources

Davidson .S et al (1975) Human Nutrition and Dietetic 6th ed; Longman Group Ltd

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UNIT 12: MEAT, FISH AND THEIR PRODUCTS

TABLE OF CONTENT

1.0 Introduction

Meat is an important type of food that majority of people have natural appetite for. As soon as the income of the household increase, the demand for meat and meat products also increases. In poor economies of the world, consumption meat has implication for status. This unit therefore treats meat and meat products.

2.0 Objective

At the end of this unit, you should be able to

- Describe meat structure and composition
- Describe meat quality, digestibility and nutritive properties
- Describe changes in meat during cooking
- Discuss offal and sausages
- Discuss fish and sea foods

30 Main Content

3.1 Meat Structure and Composition

Meat consists of muscle fibres and fatty tissue from the adipose tissue. The meat therefore contains the lean meat and the fatty tissue. The fat content of

the meat varies with the animal, the species, the age, the feed and cut or joints even from the same animal.

There are also connective tissues that bind the muscle fibres together. Dispersed through the flesh are the nerves, blood vessels, capillaries, veins and arteries.

Chemical Composition of Meat

The lean muscle contains about 20% of protein, 5% Of fat and another .1% of minerals. The rest is water.

The most abundant proteins in meat are myosin and actin. There are also the water soluble proteins, albumins and globulins. The colour of meat is influenced by another protein called myoglobin which is either purple red or bright red in raw meat. You should recall that myoglobin is used to transport oxygen to the cells where it combines with oxygen to form oxy-myoglobin. Myoblogin therefore plays important role in aerobic respiration (oxidation of glucose in the cells to release energy necessary by the body).

Connective tissue proteins, collagen and elatin form the fibrous structure of the meat. Collagen fibres are tough, while inextensible fibres. The elatin fibres are elastic and branching. Collagen fibres are more distributed in meat than the elatin fibres Older animals have greater connective tissues than the younger ones of the same specie.

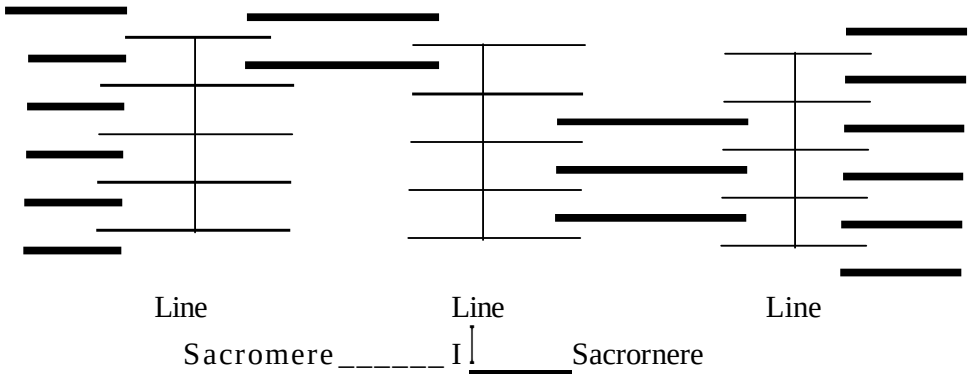
Some of the other constituents of the meat around the muscle are the non-protein water soluble materials such as lactic acid, creatin, and ions of minerals. Some of these substances are implicated as contributing to the flavour of the meat.

The adipose tissue of the meat contains mostly fats and these are mainly triglycerides with residues of stearic, oleic and palmitic acids. Some fat soluble vitamins, not in significant amounts, are also contained in the dispose tissue.

A muscle fibre is a long cylindrical structure consisting of myofibrils. A myofibril contains dark band of myosin filaments and light band of actin filament with a sort of overlap between the myosin and actin filaments. Between two bands of myosin filaments and in the light actin filament, we have the z line. The distance between two z lines forms sarcomere.

With contraction, the overlapping between the myosin and actin increases.

Figure 12.1: Muscle Fibre



Source: Lake B. and Waterworth M. (1980) Foods and Nutrition 13th edition, Mills and Boons Mews, London, pg. 275

Let us use this opportunity of the structure of muscle fibre to explain muscle contraction.

In the body, there is the metabolism of ADP, Adenosine DI — Phosphate to Adenosine tri-phosphate (ATP). This formation of ATP cause the relaxation of the muscle. With some nervous stimulation to muscle contraction, calciu, ions are released leading to activating of myosin to become enzyme called ATP — ase. This enzyme breaks down ATP to release energy needed for mechanical work of contraction. With the breakdown of ATP, there is greater overlap of the dark band of myosin and the light band of actin leading to muscle contraction.

The distance between z-z lines reduces. When there is the replenishment of ATP, the muscle relaxes by the breaking of the cross link between myosin and actin. This reaction just described is also importance in meat after slaughtering. It is important when we discuss the tenderization of meat.

When an animal is slaughtered, the circulation of blood ceases. The aerobic respiration also ceases. The temperature of the meat starts to fall. Since aerobic respiration ceases, ATP will not be replenished when it is broken down. The little glycogen in the likver is sued for anaerobic respiration for the production of lactic acid that in turns reduces the PH of meat to about 5.5.

As a result of the breakdown of ATP and without replacement of it, actin forms actinmyosin with myosin. Formation of actinmoyosin from myosin

and actin causes the stiffness of the muscle and this is called rigor mortis. If the meat is cooked at this stage, the meat will be very tough. For the tenderization of the meat, the meat should be allowed to pass the stage of rigor mortis. In view of this, carcasses are hung until rigor has passed and the muscles have become tender. Enzymes cathepsins are implicated the tenderization of meat.

The lactic acide produced during the anaerobic respiration also reduces the bacterial spoilage of the meat.

3.2 Meat Quality, Digestibility and Nutritive Properties

Man eats the flesh of more than one hundred species of animals with varying qualities as revealed by the prices of the meat. The reputation acquired by some meats at time sin not related to the nutritive value of the meats. For instance, the reputation acquired by cow legs or skin in Nigeria is not related to the quality of this joint.

You have learned in this unit that the meat consists of the lean meat and the fatty tissue or adipose tissue. You have also learned that generally, the lean muscle of most species contains about 20% protein, 5% fat, 1% minerals and the rest is water. It should be noted that there are great variations in the fat content of various joints of an animal. The fat content of meat varies with the animals, the specie, the age the feed given to the animal and the joint of the meat.

The presence of high content of fat in meat is know to cause the delay in emptying the stomach when some meats are consumed. Cuts of porks always contain large amount of fat, hence people refer to pork as indigestible. Proteins in lean meat are readily digestible and absorbed with only small amount discarded in faeces. However, the collagen in the fibrous connective tissue is not easily digested. The muscle of the older animals contains more fibrous tissue than those of the younger ones, hence the muscles of the older ones are tougher.

Meat is of particular value because it contains protein of high biological value. The meat proteins contain essential amino acids in proportions that can support growth and maintenance of body tissue. As you have learned, the protein in the meat is readily digestible and almost completely absorbed in the intestine.

Meat is an important source of energy if we consider the large amount of fat it contains. The flavouring extractives from meat have a lot of influence on the palatability of cooked meat and soup. Meat is a rich source of iron and

phosphorus. It has a little content of calcium. Meat is also an important source of nicotinic acid and riboflavin. Meat, especially pork contains some thiamin. Meat contains little vitamin a and ascorbic acid.

3.3 Changes in Meat During Cooking

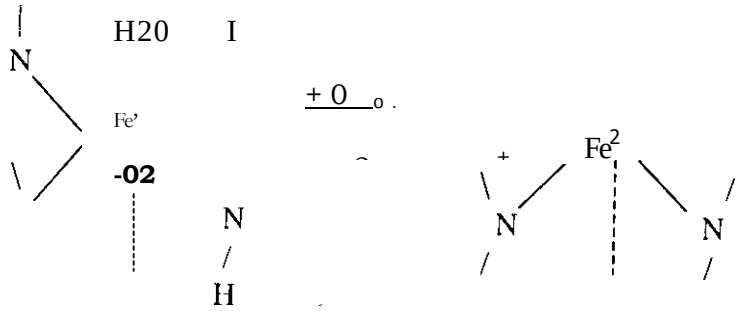
Meat must be cooked so that it can be palatable, properly chewed and digested. Some changes occur during cooking. These are changes in texture, colour and food value.

Textural Change: Cooking denatures the meat protein and causes shrinkage of the meat. The connective tissues are also softened by cooking . Collagen is converted to gelatin. The fat cells break and there is the release of fat, fat soluble substances and some water soluble substance into the stock. This is known as "cooking loss" in meat.

Colour Change: The purple red colour of meat is conferred on it by myoglobin when it forms oxymoglobin with oxygen, the colour becomes bright red. You should recall that myoglobin, like haemoglobin, is used to carry oxygen to the cells during aerobic respiration in living organisms. During cooking, the globin part of the

Myogblobin, that is the protein part undergoes denaturation and the ferrous state of iron is oxidized to ferric state. This leads to the formation of globin-haemochrome, this gives a brown colour to meat. In other words, oxymoglobin (bright red) is converted to globin — haemochrome (brown) during cooking.

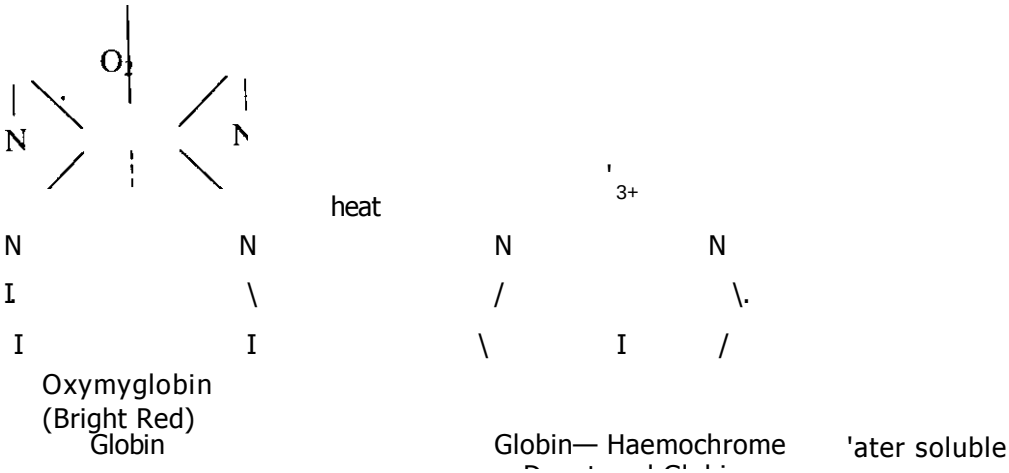
Oxidation of myodobin in stale meat in which ferrous state of iron is idized to ferric state produced met myoglobin (brownish red)



Myoglobin (Purple Red)

Globin Oxymyglobin (Bright Red)

Ion



constituents of meat and even some of the fat soluble components of meat are drained into the stock leading to cooking loss. Some thiamin is lost in the meat during cooking.

3.4 Offal

Some of the offals are liver, kidney, heart and tongue. These are foods of repute food on the menus of some restaurants. Other offals are given by Davidson et all (1975) as sweet breads (pancres and thymes), tripe (dressed stomach of horse or sheep), feet (pigs's and cow's) brains, chitterlings (pigs intestines), maws (pigs's stomach), lambs' fries and hudders. The offals have good nutritional value and contribute to the nutritional value of the diet. For instance, lvier contributes vitamin and absorbable iron to the diet. Brain contains large amount of opids especially phospholipids.

Student Assessment Exercise 12.1

Of what nutritive importance is meat in the diet?

3.5 Fish and Other Sea Foods

Fish provides an important source of animal protein lean fish contains about 10% protein and 1% fat and the common lean fish are cod, haddock, lemon sol brill, ling etc. The fish is easily digested and the fat fish contains 8-15% of fish oil.

Fat fish therefore have higher energy level than lean fish. Examples of fat fish herring, salmon and sardines. Fish protein is of high biological value. Though fish can be very delicious, they are generally less tasty than meat.

Fish contain less protein than meat. Fat oils in fish are good sources of fat soluble vitamins.

3.5.1 Shellfish

Examples are lobsters, crayfish, crabs. shrings and other crustaecea. They have little fat and energy value of 50kcal per 100g. They are very tasty and in some communities they have become expensive (prestige) food. Oysters contain more protein than most fish and about 5% of glycogen and little fat. This is an expensive luxury food.

Shell fish live on sea shores and they have been found to easily abhor bacteria particularly samoinela group.

3.5.2 Fish Meal and Fish Flour

These products are used as feeds for diary animals and poultry. In essence, they contribute to the supply of protein rich food. They are also consumed by man. They are prepared from small whole fish and they are noted for their excellent nutritional value.

Student Assessment Exercise 12.2

Discuss fish and sea foods in relation to their nutritional compositions.

