UNIT 4: LIPIDS

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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

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