Chapter

8

Foodstuffs

MILK

Milk is the lacteal secretion of mammals. As it is the only food of the young ones of mammals for a considerable period of their early life, nature has provided in it all the nutrients in an ideal proportion. It meets the nutritional requirements of adults too, save for iron and some vitamins.

Composition of Milk

Composition of milk depends upon many factors including the period of lactation, species, age, nutrition, and physical and mental condition. There is considerable individual variation too. The mammary secretion during the first three days after parturition is known as colostrum. It is yellowish, alkaline and more viscid than mature milk. It is richer in proteins, minerals, lecithin and cholesterol. Colostrum gradually changes into mature milk in about two weeks, the secretion during the intervening period being known as transitional milk.

Human beings usually consume human milk, cow's milk, buffalo's milk, and less commonly goat's milk. The average concentration of chief solid constituents in the milk of these species is given in Table 8.1.

Table 8.1: Chief solid constituents in the milk of human, cow, buffalo and goat

Species	*Proteins (gm/100 ml)*	*Fats (gm/100 ml)*	*Carbohydrates (gm/100 ml)*	*Ash (gm/100 ml)*
Human	1.2	3.8	7.0	0.2
Cow	3.3	3.8	4.8	0.7
Buffalo	4.7	7.5	4.8	0.8
Goat	3.4	4.1	4.7	0.8

The milk, as sold in the market, is legally required to contain a certain minimum concentration of solids and fats. The U.S. law lays down a minimum fat content of 3.25% and a minimum non-fat solid content of 8.25%. The exact legal standards vary from country to country and, within a country, from state to state.

Milk Proteins

Milk contains casein, lactalbumin and lactoglobulin. Quantitatively, casein and lactalbumin are predominant. Their ratio is 3 : 1 in cow's milk and 1 : 2 in human milk. Casein is present as a salt, calcium caseinate. There are at least four types of casein—alpha, beta, gamma and kappa. Lactalbumin and lactoglobulin are typical heat-coagulable albumins and globulins. All the three proteins are of a high biological value containing all the essential amino acids.

Milk proteins also include immunoglobulins belonging to the class, secretory IgA. Secretory IgA, present in mother's milk, provides passive immunity to the infant against a variety of gastrointestinal infections.

Milk Fats

Fat is very finely emulsified. It is mainly present as triglycerides containing a variety of fatty acids. Oleic and palmitic acids are the predominant fatty acids, human milk being richer in the former and bovine milk in the latter. Cholesterol and free fatty acids are present in small amounts.

Milk Carbohydrates

Lactose is the principal carbohydrate of milk. Glucose and galactose may be present in traces. Lactose provides galactose to the developing brain for the synthesis of glycolipids. It also helps in the absorption of calcium. Moreover, since it is less sweet than most other sugars, it is less satiating.

Inorganic Components

Milk is a good source of nearly all the essential minerals with the exception of iron. Calcium, potassium, sodium, phosphate and chloride are found richly in milk. Magnesium and sulphur

are present in smaller concentrations. Several trace elements are also present.

Vitamins

Milk is rich in vitamin A, riboflavin and pantothenic acid. Taking into account the vitamin stores received from the mother during intrauterine life and those synthesized by the intestinal flora, the only vitamins that need to be supplemented in the diet of an infant are vitamins C and D.

The protein and mineral content of the milk of different species is related to the rate of growth of the newborn. The birth weight of the human newborn is doubled in 6 months. Hence, the protein and mineral content of human milk is low. The protein and mineral content of milk is very high in cat and dog which double their birth weight in about a week. The lactose content depends upon the rate of growth of brain. Human milk contains the highest concentration of lactose as the rate of growth of brain is the fastest in human infants.

Examination of Milk

Physical Examination

Observe the following physical properties of milk:

1. Colour: Milk is white in colour.
2. Appearance: It is an opaque, thick liquid.
3. Odour: Milk has a characteristic odour which differs from species to species.
4. Reaction: It is neutral or acid to litmus. The pH of milk normally lies between 6 and 7.
5. Specific gravity: Measure the specific gravity of milk with a lactometer. Float the lactometer in a cylinder containing milk taking care that it does not touch the wall of the cylinder. The mark on the stem of the lactometer coinciding with the surface of the milk gives the specific gravity of milk. Normally, the specific gravity of milk lies between 1.028 and 1.034.

Chemical Examination

Add one test tubeful each of milk, water and 1% acetic acid into a small beaker and mix thoroughly. Casein is precipitated at

its isoelectric pH along with fat which is physically carried with the precipitate. Filter and preserve the precipitate and the filtrate for the subsequent tests.