4.0 Conclusion

This unit discusses the structure and composition of meat, the quality, digestibility and nutritive value of meat, changes in meat during cooking and fish and other sea foods.

Subsequent units will still build on this unit by discussion of other classes of food.

5.0 Summary

Meat is defined as containing muscle fibre and fat from the adipose tissue of flesh of animals. Most people of the world have natural apetite for meat. Meat has protein the lean part and the fatty part. The lean part consists about 20% protein, 5% fat, I% minerals and the rest water.

There are great variations in the fat content of different meat. The fat content varies in meat with the type of animal, the specie of animal, the age and the joint of the cut of the animal.

Meat protein is of high biological value since it contains most of the essential amino acids in the proportion that can support growth and maintenance of body tissue. Most of the fats are triglycerides. Meat is a good source of iron and phosphorus. It also has little content of calcium.

When meat is slaughtered, aerobic respiration ceases, hence production of ATP, Adenosine Trihosphate is limited to the small amount produced by anaerobic respiration involving glycogen. The lactic acid produced lowers the PH of the meat to about 5.5..

This reduces the bacterial spoilage of meat. As a result of the breaking down of the ATP without replenishment, actin and myosin fuse together to form a stiff structure actinomyosin. This condition is known as "rigourmortis". When the rigour is passed, enzyme cathepsin acts on the meat to cause the tenderization of the meat.

Cooking softens the meat, makes it more digestible and palatable and causes loss of nutrient into the stock. Cooking also changes the bright red colour of oxymyoglobin in meat to brown colour of globin-haemochrome.

The unit also discusses offal, fish, shell fish and fish meal and fish flour.

6.0 Tutor Marked Assignment

Discuss the various changes in meat after slaughtering and during cooking.

Answers to students' assessment exercises.

12.1 Answers are contained in section 3.2 of this unit

12.1 Answers are contained in section 3.5, 3.5.1 and 3.5.2 of this unit

7.0 References and other Sources

Davidson S et al (1975) Human Nutrition and Dietetics.
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UNIT 13: EGGS AND EGG PRODUCTS

TABLE OF CONTENT

1.0 Introduction

Eggs have been described as nature's convenient food since they come in hygienic pack, are easily stored and readily opened and cooked (Davidson et al 1975). Eggs have high nutritive value. They are used in many catering preparations. In view of these, there is a need to study eggs, its structure, composition, storage, uses spoilage and preservation.

This unit therefore treats egg under the headings stated.

2.0 Objectives

At the end of this unit, you should be able to

- Describe the structure of an *egg*
- Describe the composition of eggs
- List the uses of eggs in food preparation
- Discuss storage of eggs
- Describe quality tests for eggs
- Explain spoilage of eggs

- Discuss preservation of eggs

3.0 Main Content

3.1 Structure and Composition of Egg

Eggs come from different birds such as domestic fowl, ducks, goose, turkeys, wildbirds such as plover, gull and heron and also from fish such as herring. For the purpose of this unit, we will discuss only eggs from hens. This is because , hen is the chief supplier of eggs for human consumption. An egg is a living organism with an embryo and its store of food is contained in a protective shell. The oval shape of egg prevents the egg from rolling when it is laid and helps the packing of the eggs. The shape also increases the resistance of the shell against external pressure.

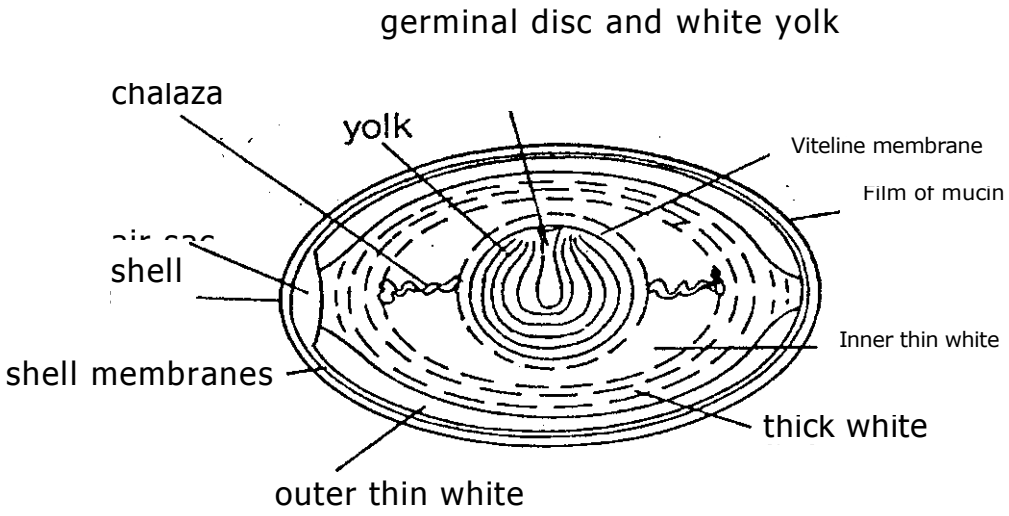
The shell is composed of calcium carbonate and some small quantities of calcium phosphate and organic materials. The porousity of the shell allows passage of air in and out of the egg through the pores. With this, the developing embryo is able to obtain oxygen for respiration and to discharge carbondioxide. The porousity of the egg shell also allows the entry of putrifying bacteria into the egg. Fortunately a freshly laid egg has mucous covering which covers the pores and prevents the entry of the bacteria. In view of this, it is advisable not to wash eggs when they are laid.

Below the shell is a thin membrane called karatene membrane which divides into two layers to form an air chamber at the broad end of the eggs. Inside the shell membrane, we hay ehte egg white and the egg yolk. The egg white consists of three layers; the thin white, the thick white and the thin white. The thick white si more viscous than the thin white. The egg yolk, a golden yellow fluid mass is enclosed in a thin elastic membrane. It is spherical in shape. The egg yolk contains the living embryo which can be seen in a fertile egg as a small circular speck underneath the yolk membrane called viteline membrane (Lake and Waterworth 1980). Two thick fibrous bands, the chalazae or balancers join the viteline membrane of the egg yolk with the thick white. When an egg becomes old, the thick white losses its carbon dioxide and becomes thinner, thereby unable to hold the egg yolk in position. The egg yolk therefore flows upward and rest against the keratine membrane. As a result of osmosis, water moves from the thick white to the egg yolk thereby increasing the volume of the yolk. The increase in the volume of the yolk, causes the viteline membrane to stretch to the extent that it tends to break. The implications of this are :

a. Old eggs are impossible to break without breaking the yolk

b. This accounts for the spread of an old egg during frying and poaching.

Figure 13.1 Structure of an Egg of Hen



Source: Lake B and Waterworth M (1980) Foods and Nutrition 13th ed. Mills and Boon Ltd, Brook•s Mews London Pg. 290

The average weight of egg is about 50g. This consists of shell and membrane 10%, egg white about 60%, yolk about 30%. The ratio of the egg white to egg yolk is about 2-1.

Table 13.1 Shows the composition of the egg of a hen.

	Water	Protein	Fat	Ash	Undetermined	Kg (per 100gm)
Whole egg (without Shell)	73.7	12.3	11.26	1.1	1.64	662
White	87.2	10.7	0.10	0.6	1.4	155
Yolk	47.1	15.5	33.3	2.0	2.1	1470

Source: Lake B and Waterworth M. (1980) Foods and Nutrition 1 3`11 ed. Mills and Boon Ltd., Brook's Mews London, pg. 291

From the table, we can see that the egg yolk is superior in food value to egg white.

The egg white contains essentially proteins with about 70% of its protein as "Ovalbumin". The egg yolk is richer than the egg white since it contains less water more protein and a greater proportion of fat. In addition to the ovalbumin contents, eau yolk contains phosphorus containing protein (vitellin), phospholipids, (lecithin and cholesterol. The lecithin si an emulsifying agens and it is very useful in the manufacture of mayonnaise. Lecthin is also used in baking to soften the crumbs. Olein, stearin and small amount of palmitin constitue the fat in egg yolk. There are also valuable calcium and iron compounds. Egg yolk is rich in thiamin, riboflavin, vitamins A and D but deficient in nicotinic acid and vitamin C. Despite all these quality attributes of egg-yolk, it is still not as expensive as egg-white

because egg-white has foaming property which is deficient in egg-yolk.

3.2 Cooking and Uses of Egg in Food Production

Eggs are consumed raw, in lightly boiled form and in the hard boiled form. Raw eggs are digested in the stomach and in the small intestine. Freshly laid eggs are more digested than the older ones. Of the three forms of consuming egg, lightly boiled egg is most digest and the hard boiled on is the least digested. This also applies to fried, scrabled and poached egg.

Heat treatment during cooking causes the denaturation fo egg like in any

other protein.

Egg yolk is a valuable ingredient in baked good since it impacts rich colour on the baked goods. It is also used to flavour and enrich baked goods. This is apart from the emulsifying effect it has on these goods: Egg are used as raising agent in baking to theextent that a flour low in sluten may be used. Eggs are used in Omellet, custard and other puddings. The egg-white is also used in meringues, macarcons royal icing and certain types of biscuits. Because of the lecithin content of egg, it is used in the production of

mayonnaise.

3.3 Tests of Quality of Eggs

You have learned that egg is very nutritive and in view of this, it can support growth of micro-organism. You have laso learned that the shell of the egg is porous and allows the entry of bacteria into the egg. This can lead to putrefaction of eggs resulting into pungent smell. Egg can have another problem apart from putrefaction. This is the problem of partial development of embryo resulting from irregular collection of egg and accidental incubation of eggs. These two problems mentioned make this type of egg unwholesome for consumption. Mere visual examination of the egg may not

reveal this problem, since the egg is enclosed in a protective shell. Two test used for measuring the quality of eggs are the brine test and the candling test.

3.3.1 Brine Test

To conduct brine test, we prepare 10% solution of brine by adding 100g of sodium chloride per a litre of the solution. We take the egg one by one and put them into the solution. A freshly laikd *egg* sinks into the solutions and lie flat at the bottom of the container containing the solution. In older eggs, there is less of water and there is shrinkage in the egg, which leads to the enlargement of the air chamber. This makes the egg lighter. As a result of this two-day egg floats near the bottom of the solution with its broad end upward. A three-day old *egg* will float half the way up of the solution while a five-day old *egg* will flow at the surface of the solution. From this it can be seen that the older the *egg,* the nearer to the surface of the solution it floats.

It should be noted that the solution should be put in a long measuring cylindrical jar that will allow *egg* to be dropped into the solution.

3.3.2 Candling Test

Candling test involves the observation of egg when it is exposed to a source of light. The apparatus may consist of lamp surrounded a metal shade, bored with a whole in a sheet of hard card board, placing the egg against the hole and holding the card board to some source of light. Any source of light that will cause the transparency of the egg for the necessary observation may be adequate for this test. With this test, the egg-white of a freshly laid egg appears dense and homogenous, the air chamber is small and the yolk is seen slightly at the middle of the egg. In the older egg, the airspace is enlarged egg-white appears cloudy and the yolk displayed to the top of the *egg.* A rotten egg becomes opaque when observed with the candling test.

Students' Assessment Exercise 13.1

Describe the two tests f measuring the quality of eggs.

3.4 Spoilage of Eggs

As a result of the porosity of the shell of the *egg* and without the mucous covering of the shell, there can be entry of bacteria into the shell through its pores. This bacteria can act on protein to cause putrefaction which leads to spoilage of *egg* and causes rotten *egg* smell. The spots on egg are due to bacteria, blood and mould growth. When the embryo of the egg is dead and

decomposing, we have spot rot. Bacteria cause decomposition in egg too and this is known as white rot. We also have mixed rot and blackrot due to decomposition in eggs. Fishy and musty flavour in eggs are caused by micro-organisms.

3.5 Treatment of Egg

Before treatment is given to egg and even after the treatment, egg is stored. In storing egg, the egg should be placed in trays with the blunt end containing the space kept uppermost so that the air space does not bear the weight of the egg. With this type of arrangement, the yolk is kept in its proper position. The egg-white containing the egg-yolk has bacteriacid action and this causes the disappearance of putrefactory bacteria during incubation. Egg stored properly at the temperature of 10°C and they should be kept away from other strong smelling food and household goods, so that the eggs do not tend to absorb the odour of these other food and goods.

We always subject eggs to some treatments so as to preserve them. These treatments are freezing, drying and pickling.

3.5.1 Freezing: Since whole eggs and cooked eggs do not freeze successfully, separated eggs are always frozen. Before freezing, egg may be pasteurized at a temperature of 63°C for about a minute.

Indeed, frozen eggs can be stored in some considerable length of time and can be transported in some refrigerated devices.

3.5.2 Dried Egg: Another way of preserving egg is by drying it. Fresh egg are mixed properly to form a homogenous liquid, pasteurized and sprayed-dried. The moisture content of the dried egg limits the growth of undesirable micro-organisms.

The temperature of the drying chamber must be controlled since too high temperature during drying has adverse effect on the flavour of the egg. The water content of the dried egg should not be more than 5%.

3.53 Picking: This is another method of preserving egg by placing in a solution of sodium silicate or lime water. This process hermetically seals the pores of the shell of the eggs, thereby preventing the entry of bacteria into the eggs. A pickled egg can have a shelf life of 9 -12 months. Since the pore of the shell of the egg is sealed, some cracking of the shell may occur when a pickled egg is boiled.

Students' Assessment Exercise 13.2

Discuss the methods me preserving eggs

4.0 Conclusion

This unit treats egg, the structure and the composition, the effect of cooking of eggs, uses of eggs in food preparation. Test for quality of eggs, spoilage and preservation of eggs.

The next unit will treat food and vegetable to conclude discussion of classes of food.

5.0 Summary

Egg has been described as the nature's convenient food packed in a hygienic form, stored and readily opened and cooked.

It has high nutritive value and high biological value. Indeed, the amino acid composition of eggs from hen is sometimes used as a standard to which we compare the chemical score of other protein.

The eggs are enclosed in a protective shell made up of calcium carbonate and some quantity of calcium phosphate. The porosity of the shell allows passage in and out of oxygen and carbondioxide and of bacteria.

The eggs consist of egg-white, yolk and germ or embryo. Though the egg yolk has been found to have higher biological value than egg-white, the egg-white is still more high priced than the egg yolk because of its foamy properties.

Eggs are rich sources of all vitamins except nicotinic acid and ascorbic acid. Eggs are also rich in protein of high quality. Eggs also contain phospholipids, lecithin which is a good emulsifying agent.

Eggs are used to impact colour and flavour in baked goods. It is also used as raising agent in confectionary and it is used as enriching agent in cake mixture and sponge.

Slightly boiled egg has been found to be more digestible than the raw egg. Hard cooked egg, fried egg and poached egg are also less digestible than raw egg.

The quality of egg to reveal deterioration, the amount of air spaces and age could be assessed by the usc of brine test and candling.

Spoilage of egg is been due to microbial action of moulds and bacteria and contamination from blood.

Storage of eggs should be done in such a way that the end containing the airspace is allowed to be uppermost when the egg is placed in a suitable tray at a temperature of about 10°C.

Preservation of eggs is achieved by freezing separated eggs, spray drying the eggs in such a way the moisture content does not exceed 5% and by pickling the egg in a solution of sodium silicate or lime water to hermetically seal the pore of the shell so as to prevent bacteria entry into the egg.

6.0 Tutor Marked Assignment

Discuss the composition of eggs and the various uses of egg in food preparation.

Answers to Students' Assessment Exercises

13.1 See answers in section 3.5 of this unit
13.2 See answers in section 3.5 of this unit.

7.0 Reference and Other Sources

Davidson S. et al (1975) Human Nutrition and dietetic.
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Lake B and Waterworth M. (1980) Foods and Nutrition
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UNIT 14: FRUITS AND VEGETABLES

TABLE OF CONTENT

1.0 Introduction

Fruits and vegetables are from plant sources. They are noted for their supply of vitamin C (Ascorbic acid). They are also noted for their roughages which are of nutritional importance in the gastro-intestinal health.

This unit discusses fruits and vegetables under types, nutritive properties and changes in chemical composition.

2.0 Objective

At the end of this unit, you should be able to:

- List the classes of fruits with examples
- Discuss the nutritive properties of fruits
- Discuss some changes in fruits during ripening and after harvesting.
- List the classes of vegetable with example
- Discuss the nutritive properties of vegetables

Discuss some of the chemical changes and changes in composition after harvesting and during cooking.

3.0 Main Content

3.1 Fruits

Fruits are developed ovaries consisting of pericarp that encloses one or more seeds. The fruits is attached to the plant by fruit stalk that develops from the flower stalk.

3.1.1 Types of Fruits

Fruits can he classified as:

a. True and false composite fruits
b. Simple aggregate and composite fruits
c. Fleshy and dry fruits
d. Dehiscent and indehiscent

a. A true fruit: A true fruit develops from a fertilized ovary and it consists of pericarp and seeds. Mango is an example of a true fruit. A false fruit develops from ovary and other flora parts. Apart from the pericarp and seed(s) it has some additional structure. Apple, figs, pineapple and breadfruits are examples of false fruits.

b. Simple, Aggregate and Composite Fruit: A simple fruit develops from flower with a simple ovary examples are cow pea, maize, okro, tomatoes and pawpaw. An aggregate fruit develops from a single flower with several ovaries. Each ovary produces a fruitlet, therefore an aggregate fruit is a cluster of fruitlets e.g kola, strawberry and clustered apple are examples of false aggregate fruit. A composite or multiple fruit is a fruit that develops from flowers that are positioned very close to one another. The composite fruit results from the fusion of all the fruitless and the flora part and form a single large false fruit. Examples of these are fig, pineapple and breadfruit.

c. Fleshy and Dry Fruit: In fleshy fruits, either the whole pericarp or one of the layers of percarp, when it is ripe is thick, soft and fleshy. That is, it is succulent. In this group, we have the following classes, drupe, berry, pome, esperidium, sorosis, syconium. Examples of drupe are mang, oilpalm fruit. Example of berry is tomatoes. Examples of espiridium are orange and leamon, examples of pome are apples and pear. An example of syconium is fig.

d. Dry Fruit: In this type of fruit the pericarp becomes dry, hard and woody when the fruits are dry and the dry one may be dehiscent or indehiscent. The dehiscent one splits when they are ripe, example of this

dehiscent dry fruits are legumes okro. The dry indehiscent fruits cannot split when they are ripe.

3.1.2 Chemical Changes in Fruits

Fruit consists mainly of sugars, starches and organic acides. It also has cellulose and peptic substance. Thepectic substances are responsible for the firm structure of the fruit.

During ripening, the peptic substances are decomposed by pecticansses thereby softening the tissue of the fruits. During ripening, there is the hydrolysis of starch to sugar mainly glucose and some fructose.

The tartaric, inarlic, citric and succinct acid that impact the sour taste of unripe fruits are wither converted to other substances, including sugar or they may have their taste completely masked by the excess of sugar. Some esters and essential oils are distributed in the pulp of many fruits and these esters and essential oil confer some particular flavour on the fruits.

Ethyleme is implicated in the ripening of fruits and its presence speeds up the ripening of apple, pear, oranges and bananas.

When fruits are overripe, some of the sugar and the acid are oxidized, the essential oils and esters are also destroyed. This leads to loss of flavour and aroma.

When a fruit is bruised or injured, there could be spoilage as well as enzymatic actions in the bruised or injured surfaces. One of the enzymatic actions is the enzymic browning. In which phenolic compound especially catechol are converted to quinines which polymerise to dark brown pigment. To prevent brownin, we can exclude air from injured or bruised surface and we can introduce reducing agents such as acorbic acid and sulphurdioxide. Heating can also be sued to destroy the enzymes. Any form of alteration of the pH in such a way that the pH is lowered will reduce the effectiveness of the enzyme involved in enzymic browning.

3.1.3 Nutritional Importance of Fruits

Ascorbic acid is the only essential nutrient in fruits. However, there could be supply of some thiamin in fruits.

Fruits contain peptic substances from which we can extract pectin that is used for production of jam, jelly and marmalades. Fruits are a good source or roughaLves that are of importance in the gastro-intestinal health.

Most fruits contain small quantities of carotene and the B group vitamin. You should note that carotene is the precursor of vitamin A. Fruits contain little or no protein or fat. Most of fruits contain 5.20% of carbohydrate and ripe fruits contain glucose and fructose.

Acids such as citric acid (citrus fruits, pineapple, tomatoes) malic acid (apples, plums and tomatoes) benzoic acid (cran berry) tartaric acid (grapes) oxalic acid (unripe tomatoes and spinach) are responsible for the sour taste of unripe fruits.

Students' Assessment Exercises

List the classes of fruit and example of each of the
Discuss the chemical changes that occur in fruits before and after harvesting.

3.2 Vegetables

3.2.1 Types of Vegetable

We have:

a. Green leaves for example lettuce, water crest, cabbage, spinach, broccoli, mustard and crest etc.
b. Leaves stalks — examples celery, rhubarb
c. Stems — example asparagus
d. Roots — examples carrot and beef root
e. Tuber — example potato
f. Bulb — examples are onions and garlic

3.2.2 Nutritive Properties of Vegetable

Vegetable supply has very small amount of energy and insignificant amount protein and essential amino acids. However, vegetables help to promote satiety and are of significant value in providing roughages for the gastro-intestinal health.

Many green leafy vegetables are rich in calcium and iron. Much of the iron in the vegetable is not absorbed. However, presence of ascorbic acid may enhance greater absorption of iron. Almost all the vegetables contain B-group vitamin. Riboflavin is found in most leafy vegetable. The consumption of green leaves as a source of riboflavin has been found to reduce the incidence' angular stomatitic in tropics. Many vegetables supply B-carotene (the precursor of vitamin A). Ascorbic acid and folic acid. Folic

acid is very important to pregnant women. Some of these vitamins especially ascorbic acid are lost during cooking

3.2.3 Chemical changes in Vegetables During Cooking

During cooking of vegetables, there is the softening of tissues and there are a lot of other changes during cooking. One of the changes is that of colour change.

The green characteristics colour of green leafy vegetable is derived from chlorophyll in the leaf. When green vegetables are blanched or cooked, there is the breakdown of chlorophyll leading to loss of magnesium ions in the chlorophyl. The vegetable therefore turns yellowish green or brown. Acidic condition accelerates this change in colour.

Blanching in alkaline condition allow the retention of green colour. However, the alkalinity destroys some amount of ascorbic acid and affects the textural integrity of the vegetables. During blanching, the leaves become brighter, some enzymes are destroyed and there can be loss of ascorbic acid. In water blanch, there is leaching of some mineral and vitamin into the blanching water.

Students' Assessment Exercise 14.2

State the classes of vegetables and the changes that occur in vegetables during cooking.

4.0 Conclusion

In this unit, fruits and vegetables are discussed under the following headings:

a. Classes
b. Nutritive Properties
c. Chemical Changes During Processing

Exercises are provided to test the understanding of the students of the content of the unit.

5.0 Summary

Vegetables and fruits are from plant origin. They are rich sources of ascorbic acid. They are also sources or roughages that are of significant importance to gastro-intestinal health.

Fruit is a developed ovary consisting of pericarp seed(s). We have tru and false fruit, simple, aggregate and composite fruits, flesh and dry fruits and dehiscent and indehiscent fruits.

Fruits consist of little or no protein and fat. It is a good source of ascorbic acid. It also has pectic substances from which pectin can be extracted for making jam, jerry and marmalades.

Ripe fruits consists of sugar, mostly glucose and some amount of fructose that confers the sweetness on the fruit. The cellulose in the fruits are good sources or roughages needed during digestion. During ripening of fruits, pectinnaise acts on pectic substances to cause the softening of tissues, starch is also hydrolised to glucose and fructose.

You have also learned the bruised or injured fruits can undergo enzymic browning from the conversion of phenolic compounds such as catechnol to quInond. which polymerize to form dark brown pigment. Exclusion of air from the bruised surface and introduction of reducing agents such as ascorbic acid and sulphurdioxide can prevent enzymic browning.

Vegetables, leaf stalks, stems, roots, tubers and bulbs like fruits vegetables are good sources of vitamin C they are also low in protein and fat content. They are rich in carotene the precursor of Vitamin A and most of the B-group vitamins. Vegetables especially leafy vegetables are good sources of calcium and iron, though most of the iron is not absorbed, however, the presence of ascorbic acid enhances greater absorption of iron.

During cooking of vegetables, chlorophl is broken down and the magnetism in it is lost, thereby resulting to yellowish green or brown colour of vegetables when blanched or cooked. During cooking, there is loss of some water soluble vitamin that are leached into the blancing water. You also learned that the acidity of the blanching medium or cooking medium accelerates the change in colour of vegetables from green to yellowish green or brown. Alkalinity of the blanching medium or cooking medium has been found to enhance the retention of the green characteristics colour. However, alkalinity has adverse effect on the ascorbic acid content and textural integrity of vegetables during cooking or blanching.

6.0 Tutor Marked Assignment

Discuss the nutritive properties of both fruits and vegetablesA

Answers to Students' Assessment Exercise

14.1 See answers in sections 3.1.1 and 3.1.3 of this unit.

14.2 See answers in sections 3.2.1 and 3.2.3 of this unit

7.0 References and Other Sources

Davidsons S. et al (1975) Human Nutrition and Dieteticse ed. Longman Group Ltd

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Sarojin T.R, (1993) Modern Biology for Senior Secondary Schools 4th ed., Africana — Fep Publishers Ltd Onitsha Nig.