1. ***Tests with the Precipitate***

Take a small amount of the precipitate in a test tube. Add 10–12 ml of water and 2–3 drops of 10% sodium hydroxide. Shake until the precipitate dissolves, heating gently if necessary. Perform the following tests with the resulting solution:

1. Biuret test
2. Xanthoproteic test
3. Millon-Nasse test
4. Aldehyde test
5. Sakaguchi's test
6. Lead sulphide test
   (All the above tests are positive except the lead sulphide test as casein is very poor in cysteine and cystine, and the test is not given by methionine which is present in casein).
7. Neumann's test: Dry a small amount of the precipitate by pressing it between a folded filter paper. Perform Neumann's test with a portion of the dried precipitate. The test is positive showing the presence of phosphorus in casein.
8. Grease spot test: Dissolve a portion of the dried precipitate in ether, and perform grease spot test. A positive test shows the presence of fat.

2. ***Tests with the Filtrate***

Perform the following tests with the filtrate:

1. Biuret test
2. Heat coagulation test
3. Xanthoproteic test
4. Millon-Nasse test
5. Aldehyde test
6. Sakaguchi's test
7. Lead sulphide test
   (All these tests are positive, and show the presence of heat-coagulable proteins, lactlabumin and lactoglobulin).
8. Benedict's test: Lactose gives a positive test.

9. Barfoed's test: A negative test shows the absence of monosaccharides.
10. Osazone test: Characteristic crystals of lactosazone are obtained.
11. Test for calcium (*see* page 60 for procedure): A white precipitate shows the presence of calcium.
12. Test for phosphorus (*see* page 60 for procedure): A yellow precipitate shows the presence of inorganic phosphorus.

EGG

Hen's and duck's eggs are usually consumed as food. The average composition of hen's egg is as follows:

Eggshell (made up of $CaCO_3$)	10%
Egg white	60%
Egg yolk	30%

The edible part (egg white and egg yolk) is composed of:

Water	70 to 75%
Proteins	12 to 15%
Fats	10 to 11%
Carbohydrates	1 to 1.5%
Ash	1%

Egg White

Egg white is mainly composed of proteins and minerals. The proteins are ovalbumin, ovoglobulin and ovomucoid. Egg white also contains a small amount of the protein, avidin which binds biotin, and prevents its absorption from the intestine. Avidin is inactivated on heating.

Egg Yolk

Egg yolk mainly contains proteins, lipids and minerals. Its water content is much less as compared to egg white. The proteins are ovovitellin, ovalbumin and ovoglobulin. The main lipid is lecithin which is combined with vitellin to form lecithovitellin. Other phospholipids, cholesterol and glycerol are present in smaller amounts. The chief minerals are calcium

and phosphate. Small amounts of vitamins A, D, E and B complex are present.

Examination of Egg

Take an egg, and collect the egg white and egg yolk in separate beakers. Examine them separately.

Examination of Egg White

Physical examination: Observe the following physical properties:

1. Appearance: It is a viscous lipid.
2. Colour: It is white in colour.
3. Odour: It has a characteristic odour.
4. Reaction: It is alkaline to litmus.

Chemical examination: Beat the egg white with four times its volume of water, and perform the following tests:

1. Biuret test: A positive test shows the presence of proteins.
2. Test for ovomucin: Take 3 ml of the egg white solution in a test tube. Add 1% acetic acid drop by drop with continuous stirring. A frothy precipitate of ovomucin is obtained.
3. Heat coagulation test: A positive test shows the presence of albumin and globulin.
4. Half saturation test: Globulin is precipitated by half saturation with ammonium sulphate. Filter and perform the subsequent test with the filtrate.
5. Full saturation test: Albumin is precipitated by full saturation with ammonium sulphate.
6. Xanthoproteic test
7. Millon-Nasse test
8. Aldehyde test
9. Sakaguchi's test
10. Lead sulphide test

The tests (6) to (10) are positive and show the presence of various amino acids in the proteins of egg white.

Examination of Egg Yolk

Physical examination

1. Appearance: It is a thick viscous liquid.
2. Colour: It is yellow in colour.

3. Odour: It has a characteristic odour.
4. Reaction: It is alkaline to litmus.

Chemical examination: Dilute the egg yolk 1 : 4 with saline for tests for proteins and amino acids except Neumann's test. Perform Neumann's test and the tests for lipids with concentrated egg yolk.