UNIT 15: DIETARY STANDARDS AND TABLES OF FOOD COMPOSITION

TABLE OF CONTENT

1.0 Introduction

Some previous units discussed the roles of essential nutrients: carbohydrates, protein, fats and oil, minerals and vitamins. Some other previous units discuss the classes of food such as cereals, fruits and vegetables, meat and meant products, eggs and egg products, milk and milk products. Diets are made from these foods. The diet must be adequate in the supply of nutrients required by individual for energy and for other metabolic processes.

In view of this, there is need to have recommended dietary allowances for individual with consideration of age, sex, and body weight and size and types of occupation etc. There is also a need to know the nutrients composition of various foods so as to be able to make recommendations for dietary standards when the foods are consumed.

This unit therefore treats recommended dietary allowance and tables of food compositions.

2.0 Objectives

At the end of this unit, you should be able to:

Discuss the need for dietary standards

- List the criteria for the establishment of dietary standards
- Interpret value of some recommended daily dietary allowance
- List the uses of dietary standards
- List the limitations of dietary standards
- Discuss the derivation of tables of food composition
- List the uses of tables of food composition
- List the limitation of tables of food composition

3.0 Main Content

3.1 Dietary Standards

The average food intake of individual family or groups of people over a period of time is called "diet". The diet can be balanced or it may not be balanced. A balance diet is quantitatively or qualitatively adequate in terms of the supply of nutrients for energy needs, growth, maintenance of body tissue and for the body metabolic functions. Therefore, a balanced diet contains the nutrients required in the correct proportions for the body to perform its functions.

The daily nutrients and energy requirement s of individuals vary with age, sex, body weight and size and occupation. Illnesses and defectiveness of the body to digest nutrients can also affect the daily requirement of nutrient of an individual. Depending on the quantity and quality of the diet of an individual, there can be over-nutrition and under-nutrition. These two situations are not good for the individuals. To solve the problems created by these two situations, there is a need for the recommended dietary allowances (RDA).

3.1.1 Needs for Dietary Standards

The recommended dietary allowance (RDA) is necessary because:

a. They provide a useful guide for nutritionists, dietitians and agricultural experts to plan and evaluate the diets of population groups.

b. To decide on food production, agricultural policies and programmes

c. To solve the problems of over-nutrition and under-nutrition resulting from ignorance in intakes of nutrients.

3.1.2 Establishment of Dietary Standards

In view of the needs identified in Section 3.1.1 of this unit, some countries notably United States of America, Britain and Canada have made recommendations for the recommended daily allowances (RDA). Agriculture Organization (FAO) and World Health Organization (WHO) along with others have developed recommended dietary allowances tables.

The tables show the daily nutrients requirement of different classes of people in a given population. These allowances are different from one country to another because of the differences in the population of the people that live in different climatic and environmental conditions and with different dietary practices. Also the different maker of the standards did not have the same

interpretations to scientific data

In United States of America, the allowances are numerical quantities of certain nutrients that were made in such a way that they will meet the nutritional needs of practically all healthy persons in the country.

Consideration was made for differences in nutritional requirement for different ages and sizes. The allowances are more than those required by average persons but were set sufficiently high to cover the needs that will maintain good nutrition in practically all healthy persons in United States Allowances were also made for losses in nutrients during cooking. There is allowance also to cover wide range of requirements for the population and to provide a buffer for conditions of stress. In establishing the standards

considerations were given to

a. Stability of nutrients
b. The body ability to store the nutrients
c. The range of observed requirement
d. The availability of nutrient in America diet
e. The possible hazard from an excessive intake
f. Difficulties involved in establishing precise requirement.

(Guthrie, 1979)

The British Medical Association in setting the British dietary standards gave the dietary standards for the average healthy individual. Since these levels were never intended to cover the need of all persons, the British standards tend to be lower than American standards although they could be the same in some cases.

a. They are used to plan and procure food supplies for population groups
b. They are widely accepted as bases for evaluating diets
c. They are used as bases for formulating regulations governing the composition of food, dietary supplements and nutrients labeling
d. They are used for planning diet for institutions, schools, prisons and armed forces
e. They help to interprete food consumption data in relation to the assessment of nutritional status
f. They are useful in establishing nutritional guidelines for health and for other programmes
g. The development of dietary standards leads to new product development in food industry
h. They are useful in developing nutrition education programs

3.1.5 Limitation of the Dietary Standards

Some of the limitations of the dietary standards are

a. They do not give consideration to conditions of illness, metabolic disorders and chronic diseases
b. They do not consider those who use some drugs for some clinical reasons
c. The guidelines are not adequate enough to ensure adequate daily intake of essential nutrients

Student Assessment Exercise 15.1

Discuss the needs for and the uses of dietaty standards

3.2 Tables of Food Composition

This is the table that gives the amount of energy and nutrients in 100 grams of the edible portion of a food. The determination of this amount may be raw food material on cooked and ready for table portions of food dishes. The unit of energy used is keal. The unit for carbohydrate, protein, fat and oil is gram. For the other nutrients such as vitamins or minerals. microgram or milligrams are used.

Most of the data used for compilation of food composition table were obtained form the results of published and unpublished analyses made by laboratories of Government Agencies, Institutions and Industries. Considerations were also given to vareital, seasonal and geographical differences in the nutrients content on foods and loss or gain of nutrients during processing. The table also contains those nutrients for which data were available for a sufficient number of foods.

Tables of food compositions have been published for many years and the differences between the values of some nutrients in the different editions of tables of food composition. These differences in the values for the same foods may be a product of changes in processing techniques and improved analytical techniques.

3.2.1 Derivation of Tables of Food Composition

Highly developed analytical methods are used to obtain the values of he nutrients. For instance, the energy in a food item is determined by knowing the weights of carbohydrate, protein and fat and oil in the food and by multiplying these weights by their respective coefficients of digestibility to obtain the available amount of nutrients. For carbohydrate, protein and fat respectively, we multiply the available amount by Atwater Factors of 4,4 and 9 to obtain the energy contents of the nutrients. For protein, we obtain the nitrogen contents and multiply it by 6.24 to obtain the protein content. However, if it is milk we use a factor of 6.38, refined flour 5.7, whole weheat flour 5.8 and nuts, 5.3.

For fat content, we use simple solvent extraction method.

For carbohydrate content, we subtract the weight of water, protein, fats and oil and mineral from the total weight of the food to obtain the weight of carbohydrate. For all other nutrients vitamins and minerals, highly developed analytical methods are used.

3.2.2 Some Values of Tables of Food Composition

For you to appreciate the way table of food composition is presented and the contents of the table, a sample of table of food composition is presented in Appendix E

3.2.3 Uses of Tables of Food Composition

a. The table of food composition allows the estimate of the nutritive content of diet to be made quickly at low cost
b. Tables of food composition are indispensable tools for programs for food planning and distribution for evaluating food consumption surveys and for estimating the nutritive intake of individuals
c. Since the information can be readily obtained from computers, they can be used for menu planning, analysis of dietary intake and as basis for nutritional counseling.

3.2.4 Limitation of Tables of Food Composition

Some of the limitations of food composition tables are

a. There exists variations in the amount and specificity of data available for different foods and different nutrients
b. Some products are inadequately described as regards their sources and methods of processing. Hence, some of the data that are useful from these types of nutrients can not be included in the tables of food composition.

3.3 Food Guide Table

The food guide table refers to the amount of food recommended per serving of a particular food item to ensure adequate supply of nutrients recommended by the RDA for maintenance of good health. The amount of food is given in grams and the number of servings of the food for different foods is also given. The food guide is to assist families in selecting an adequate diet.

The food guide is different from the food composition table in the sense that food composition table gives different amount of the nutrients in the foods. The food guide gives the amount of food per serving and the number of servings to meet the RDA requirements.

Table 15.3: Composition of United States Food Guide 1016, 1943 and 1956

Five Food Groups 1916	Basic Seven 1943*	Basic Four 1956*
Milk, Meat, Fish Poultry egg and Meat substitutes	Milk and milk products (2) Meat, Fish etc (2), Eggs (4 per week)	Milk and milk products (2), Meat, Fish, Poultry eggs (2)
Vegetables and Fruits	Green and yellow vegetables (1) citrus fruits and raw cabbage (1), Potatoes, other fruits and	Fruits and Vegetables (4)
Bread and other Cereal Food	vegetables (2)	Bread, Flour, Cereal (enriched or Whole Grain) (4)
Butter and Wholesome Fat	Bread, Flour, Cereal enriched or Whole Grain (3)	
Simple Sugars	Equivalent of 2 tablespoons butter or fortified margarine	

* Number of Servings per day in Parentheses

Source: Guthrie H. A 1979. Introductory Nutrition 4[111] edition, The C.V Mosby Company, St. Louis London. Pg 352

Student Assessment Exercise 15.2

Discuss food guide and differences between Pod guide table and Pod composition table

4.0 Conclusion

This unit discusses recommended dietary allowances (RDA), table composition and food guide table. The unit also discusses the uses and limitations of dietary standard, food composition table and food guide. Exercises are provided to make the student assess their understanding of the content of the unit.

5.0 Summary

The unit discusses dietary standards, table of food composition and food guides. The needs for dietary standards arise from the face that dietary standards provide useful guide for nutritionists and Dieticians to plan and evaluate diets of population groups, to decide on food production, agricultural policies and nutrition programs and to solve the problems of over nutrition and under nutrition.

The dietary standards contain the amount of energy and the nutrients that are required for individuals at different ages with different sexes, body weights and occupation activities.

Values of recommended dietary allowances vary from one country to another especially in United States, United Kingdom and Canada from where we have RDA because of the differences in the bases for the compilation of their RDA.

Despite some limitations of the RDA, they are useful in planning and procurement of food supply for population groups, as basis for evaluating diet; as basis for formulating regulations governing composition of food, dietary supplement and nutrient labeling; for planning diet for institutions for establishing nutritional guideline; for health and other program.

Food composition table gives the amount of nutrients and energy in 100 grams of edible portion of a food. The table is compiled from the results of chemical analysis of the nutrients in the foods.

Food composition table is useful in the sense that it enables the nutritive content of a diet to be made quickly at a low cost. It is used to evaluate national food supply for developing programs for food planning and distribution. It is also used for menu planning, analysis for dietary intake and basis for nutritional counseling.

Food guide table consists of the amount of food recommended per serving of a particular food item to ensure adequate supply of nutrients recommended by RDA for maintenance of good health. While food guide gives the amount of food per serving and the number of serving and the serving to meet the RDA requirement, food composition table gives the amount of nutrients in the food.

6.0 Tutor Marked Assignment

Discuss the uses and limitations of dietary standards.

Answer to Student Assessment Exercises

15.1 See answers in Sections 3.1.1 and 3.1.4 of this unit
15.2 See answers in Sections 15.3 of this unit

7.0 References and Other Sources

Davidson S. et at (1975) Human Nutrition and Dietetics. Sixth edition Longman Group Ltd.

Guthrie H. A (1979) Introductory Nutrition 4th edition, The C. V. Mosby Company St. Louis London, Toront

UNIT 16: FOOD TOXICANTS

TABLE OF CONTENT

1.0 Introduction

Ordinarily, foods are sources of nutrients needed for energy, growth, maintenance of body tissues and some body metabolism. Some foods still contain toxicants that inhibit the metabolic functions of some nutrients and enzymes that can cause physiological disturbances when they are consumed as part of the food.

Some of the toxicants are naturally present with the food and some are accidentally introduced into the food during cultivation and processing.

This unit therefore, treats the classes of toxicants and the methods of detoxifying the toxicants.

2.0 Objectives

At the end of this unit, you should be able to

- Know the classes of toxicants
- List some naturally occurring toxicants
- List some adventitious toxicants
- Discuss the mode of action of some toxicants
- Discuss some methods of detoxifying some toxicants

3.0 Nlain Content

3.1 Classes of Toxicants

There are two classes of toxicants. These are Natural toxicants and adventitious toxicants.

3.1.1 Natural Foods Toxicants

These are genetically determined substances that are naturally present in foods;

Soy beans contain anti-growth factor and anti-tryptic factor. The ant-tryptic factor prevents trypin from playing its digestive role.

Anti-pyridoxine in bean seeds causes vitamin B6 deficiencies. Alkaloids in legumes induce carcinogenesis that is, it can cause caner if the alkaloids accumulate in the body.

There are some goitrogenic substances in cabbage. These substances induce goitre.

Cyanogen and glycosides are present in cassava and these can cause nerve deafness.

Oxalate in form of oxalic acids occurs naturally in spinach, beet and rhubarbs are toxicants. These foods are eaten without any ill effect because of the low concentration of the toxicants in them but in the leaves of rhubarb the concentration of acid is high enough to cause illness.

In bananas and some other foods there is 5-hydroxyl, tryptamin, adrenaline nor adrenaline. These toxicants produce effects on central and peripheral nervous system.

In cheese the presence of thyramine raises blood pressure and this is enhanced by monoamine oxidase inhibitors.

In some fish, meat and fish, there is nutrosamines which cause damage to liver and can also cause cancer.

In many furgi, we have various microtixins which produce toxic effects on nervous system and liver.

Aflatoxins is produced by Aspergillus flavus in mouldy nuts. Aflatoxins damage the liver and lead to casinoma in animals.

There are also some anti-vitamin factors. The Dicoumarin in clover produces haemorrhages in cattle by causing vitamin K deficiencies in the tissues. Thiaminase found in several species of fish has been found to prevent the absorption of thiamin..

There are some toxins that are found in food that cause hallucination. Alkaloids such as scopolamine consumed in a salad containing the jimson weed have been found to produce hallucination.

Cereals contain phytin which can bind calcium and make it unavailable to the body.

Eggs also contain avidin and conalbumin which are toxic substances that prevents protein digestion. Lipoxidase contained in soy beans destroys vitamin A.

Some vitamins such as vitamin A and D some amino acids such as methioline exhibit toxic effects when they are consumed in excessive doses.

3.1.2 Adventitious or Accidental Toxicants

Some harmful substances that are not naturally parts of foods but become part of the food as a result of human activities are called accidental or adventi ious toxicants. These types of substances are coming from outside. Among them are antibiotics in poultry and in food preservation. We also have sulphurdioxide that destroys vitamin B_i. Some trace elements like lead, mercury and cadmium may contaminate food and cause poisoning. Zinc and copper are among the trace elements needed in the body in small amount but they may be toxic if they are consumed in excessive amounts.

Other accidental toxic substances that can come in contact with food are pesticides, insecticides, fungicides, rodenticides and herbicides.

Students Assessment Exercise 16.4

List some examples of naturally occurring toxicants and accidental toxic substances in foods.

3.2 Methods of Detoxification

Some of the natural toxicants are removed during the processing of the different food items containing them.

Heat treatment destroys the thiamilase in fish, avidin in egg, the heamaglutin inhibiting enzymes present in beans. Heat is also used to destroy anti-growth and anti-tryptic factors in soybeans.

Soaking cassava tubers, fermentation of grated cassava tubers, pressing the grated tuber and the garrification process (frying) have been responsible for the removal of the hydrocyanic acid in cassava.

Peeling of potatoes helps to remove some toxicants like somarin under the skin of potatoes.

Naturally, the body of human being is able to detoxify many harmful substances when there is adequate nourishment with intake of nutrients that are adequate qualitatively and quantitatively.

A very healthy person with good nourishment will also be able to naturally detoxify toxicants. Some sulphur containing amino acids have been implicated in the detoxification of residual hydrocyanic acids in cassava products.

Student Assessment Exercise 16.2

Discuss the methods of detoxification of toxicants.

4.0 Conclusion

In this unit, you learned the classes of toxicants as naturally occurring toxicants and accidental or adventitious toxicants. You also learned how some of these toxicants could have been detoxified. Exercises are also provided to assist you to assess your understanding of contents of the unit.

5.0 Summary

Foods generally are supposed to supply nutrients for growth, energy, maintenance of body tissue and functioning of some metabolic activities in the body.

However, there are some naturally occurring toxicants in some foods. Some of other toxicants are adventitiously or accidentally added to the foods.

Some of the naturally occurring toxins are gosypol in cotton seed, anti-tryptic and anti-growth factors in soy beans. Anti-pyridoxine in lean seeds and alkaloids in legumes. Other naturally occurring toxins are cyanide in cassava, aflatoxin in mouldy nuts, dicoumarin in clover and so on.

Some of the accidental toxitants are pesticides, insectides, herbicides, fungicides and some trace elements like mercury, lead, cadmium, selelium.

Some of the toxicants can be destroyed by heating. These include thiamilase in fish, avidin in eggs, heainaghitin inhibiting enzymes in beans, anti-tryptic and anti-growth factors in soy-beans.

Cyahide in cassava can be removed during soaking fermentation and frying of the grated tubers.

Some sulphur containing amino acids have been impheated in the detoxification of the residual hydrocyanic acid in cassava products.

Healthy human beings with adequate supply of nutrients in correct proportions for growth, maintenance of tissues, energy and body metabolic functions can naturally detoxify some toxicants.

6.0 Tutor Marked Assignment

Discuss the naturally occurring toxicants in foods.

Answers to Students' Assessment Exercises

16.1 See answers in Section 3.1.1 of the unit
16.2 See answers in Section 3.2 of the unit

7.0 References and Other Sources

Davidson S. et al (1975) Human Nutrition and Dietetics. Sixth edition Longman Group Ltd.

UNIT 17: FOOD ADDITIVES

TABLE OF CONTENT

1.0 Introduction

In many catering preparations, additives are used for enrichment, as raising agents, as colouring agents, as flavouring agents, thickening and as stabilizing agents and in many forms.

In view of this, there is a need to study the requirements for these additives and the classes and uses of the additives in food.

This unit therefore, treats those compounds that are intentionally added to food to perform the functions listed below.

2.0 Objectives

At the end of this unit you should be able to

- Define food additives
- Explain the need for additives
- Discuss food evaluation for the use of additives
- List characteristics of additives
- Discuss various classes of additives

Discuss uses of additives

30 Main Content

3.1 Definition and Basic Requirements of Additives

3.1.1 Definition

An additive is defined as a substance or mixed substances other than the basic food that are present in food during processing, packaging and storage.

They may be intentionally added to improve the keeping quality or at times they may occur accidentally. They may be inert or physiologically active to promote better nutritive value.

3.1.2 Factors Affecting Composition of Food

There is a need to discuss the composition of food to know the nutrients present in the food and to know the need for supplements of nutrients in the food.

Variability in the biological system of food affects the composition of the food. The level of soil fertility has effects on the composition of food. The intensity of light can also have effect on the nutritive value of the food.

Disease and insect infestations of food affect the chemical composition of the food as well as the flavour, colour and nutritional quality of the food.

Some of these actions cause loss or deficiency of some nutrients in the food and there may be the need for some food additives to correct these losses and deficiencies.

3.1.3 Needs for Additives

a. Baby foods are enriched by calcium due to rickets in children. To prevent anaemia, iron is added to flour, for fortification of garri protein from soy beans is added.
b. There must be food conveyor for the additives
e. The additives must be able to increase the keeping quality of the food and must increase the colour and flavour of the food.
d. The additives must be safe, must not interact with or antagonize the food to which it is added.

3.1.4 Food Evaluation of the Additives

When a new additive is to be used in food, you should do the following:

a. Establish Standard of Identity

We would know what minimum and maximum amounts of the additives that are required by the food, the people that will be affected by the use of the additives whether children, women, adult or priviledged people, the duration of the use and the frequency of the use.

b. Determine the property of the Additives

We should know the composition and the stability of the additive. We should also know how to remove any form of interaction between the food and the additive and how to study the cumulative effect on the consumption of the additive

c. Establish Safety Level

We should establish the minimum and maximum tolerance level of the additive.

3.1.5 Uses of Additives

Some additives are added to food to improve the colour and the flavour of the food. Some are added to prevent the growth of mould (anit-mycotic agent) and bacteria. Some are added as anti oxidants and emulsifiers.

Additives are generally added in small qualities to produce desired effects. You should note that every chemical additive added must be able to perform one or more of the following functions:

a. Increase the nutrition values of the food.
b. Enhance the consumer acceptability of the food
c. Improve the keeping quality of the food
d. Facilitate the preparation of the food.

Students' Assessment Exercise 17.1

Discuss the uses of Additives

Classification of Food Additives

3.2.1 Acids, Alkalis, Buffers and Neutralizing Agents

The degree of acidity and alkalinity is of importance to many foods

The tartness (caustic taste) of a number of soft drink other than cocoacola is impacted by the addition of organic acids such as citric acid from citrus, marlic acid from apple and tartaric acid from grapes.

In confectionary products, acids are also used as flavouring agent and in chocolate, we use alkaline as flavouring agents.

In baking industry, raising agents are used to produce carbondioxide which makes the batter light and porous thereby providing a finished product of good volume, crumb, texture and palatability. This has been properly discussed under raising agents in Unit 10.

Emulsification and the desired tartness in processing cheese and cheese spread are obtained by addition of acids such as citric, lactic, marlic and phosphoric acid.

Buffering agents such as sodium salts of citric, marlic and tartaric acids are used to control the degree of acidity of soft drinks,

PH adjustment is necessary in diary as excessive acidity in cream must be neutralized for satisfactory churning and to produce butter of acceptable flavour and keeping quality.

3.2.2 Emulsifying, Stabilizing and Thickening Agents

Emulsifying agents are used in baked goods, cake mixes, ice cream, confectionary goods, frozen preserve and mayonnaises. Some of these emulsifying agents are lecithin, mono and diglycerides, polyoxyyethelenc

fatty esters. In bakery the emulsifying agents increase the volume, uniformity and finess of the bread.

The texture of the ice cream and other frozen preserve is dependent in part on the size of the ice crystals which is controlled by small amount of stabilizing agents such as agar, gelatine cellulose gum and some edible vegetable gums.

Gelatin. peptin and starch are used in confectionary products to give its specific texture. The lbaming property of brewed beer can be improved by the addition of certain stabilizing, agents such as gum sodium alginate, cellulose ;:tim and sorbitol.

3.2.3 Bleaching Agents, Maturing Agent and Bread Improvers

You learned in unit nine that wheat flour is bleached when it is exposed and stored. the colour changes from pale yellow tint to white. These colour changes can be sped up by the addition of some oxidizing agent such as benzoid peroxide. oxide of nitrogen nitroxyl chloride and chlorine. These oxidizing agents improve the baking quality, decreases storage cost and hazards of spoilage and insects and rodents infestation. Potassium iodides, potassium bromate and calcium peroxide are used as bread improvers. Those inorganic salts used as yeast food and dough conditioners are ammonium chloride, ammonium phosphate, calcium phosphate and ammonium sulphate and calcium sulphate.

3.2.4 Flavouring Agents

Some spices and some essential oils are used as flavouring agents in some processed food. Some synthetic types of these additives are also used now in soft drinks, baked goods. ice cream and confectionary. They are used in small amount in the food. Their concentration is low because some of them are cancinogenic. Examples of synthetic flavouring agents are benzaldehyde, carvone, enthylacetate and methsalicynate.

3.2.5 Colouring Agents

They are used extensively in confectionary, baked goods, soft drinks and dairy products, some of the colouring agents from plant sources are annatto alanat, carotene, cochineal, chlorophyll, and turmeric.

3.2.6 Nutritional Supplements

Wheat flour is supplemented with vitamins and minerals. You learned before that we supplement rice with thiamine.

In margarine, we add vitamin A and D. In evaporated milk vitamin D is added.

You have learned in this unit that garri is supplemented with protein from soy beans.

3.2.7 Preservatives and Antioxidants

Sodium diacetate is added to flour to prevent ropiness in bread. Some other products that can be used to prevent ropiness are proportionate of sodium and lactic acid as well as monocalcium phosphate.

Sorbic acid is used as anti-mycotic agents (Prevention of mould growth) in cheese.

Benzoic acid and sodium benzoate are used in oleo-margarine, fruit juices and confectionary to inhibit bacteria and mould growth.

Salt 2nd vinegar are used as preventing agents against microbial activities in rocess of meant and meat products.

Students' Assessment Exercise 17.2
List some examples of colouring and flavouring agents and the food in which they are used.

4.0 Conclusion

In this unit, additives are defined: the needs for additives, the food evaluation for the use of additives and the uses of additives are discussed. Also discussed are the classes of intentional food additives and the foods in which they are used.

5.0 Summary

An additive is defined as a substance or mixed substances other then the basic food which are present in the food during processing, packaging and storage. Some of the additives may be intentionally added to the food to enhance the quality of the food, to promote better nutritional status, to enhance the consumer acceptability of the food and to promote better nutritional status of the food.

The food additive must be added in small amount to the food and they must not interact with or antagonize the foods that convey them.

The minimum and the maximum tolerance levels of the additives must be ascertained before they are used.

The food additives may be used as colouring agents, flavouring agentd, preservatives, food supplements, thickeners in soup, emulsifying agents, raising agents buffers, acids and alkalis (used to regulate the PH of some mixture of food).

6.0 Tutor Marked Assignment

Discuss the use of acids, alkalis, buffers and neutralizing agents as additives in food.

Answers to Students' Assessment Exercise

17.1 See answers in Section 3.1.5
17.2 See answers in Sections 3.2.4 and 3.2.5

7.0 References and Other Sources

Davidson S. et al (1975) Human Nutrition and Dietetics. Sixth edition
Longman Group Ltd.

UNIT 18: NUTRITIONAL DISORDERS OF IMPORTANCE IN NIGERIA

TABLE OF CONTENT

1.0 Introduction

The nutrients consumed as you learned before must be adequate both in quantity and quality to meet the energy requirement, promote growth and maintenance of body tissues and to ensure proper metabolic functions of the body.

At times, there is inadequate supply and excessive supply, some other times of these nutrients. These conditions amount to malnutrition. The conditions also result into nutritional disorders.

This unit therefore, treats the nutritional disorders of importance in Nigeria.

2.0 Objectives

At the end of this unit, you should be able to:

- Describe some nutritional disorders of importance in Nigeria
- List the causes of the disorders
- List the symptoms of the disorders
- Prescribe treatment for the nutritional disorders

30 Main Content

31 Kwashiorkor

Kwashiorkor occurs when a child who has remained on prolonged breast feeding is weaned and then fed with diet that is low in protein, probably because of poverty or ignorance in the part of the mother. This is a disorder resulting from protein-energy malnutrition. It occurs mostly in children between the ages of 12 and 18 months though children up to five years may still be affected by Kwashiorkor. The disease is more prevalent among children of rural dwellers who are not able to provide for their children after they are weaned. The mothers tend to use mostly carbohydrates to feed their children, thereby causing poor intake of protein in the diet of the children.

The diet contributing to Kwashiorkor has been found to lack vitamin Bp

3.1.1 Symptoms of Kwashiorkor

Some of the symptoms are:

a. The growth of the child is retarded
b. The hair changes colour, loses its sheen and becomes thin
c. There is development of oedema with the feet, face and hands swollen
d. There could be diarrhea
e. There is generalizes unhappiness or apathy
f. There could be some degree of anaemia, though not severe
g. There could be dryness and flaking off of skin

3.1.2 Factors Contributing to Kwashiorkor

Some of the factors contributing to Kwashiorkor are

a. Shortage of protein food especially animal protein for weaning
I;. Inability to meet the high protein requirement during infancy

c. The ignorance of some parents that well n; '.irished foods containing meat and eggs should be the preserve of the adults specially heads of the family
d. Exposure of children before five years to som infections

3.1.3 Treatment and Control of Kwashiorkor

Some mild cases of Kwashiorkor can be treated by the mothers, by feeding the baby with good quality protein such as egg, milk. beans, groundnuts three times daily.

In ensuring that the diet of the child contains sufficient protein of high quality, we should make sure that adequate calorie can also be supplied by the diet. This is done by making sure that the diet contains enough oil from palm oil, groundnuts and cotton seeds. Apart from all these, the child should be given adequate care and attention.

Severe cases must be reported to doctors and treatment should include the consumption of high quality protein food.

3.1.4 Preventions

a. After weaning the child, the diet must contain high quality protein food.
b. There must be nutrition educational programs on the feeding of the children.

3.2 Rickets

Rickets is essentially a disease of the poor in which there is inadequate supply of calcium and phosphorous. It results in defective bones formation when there is inadequate deposition of calcium and phosphorous in the body.

As a result of poor calcification of the bone at the time of birth, the bone remains soft and pliable. When the children are growing up and the bones are to perform their roles, deformities occur because the bones are not strong.

Rickets is a disease of the children. It is the equivalent of osteomalacia in adults.

3.2.1 Symptoms of Rickets

a. Deformities such as bending or bowing of the bones occur when the child starts to walk. This is because the bones are not strong enough to support the weight of the body.

b. There could be soft-lining of the skull leading to its box-like appearance with protruding fore head
c. There could be teeth eruption and the teeth are less well formed than the normal. They also undergo decay earlier •
d. Growth can be retarded
e. There is enlargement of the ends of long hones causing difficulty in movement as a result of knock knees resulting from the flattening which occurs when poorly calcified ends are subjected to carry the weight of the body
f. There could be deformities of the ribs that cause crowding of the chest cavity.

3.2.2 Causes of Rickets

a. Rickets is caused by deficiency in calcium and phosphorous and by the inability of the parents in providing mild, cream, butter and eggs that can provide calcium and vitamin D.
b. Feeding on diet that contains high quality cereal food in which the absorption of calcium may be interfered with by phytic acid.
c. Frequent occurrence of diarrhea that results from digestive disorders in which adequate absorption of calcium is distributed.

3.2.3 Treatment and Prevention of Rickets

Rickets and the attendant deformity could be treated and corrected by:

a. Synthesis of adequate amount of vitamin D through exposure to sunlight rays
b. Feeding the children with the diet that is rich in vitamin D and calcium. Such foods are milk, cod-liver oil, fish, butter and so on.

3.3 Osteomalacia

Osteomalacia, adult rickets, is a defect in bone formation that is not necessarily as a result of vitamin D deficiency. In osteomalacia, the shaft of the long bones and flat bones such as the pelvics are affected. Osteomalacia is more prevalent in women of child bearing age than men.

3.3.1 Symptoms of Osteomalacia

Some of the symptoms of osteomalacia are:

a. Skeletal pains
I). Muscle weakness that is present and that is producing disability

c. Skeletal deformity
d. There could be replacement of bony subs', ince in the body with osteoid tissue as a result of the progressive decalcification of the bones. The effect of this decalcification of the bones is felt in the spine, ribs, pectoral girdle and in the pelvics and lower limbs.

3.3.2 Causes of Osteomatacia

Some of the causes of osteomalacia are:

a. Low intake of dietary calcium and vitamin A and D
b. Lack of adequate exposure to sunlight
c. Frequencies of pregnancy and lactation with its attendant increase in the demand for calcium and vitamin D.

3.3.3 Treatment of Osteomalacia

a. There should be maintenance treatment with vitamin D
b. Good diet that contains milk, egg, butter and margarine should be supplied
c. In all cases of osteomalacia, we should give a supplement of calcium orally. However in doing this, we should give consideration to the toxic effect of excessive intake of vitamin D whose absorption is related to the presence of calcium.

Students' Assessment Exercise 18.1

List the causes of Kwashiorkor, rickets and osteomalacia.

3.4 Obesity

This is a state where excess fats accumulate in the body as a result of excess calorie consumed and absorbed. This condition could be assessed visually. It is important to assess the degree of obesity for the purpose of regulation and treatment. This can be done by comparing the weight of the person with the value in the table of standard weights.

We should also note that the normal body weight of an individual is dependent on body build. Heredity confers large frame and large body muscle on some individuals.

Even when these individuals are more than 20% over their standard weight, they are still not regarded as obese.

Obesity can be assessed by obtaining fats as a percentage of total body weight.

For normal men and women, the fat content percentage of the total weight should be respectively about 12 — 18% and about 18 — 24% when men and women have fat content of about 20% and 30% respectively, they could be considered as obese.

Obesity occurs when on a continuous basis the caloric intake exceeds the caloric requirement. This excess is always stored inform of fat in the adipose tissue.

Some people are also considered overweight when their weights are slightly above the standard weights.

However, if consumption of calorie is not controlled at the point the overweight is noticed, the overweight people can later on become obese.

3.4.1 Causes of Obesity

The causes of obesity can be due to

a. Environmental Factors
b. Psychological Factors
c. Genetic Factors
d. Cultural Factors
e. Physiological Factors

a. Environmental Factors: Some environmental causes of obesity are demand for food causes individual to consume more food than necessary thereby resulting into obesity.
b. Psychological Factors: Technology has brought energy saving mechanical devices and convenience foods. All these reduce the energy expenditure of the individual thereby causing the caloric intake to be in excess of caloric requirement.
c. Genetic Factors: Especially in Africa, foods and drinks are used to express hospitality. A person who is offered foods and drinks from early morning to late in the evening may become obese after some time.
d. Cultural Factors: The decrease in the amount and intensity of physical activity with age without corresponding decrease in caloric intake can result into obesity.

Some mothers are always interested in the large weight gained by their children and they consider this weight gain as desirable. This leads them to

introduce their children to solid foods at early age to feed them with milk of high caloric value and to encourage them to consume large portions of food. All these encouragement can lead to obesity.

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Some psychological factors that are implicated as causes of obesity are anxiety, disappointment especially in love affairs and frustration.

Anxiety can lead to more intakes in caloric consumption. A lady that is jilted by a man may substitute foods for lost love. In some people, food is used to compensate for some sort of frustration.

As we discussed before, heredity has a role to play in the body frame and the amount of muscles of an individual. Heredity is also the tendency for some obese parents to have some obese children.

Cultural factors are also implicated as causes of obesity. To some people in some cultures, a large body size is a sign of wealth. In this type of culture excessive intake of calorie may be encouraged and this may lead to obesity.

Other factors causing obesity are Physiological Factors such as hormonal factors and regulation of food intake.

3.4.2 Effects of Obesity

a. As a result of the increase in weight, the heart and some other organs of the body receive additional work load to maintain and move the extra weight around.
b. There is reduction in the body reserves to deal with infection and acute illnesses.
c. There is increase in the incidence of such diseases as diabetes, coronary heart diseases and arterial diseases.
d. The joints between bones particularly those of the leg are overloaded and may wear down
e. As a result of the increase in weight there is a reduction in the tendency for the obese to participate in physical activities, hence the obese becomes dull and sluggish.

3.4.3 Treatment and Prevention

The treatment of obesity can be achieved by any measure that can cause a successful reversal of the positive caloric balance that result in obesity. Therefore, in treating obesity there must be

a. Decrease in caloric intake

b. Weight adjustment through increased physical activities
c. Consumption of reducing diets consisting of high protein, high fat and low carbohydrates content
d. Administration of agents that can reduce food intake that is administration of appetite depressants or anorexigenic drugs.

4.0 Conclusion

In this unit. kwashiorkor, rickets, osteomalacia and obesity, some nutritional disorders in Nigeria are discussed under causes, symptoms and treatments. Some students' assessment exercises are given to make the student assess their understanding on the contents of the unit.

5.0 Summary

The body needs nutrients that are adequate in quantity and quality for its energy need, growth, maintenance of body tissues and some metabolic functions in the body. Under intake and over intake of these nutrients could lead to nutritional disorder.

Under intake of nutrients leads to kwashiorkor, rickets and osteomalacia that are discussed in this unit while over intake of calorie over and above the requirement leads to obesity.

Kwashiorkor is a disease of children in which there is protein energy malnutrition leading to retardation of growth, decolouration of hair and losses of its sheen oedema with feet, face and hands swollen, dullness and apathy. Kwashiorkor can be treated by feeding the baby with good quality protein such as milk, eggs, beans and groundnut.

Rickets is as a result of deficiency of calcium and phosphorous and poor calcification of bones in children. This leads to deformity of the bones and enlargement of the ends of long bones when the children arc trying to walk. The fore-head may also protrude and eruption of teeth delayed. Exposure of body to sunlight and inclusion of food rich in vitamin D and calcium into the diet can be used to treat rickets.

Ostcomalacia is adult rickets characterized with skeletal pain and pains in the limbs. It is more prevalent in women than in men. It is caused by low intake of calcium and vitamin D. lack of exposure to sunlight and frequent pregnancy and lactation.

Obesity is caused when there is excess of caloric intake over the caloric requirement. The causes can be environmental, physiological, cultural, psychological and genetic.

Obesity can be treated by increasing physical activity decreasing caloric intake, consuming reducing diet of high protein content, high fat content and low carbohydrate content and administration of appetite, depressant or anorexigenic drugs.

6.0 Tutors Marked Assignment

Discuss the causes and the treatments of rickets and obesity

Answers to students' assessment exercises

18.1 See answers in Sections 3.1.2, 3.2.2 and 3.3.2 of this unit
18.2 See answers in section 3.4.2 of this unit

7.0 References and Other Sources

Davidson S. et al (1915) Human Nutrition and Dietics, 6th edition, Longman Group Ltd

Guthrie H. A (1979) Introductoru Nutrition 4thedition, The C. V Mosby Company, St Louis London, Toront

UNIT 19: EFFECTS OF PROCESSING ON THE NUTRITIVE VALUES OF FOOD

TABLE OF CONTENT

1.0 Introduction

This course is concerned with foods and nutrition. Hence, the nutritive value of foods is very important to us in this course.

Some raw food stuffs can be eaten raw. Most raw food stuffs must be processed to preserve, to improve the keeping quality and to remove all food hazards in the foods.

In all food processing, care must be taken that all the original nutrients in the raw food stuffs are retained as much as possible in the finished goods and that all the sources of either chemical, biological hazards in the raw food stuffs are removed.

In achieving all these objectives mentioned above, the nutritive value of food is affected either positively or negatively.

This unit therefore, discusses the effects of processing on the nutritive value of foods.

2.0 Objectives

At the end of this unit, you should be able to:

- List some processing procedures
- Discuss the effects of these processing methods on the nutritive values of foods.
- Discuss how to control changes in the nutritive value of food during processing.

3.0 Main Content

3.1 Preparation Operations

These operations include peeling, coring, washing, dry cleaning, winnowing, slicing, etc.

The effects of these operations on the nutritive values of foods depend on the type of food being processed. In some foods, preparation operation may have effects on the nutritive value of the food being processed. In some others, the preparation operations may not have any effect on the nutritive value of the food.

Nutrients are not distributed uniformly throughout the food. In some cases, he nutrients are highly concentrated just below the skin. In this case, you need to take a lot of care so as not to lose a significant amount of the nutrients during the preliminary operations. For instance, ascorbic acid is higher in the peel of fruits and vegetables than in the cortex. This brings about the loss of ascorbic acid when we are peeling oranges and pineapples.

In processing rice, thiamin is lost into the bran and this loss of thiamin for some years causes beriberi in rice consuming population until rice was later fortified with thiamin.

In peeling carrots, niacin and carotene are lost. In peeling of some fruits and vegetables, loss of riboflavin is experienced.

In washing of some food items, some nutrients are lost. Some leafy vegetables lose some of their vitamins during washing.

Washing of meat before processing can result into loss of some nutrients.

3.2 Heat Treatment

The heat treatments include blanching, pasteurization, sterilization, cooking, roasting, smoking and baking.

3.2.1 Blanching

There are water blanch and steam blanch.

In water blanch; water soluble nutrients are lost in the water. There is loss of minerals and vitamin C during the blanching of fruits and vegetables. There is destruction of some heat liable vitamins especially riboflavin. Loss of nutrients during blanching is generally due to leaching of nutrients from the leaf.

Generally. in heat treatment operations, spoilage micro organisms and pathogenic micro organisms are destroyed.

3.1.1 Pasteurization

We have low temperature long time method and high temperature short time method. There is loss of vitamin C during pasteurization especially when high temperature short time method is employed.

Pasteurization in milk also results into loss of some amino acids such as cystine.

3.2.3 Sterilization

In sterilization, the heat employed is very high (up to 121°C) so as to be able to destroy all forms of pathogenic and non-pathogenic micro organisms, spore forming micro organisms. In view of this, all nutrients that are liable to heat are destroyed. It should be noted that heat treatment denatures protein thereby decreasing or totally destroying the catalytic and the enzymatic activities of the protein. This decrease in catalytic and enzymatic activities of the protein is also a loss in the nutritive value of protein. The heat treatment during sterilization destroys essential amino acids such as niacin and histidine. Some vitamins and minerals are also leached from the canned foods into the liquid to which it is canned. This occurs when green pea is canned in brine.

3.2.4 Cooking

In cooking, such as in stewing and deep frying, there is loss of vitamin Bp and vitamin C. During boiling of potato some thiamin is lost. • Excessive cooking has been found to have effects on amino acids. In cooking of meat, water soluble nutrients and some fat soluble nutrients are lost into the stock. Also cooking causes the Denaturation of protein with the attendant loss of the catalytic and the enzymatic activities of the protein.

Many heat unstable vitamins such as vitamin A, D and fl. are generally affected during cooking.

3.2.5 Roasting, Smoking and Baking

In roasting, smoking and baking, heat treatment is also employed. The temperature is so high in these processes that many heat liable nutrients especially at the outer part of the food are lost or diminished. Protein is denatured; some essential amino acids are destroyed.

However, in smoking, some phenolic compounds that are implicated in the flavours of the smoked foods are added.

Students' Assessment Exercise 19.1

Discuss losses in nutrients during heat treatments

3.3 Cold Treatment

Cold treatment involves keeping of food in an environment of low temperature. It could be chilling, refrigerating or freezing.

There is the loss of about 40% vitamin during freezing of vegetables and animal tissue. Cold storage of sweet corn for about 4 days leads to about 20% loss of its sweetness. There is a loss of 53% of asparagus stored for 7 days. In potato, there is loss of vitamin C when it is stored in cold environment. When frozen food stuffs such as meat, fruits and some leafy vegetables are thawed, some nutrients are lost.

3.4 Irradiation

This is a method of food preservation in which radiation emitted by radio active elements is passed through the food. This is to effect a complete sterilization of the food. However, this method has a number of effects on the nutritive value of the food. The effects are:

a. It reduces the available calcium in egg and meat.
b. Production of peroxide and hydroxide radicals from the water molecules in the food. The peroxide constitute biological hazard in the food. A hydroxide radical reacts with some organic materials in the food and grossly alters the molecular structure of the organic compounds.

Apart from the loss of nutrients that occurs in irradiated foods, loss of colours can also occur. For instance, there is the bleaching of butter, loss of red colour in of salmon and darkening of meat.

In fruits containing high content of proteins there can be burnt-off flavour occurring when the foods are irradiated.

3.5 Uses of Preservatives

Preservatives are chemical substances, intentionally added to food to increase the keeping quality, to prevent deterioration, to inhibit the growth of micro organisms, to destroy and inactivate spoilage and deteriorative enzymes.

The safety levels of the additives must be clearly prescribes so as not to cause toxicity of the preservatives in the body. It should be noted that the excessive intake of the preservatives can cause physiological disorders in the body.

Sulphiting of fruits and vegetables has positive effect on the retention of ascorbic acid during freezing. Sulphur oxide is added to fruit juice, fruit pulp and jam to prevent microbial growth.

Proplonic acid is added to flour to prevent mould growth in bread. You also learn in Unit 18 under additive that iron is added to flour to prevent anaemia and garri is fortified with protein during processing. Vitamins are added to margarine to increase the nutritive value. With these, the actions of deliberate additives as you learn before can improve the nutritive values of foods during processing.

Students' Assessment Exercise 19.2

Discuss the effects of irradiation and cold storage on tire nutritive value of pod.

4.0 Conclusion

In this unit, the effects of processing such as preparation operations, heat treatment cold storage, irradiation and use of preservatives on The nutritive value of food are discussed.

Some students' assessment exercises are provided to test the students' understanding of the contents of the unit.

5.0 Summary

You learned that processing of food stuffs prevents deterioration of the food by eliminating or destroying the pathogenic or non-pathogenic organisms.

Processing also helps to improve the keeping quality of the foods. However, some processing methods leads to either the loss of nutrients or destruction of nutrients. Some other processing methods lead to improvement of the nutritive value of the food.

Some preparation operations of food lead to loss of nutrients during peeling and leaching of water soluble nutrients during washing. In fruits and vegetables some vitamin C and riboflavin are lost during peeling. Peeling of potatoes leads to loss of niacin. In milling of rice, thiamin is lost in the bran.

Generally, in heat treatment, protein is denatured leading to the loss of catalytic and enzymatic activities of the protein as a result of the change in the three-dimensional configuration of the protein. Some water soluble nutrients are lost during blanching through leaching.

Vitamin C and some heat liable nutrients are destroyed during heat treatment. In pasteurization and sterilization, some heat unstable vitamins such as vitamins A, D and E are destroyed.

Irradiation of the food also leads to destruction of nutrients. In irradiated eggs and milk there is reduction of calcium.

Some additions of chemical compounds can improve the nutritional quality of food as well as preventing the microbial deterioration of the food. Iron is added to flour to prevent anaemia. .

Rice is fortified with thiamin to prevent beriberi. Margarine is enriched with vitamins A and D.

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Rice is fortified with thiamin to prevent beriberi. Margarine is enriched with vitamins A and D.

6.0 Tutor Marked Assignment

Discuss the effects of heat treatment on the nutritive values of food.

Answers to students' assessment exercises

19.1 See answers in Sections 3.2, 3.2.1 to 3.2.5
19.2 See answers in Sections 3.3 and 3.5

7.0 References and Other Sources

Davidson et al (1975) Human Nutrition and Dietictis 6[11]edition, Longman Group Ltd.

Lake B. and Waterworth M, Foods and Nutrition 13[th]edition, Mills and Boons Ltd., Brooks Mews, London

APPENDICES

APPEDIX A •

	Age (years)	Weight		Height		Protein (9)	Fat-Soluble Vitamins		
		kg	lb	cm	in		Vitamin A (¹9 RE)t	Vitamin D 610	Vitamin E (mg a TE)§
Infants	0.0 - 0.5	6	13	60	24	kg x 2.2	420	10	3
	0.5 - 1.0	9	20	71	28	kg x 2.0	400	10	4
Children	1- 3	13	29	90	35	23	400	10	5
	4 - 6	20	44	112	44	30	500	10	6
	7 - 1 0	28	62	132	52	34	700	10	7
Males	11 - 14	45	99	157	62	45	1000	10	8
	15 -18	66	145	176	69	56	1000	10	10
	19 - 22	70	154	177	70	56	1000	7.5	10
	23- 50	70	154	178	70	56	1000	5	10
	51+	70	154	178	70	56	1000	5	10
Females	110- 14.0	46	101	157	62	46	800	10	8
	15 - 18	55	120	163	64	46	800	10	8
	19-22	55	120	163	64	44	800	7.5	8
	23-50	55	120	163	64	44	800	5	8
	51+	55	120	163	64	44	800	5	e
Pregnant						+30	+200	+5	+2
Lactating						+20	+400	+5	+3

*The allowances are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well define. See text for detailed discussion of allowances and of nutrients tabulated. See Table (reverse page) for weights and heights by individual year of age...

tRetinol equivalent. 1 Retinol equivalent = 1 mg retinol or 6 1,tg Pcarotene. See text for calculation of Vitamin A activity of diets as retinol equivalent.

cholecalciferol, 10 cholecalciferol = 400 NJ vitamin D

§ a tocopherol equivalents. 1 iru! d-a-tocopherol = I a TE. See text for variation in allowances and calculation of vitamin E activity of the diet as a tocopherol equivalent

91 NE (niacin equivalent) is equal to I mg of niacin or 60 mg of dietary tryptophan

Water Soluble Vitamins							Minerals					
Vitamin (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg NE)	Vitamin 136 (mg)	Folacinj (mg)	Vitamin B12 (mg)	Calcium (my)	Phosphorous (my)	Magnesium (mg)	Iron (my)	Zinc (mg)	Iodine (mg)
35	0.3	0.4	6	0.3	30	0.5"	360	240	50	10	3	40
35	0.5	0.6	8	0.6	45	1.5	540	360	70	15	5	50
45	0.7	0.8	9	0.9	100	2.0	800	800	150	15	10	70
45	0.9	1	11	1.3	200	2.5	800	800	200	10	10	90
45	12	1.4	16	1.6	300	3.0	800	800	250	10	10	120
50	1.4	1.6	18	1.8	400	3.0	1200	1200	350	18	15	150
60	1.4	1.7	18	2.0	. 400	3.0	1200	1200	400	18	15	150
60	1.5	1.7	19	2.2	400	3.0	800	800	350	10	15	150
60	1.4	1.6	18	22	400	3.0	800	800	350	10	15	150
60	12	1.4	16	22	400	3.0	800	800	350	10	15	150
50	1.1	1.3	15	1.8	400	3.0	1200	1200	300	18	15	150
60	1.1	1.3	14	2.0	400	3.0	1200	1200	300	18	15	150
60	1.1	1.3	14	2.0	400	3.0	800	800	300	18	15	150
60	1.0	1.2	13	2.0	400	3.0	800	800	300	18	15	150
60	1.0	12	13	2.0	400	3.0	800	800	300	10	15	150
20	+0.4	+0.3	+2	+0.6	+400	+1.0	+400	+400	+150	++	+5	+25
40	+0.5	+0.5	+5	+0.5	+100	+1.0	+400	+400	+150		+10	+50

folacin allowances refer to dietary sources as determined by *Lactobacillus cash'* assay after with enzymes ("conjugases") to make polyglutamyl forms of the vitamin available to the test organism
**The RDA for vitamin B1, in infants s basd on average concentration of the vitamin in human milk. The allowances after weaning are based on energy intake (as recommended by the American Academy of Pediatrics) and consideration of other factors such as intestinal absorption; see text.
÷÷ The increased requirement during pregnancy cannot be met by the iron content of habitual American diets nor by the existing iron stores of many women; therefore the use of 30-60mg of supplemental iron is recommended. Iron needs during lactation are not substantially different from those of non pregnant women, but continued supplementation of the mother for 2-3 months after parturition is advisable in order to replenish stores depleted by pregnancy.

Source: Guthrie. H. A (1979) Introductory Nutrition, 4th edition,
The C.V. Mosby Company, St. Louis, London

APPENDIX B

Mean heights and weights and recommended energy intake'

Catergory	Age • (years)	Weight		Height		Energy needs (with range)		
		kg	lb		in	kcal		MJ
Infants	0.0 - 0.5	6	13	60	24	kg x 115	(95- 145)	kg x48
	0.5- 1.0	9	20	71	28	kg x 105	(80- 135)	kg x44
Children	1 -3	13	29	90	35	1300	(900 - 1800)	5.5
	4—6	20	44	112	44	1700	(1300 - 2300)	7.1
	7- 10	28	62	132	52	2400	(1650 - 3300)	10.1
Males	11 - 14	45	99	157	62	2700	(2000 - 3700)	11.3
	15 - 18	66	145	176	69	2800	(2100 - 3900)	11.8
	19 - 22	70	154	177	70	2900	(2500 - 3300)	12.2
	23 - 50	70	154	178	70	2700	(2300 - 3100)	11.3
	51 -75	70	154	178	70	2400	(2000- 2800)	10.1
	76+	70	154	178	70	2050	(1650 - 2450)	8.6
Females	11—14	46	101	157	62	2200	(1500- 3000)	9.2
	15 - 18	55	120	163	64	2100	(1200 - 3000)	8.8
	19 - 22	55	120	163	64	2100	(1700 - 2500)	8.8
	23 - 50	55	120	163	64	2000	(1600 - 2400)	84
	51 - 75	55	120	136	64.0	1800	(1400 - 2200)	7.6
	76+	55	120	163	64	1600	(1200 - 2000)	6.7
Pregnant						+300		
Lactating						+500		

*From: Recommended Dietary Allowances. Revised 1979. Food and Nutrition Board National Academy of Sciences National Research Council. Washington. D.0

The data in this table have been assembled from the observed median heights and weights of children shown in Table I. together with desirable weights for adults given in Table 2 for the mean heights of men (70 inches) and women (64 inches) between the ages of 18 and 34 years as surveyed in the US population (HEW/NCHS data°

The energy allowances for young adults are for men and women doing light work. The allowances for the two older age groups represent mean energy needs over these age spans allowing for a 2% decrease in basal (resting) metabolic rate per decade and a reduction in activity of 200 kcal/day for men and women between 51 and 75 years. 500 kcal for men over 75 years and 4(X) kcal for women over 75 The customary range of daily energy output is shown for adults in parentheses and is based on a variation in energy needs of ±-400 kcal at any one age.. emphasizing the wide range of energy intakes appropriate for any group of people.

Energy allowances for children through age IS are based on median energy intakes of children these ages followed in longitudinal growth studies. The values in parentheses are 10^{th} and 90^{th} percentiles of energy intake, to indicated the range of energy consumption among children of theses ages/

Sources of Appendices: Guthrie 11. A (1979) Introductory Nutrition 4^{th} edition. The C.V Mosby Company. St. Louise London

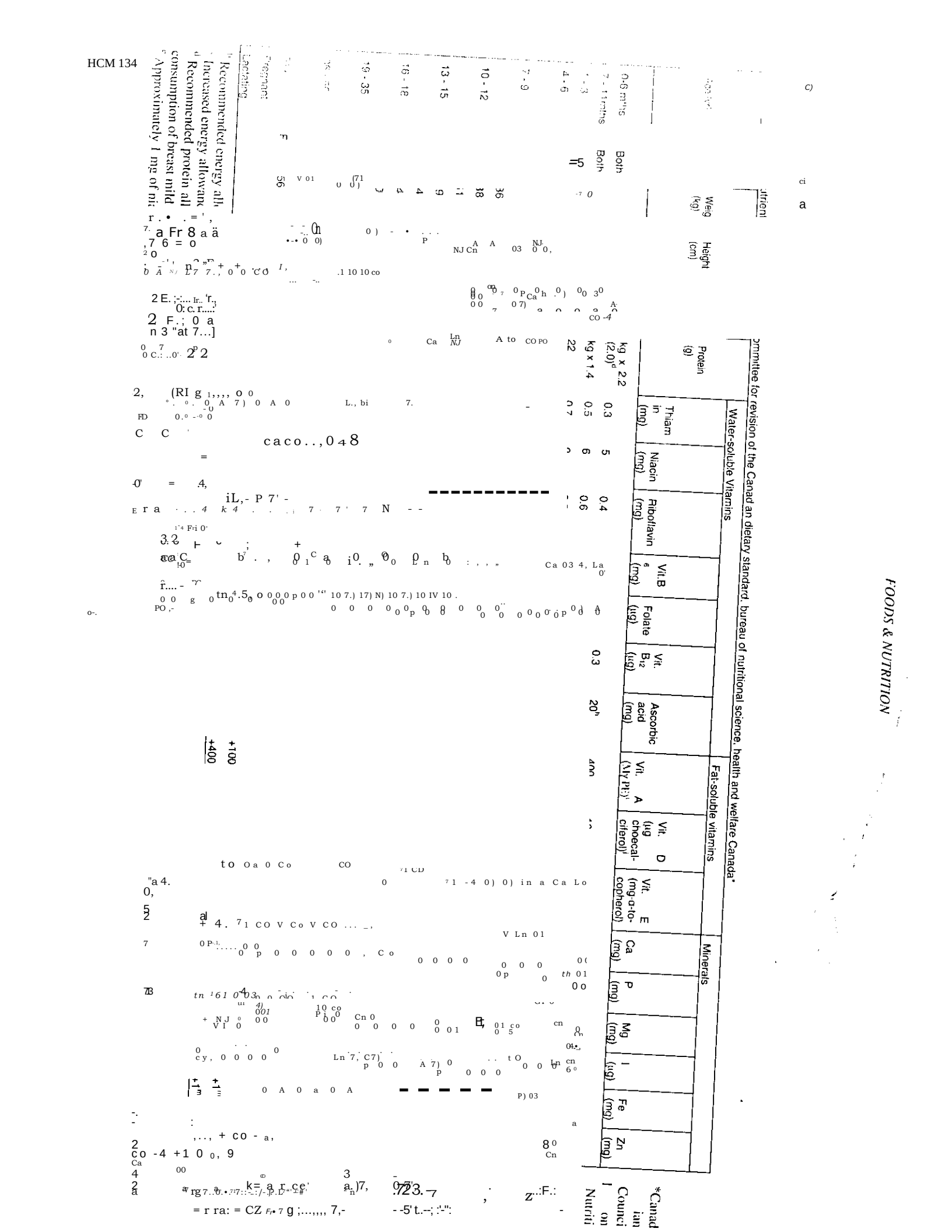
APPENDIX C

United States Recommended Daily Allowances (U.S. RDA)*

	Adults and children 4 or more years of age (For use in labeling conventional foods and also for 'special dietary foods")	Infants	Children under 4 years of age (For use only with 'special dietary foods"	Pregnant Or lactating women
Nutrients which must be declared on the label (in the order below)				
Protein+		45g "high quality protein 65g 'proteins in general'		
Vitamin A	5000 IU	1500 IU	2500 IU	8000 IU
Vitamin C (or ascorbic acid)	60 mg	35 mg	40 mg	60 mg
Thiamin (or vitamin BO	1.5 mg	0.5 mg	0.7 mg	1.7 mg
Riboflavin (or vitamin B2)	1.7 mg	0.6 mg	0.8 mg	2.0 mg
Niacin	20 mg	8mg	9 mg	20 mg
Calcium	1.0 mg	0.6 g	0.8 g	1.3 g
Iron	18 mg	15 mg	10 mg	18 mg
Nutrients which may be declared on the label an the order below)				
Vitamin D	400 IU	400 IU	400 Ill	400 IU
Vitamin E	30I1)	5 IU	10 IU	301U
Vitamin B6	2.0 mg	0.4 mg	0.7 mg	2.5 mg
Folic acid (or folacin)	0.4 mg	0.1 mg	0.2 mg	0.8 mg
Vitamin B12	6117	2 pg	3 Mg	8 pg
Phosphorous	1.0 g	0.5 g '	0.8 g	1.3 g
Iodine	150 py	45 jig	70 jig	150 jig
Magnesium	400 mg	70 mg	20 mg	450 mg
Zinc f	15 mg	5 mg	8 mg	15 mg
Copper t	2 mg	0.5 mg	1 mg	2 mg
Biotin t	0.3 mg	0.15 mg	0.15 mg	0.3 mg
Pantothenic acid t	10 mg	3 mg	5 mg	10 mg

*U.S. RDA- is a new term replacing "MI111111011[1] daily requirement" (MDR). RDA value chosen are derived from the highest value for each nutrient given in the NAS-NRC tables except for calcium and phosphorous. flligh quality protein" is defined as having a protein efficiency ratio (PER) equal to or greater than that of casein; "proteins in general' are those with a PER less than that of casein. Total protein with a PER less than 20% that of casein are considered "not a significant source of protein- and would not be expressed on the label in tams of the U.S. RDA but only as amount per serving.

There are no NAS-NRC RDAs for biotin, pantothenic acid, zinc and copper.



Committee for revision of the Canadian dietary standard, bureau of nutritional science, health and welfare Canada*

Nutrient	Weight (kg)	Height (cm)	Protein (g)	Water-soluble Vitamins						Fat-soluble vitamins			Minerals						
				Thiamin (mg)	Niacin (mg)	Riboflavin (mg)	Vit.B6 (mg)	Folate (µg)	Vit. B12 (µg)	Ascorbic acid (mg)	Vit. A (µg Ret Eq)	Vit. D (µg cholecalciferol)	Vit. E (mg-a-tocopherol)	Ca (mg)	P (mg)	Mg (mg)	I (µg)	Fe (mg)	Zn (mg)
0-6 mths	6	60	2.0 kg x 2.2	0.3	5	0.4	0.3	30	0.3	20	400	10	3	400	300	40	50	6	5
7 - 11 mths	9	72	1.4 kg x 2.2	0.5	6	0.6	0.4	45	0.5	20	400	10	4	600	400	60	70	10	5
1 - 3	13	90	22	0.7	9	0.8	0.5	70	0.7	25	400	10	5	600	400	80	90	7	5
4 - 6	20	112	30	0.9	12	1.1	0.7	100	1.0	30	500	10	6	800	600	120	90	10	7
7 - 9	28	132	36	1.1	16	1.3	1.0	150	1.5	35	700	10	7	800	600	170	120	8	7
10 - 12	36	147	43	1.3	18	1.5	1.2	200	2.0	40	800	10	8	1000	800	220	120	8	8
13 - 15	49	162	46	1.5	20	1.7	1.4	250	2.0	45	1000	10	9	1200	1000	270	150	8	9
16 - 18	54	165	46	1.5	20	1.7	1.4	250	2.0	45	1000	10	9	1200	1000	280	150	8	9
19 - 35	54	165	44	1.4	19	1.6	1.4	250	2.0	45	1000	10	9	1000	800	280	150	8	7
36 - 55	54	165	44	1.4	19	1.6	1.4	250	2.0	45	1000	10	9	1000	800	280	150	8	7
56 - 75	54	165	44	1.4	19	1.6	1.4	250	2.0	45	1000	10	9	1000	800	280	150	8	7
76 +	54	165	44	1.4	19	1.6	1.4	250	2.0	45	1000	10	9	1000	800	280	150	8	7
Pregnant			+10	+0.1	+2	+0.2	+0.2	+100	+0.3	+20	+200	+5	+2	+400	+400	+40	+25	[illegible]	+2
Lactating			+20	+0.2	+3	+0.3	+0.2	+100	+0.3	+40	+400	+5	+3	+400	+400	+80	+50	[illegible]	+3

[illegible] Recommended energy allowance

[illegible] Increased energy allowance

Recommended protein allowance

consumption of breast milk

Approximately 1 mg of nic

*Canadian Council on Nutrition

Recommendations are based on the estimated average daily protein intake of Canadians g Recommendations given in terms of free folate

Considerably higher levels may be prudent for infants during the first week of life to guard against neonatal tyrosinemia

'One pg retinol equivalent (I ph RE) corresponds to a biological activity in humans equal to I pg of retinol (3.33 IU) and 6 pg of 11-carotene (10 U)

One mg cholecalci feral is equivalent to 40 IU vitamin D

"Most older children and adults receive enough vitamin D from irradiation but 2.5 pe daily is recommended. This recommended allowance increases to 5.0 pg daily for pregnant and lactating women and for those who are confined indoors or otherwise deprived of sunlight for extended periods.

' The intake of breast-fed infants may be less than the recommendation but is considered to be adequate

"A recommended total intake of IS mg eaily during pregnancy and lactation assumes the presence of adequate stores of iron. If stores are suspected of being inadequate, additional iron as a supplement is recommended.

Cup, not pressed down	1 cup	2	18			0	19.1	7.7	0.3	4	1376	807			7		
Tablespoon			18						Trace	Trace	69	40					
0 a)			18			9			0.1	1	390	229					
Provolone			41						0.1	1	214	141	d				
Ricotta, made with																	
Whole milk									0.7	7	509	389	0.9		1		
Part skim milk	1		74						0.5	13	669	449	1.1		1		
Romano	1		31				-	-	-	1	302	215	-	-		-	

From Nutritive value of foods, House and Gardens Bulletin No. 72 Washington D.C, 1977, U.S. Department of Agriculture.pp. 4 to 30
Oshes denote lack of reliable data for a constituent believed to be present in measurable amount.