1. Biuret test: A positive test shows the presence of proteins.
2. Heat coagulation test: A positive test shows the presence of albumin and globulin.
3. Half saturation test: Globulin is precipitated by half saturation with ammonium sulphate. Filter and perform the subsequent test with the filtrate.
4. Full saturation test: Albumin is precipitated by full saturation with ammonium sulphate.
5. Neumann's test: A positive test shows the presence of ovovitellin which is a phosphoprotein.
6. Dunstan's test: A positive test shows the presence of glycerol.
7. Salkowski's test: A positive test shows the presence of cholesterol.
8. Liebermann-Burchard test: A positive test shows the presence of cholesterol.

Perform the colour reactions for amino acids as with the egg white. All of them are positive indicating the presence of various amino acids in the proteins of egg yolk.

MEAT

Meat consists mainly of skeletal muscle. Non-fleshy part of meat is known as offal. Meat is an important source of proteins of high biological value in a non-vegetarian diet. The composition of uncooked meat is as follows:

Water	75 to 80%
Proteins	18 to 20%
Fats	1 to 2%
Glycogen	0.5 to 1.5%
Creatine	0.1 to 0.5%

Various minerals such as potassium, sodium, calcium, iron, phosphate and chloride are also present. On cooking, the proportion of solids increases by about 50% due to evaporation of water.

Preparation of Meat Extract

The animal is killed, bled and skinned. The muscles are excised and washed with 0.85% saline. They are thoroughly chilled by keeping them on ice and then minced. Five volumes of 0.5 M magnesium sulphate or potassium chloride are added to the mince. The mixture is kept in refrigerator for 24 hours. The extract is filtered, and the filtrate is examined.

Examination of Meat Extract

Physical Examination

Observe the following physical properties:

1. Appearance: It is an opalescent liquid.
2. Colour: It is light pink in colour.
3. Odour: It has a characteristic odour.
4. Reaction: It is acid to litmus.

Chemical Examination

Perform the following tests with the meat extract:

1. Biuret test: A positive test shows the presence of proteins.
2. Tests for myosin: Myosin, the chief protein of muscles, can be detected by the following tests:
   (a) Take 2 ml of the meat extract. Add an equal volume of cold water. Shake and allow to stand for a few minutes. Myosin is precipitated.
   (b) Keep a test tube containing 5 ml of meat extract in a water-bath at 37°–40°C for 15 minutes. Myosin is precipitated at body temperature.
   (c) To 5 ml of meat extract, add 1% acetic acid drop by drop. Myosin is precipitated at its isoelectric pH.
3. Heat coagulation test: A positive test shows that myosin is a heat-coagulable protein.
4. Xanthoproteic test
5. Millon-Nasse test
6. Aldehyde test

7. Sakaguchi's test
8. Lead sulphide test
   (The tests 4–8 are positive and show the presence of various amino acids in meat proteins).
9. Jaffe's test: This is a test for creatinine which is formed from creatine in the body.

Reagents

(i) Picric acid: Saturated solution in water.
(ii) Sodium hydroxide: 10% solution in water.

Procedure: Take 5 ml of meat extract in a test tube. Add 2 ml of saturated picric acid solution and 0.5 ml of 10% sodium hydroxide solution, mix and allow to stand for 5 minutes. A deep orange colour shows the presence of creatinine in meat extract.

Principle: Creatinine reacts with picric acid in the alkaline medium provided by sodium hydroxide to form orange-coloured creatinine picrate.

10. Uffelmann's test: This is a test for lactic acid which is formed from glycogen in exercising muscles.

Reagent: Uffelmann's reagent: This is prepared by mixing equal volumes of 10% ferric chloride and 1% phenol solutions just before use. The reagent is violet in colour.

Procedure: Take 5 ml of Uffelmann's reagent in a test tube. Add meat extract drop by drop (about 0.5–1 ml) with mixing. The colour changes to yellow indicating the presence of lactic acid in the meat extract.

Principle: Lactic acid reacts with ferric chloride in the presence of phenol to form yellow-coloured ferric lactate.

WHEAT FLOUR

Whole wheat flour is prepared by milling dried wheat. It is composed of:

Water	10 to 15%
Carbohydrates	70 to 75%
Proteins	10 to 13%
Fats	0.5 to 1%
Minerals	1 to 2%

The chief carbohydrate is starch. Cellulose is present in smaller amounts, mainly in the outer envelope of the grain. The proteins are gliadin and glutelin. The main lipid is a triglyceride, triolein. Calcium and phosphate are the most abundant minerals. Phosphate is partly found as inositol hexaphosphate (phytic acid) which cannot be absorbed from the intestines and which also impairs the absorption of calcium by forming insoluble calcium phytate. Small amounts of vitamins B complex and E are present mainly in the outer part of the grain. White flour is prepared by removing the outer layer of the grain. It is, therefore, poor in vitamins. Some cellulose, which adds roughage to the diet, is also lost.

When wheat flour is mixed with water, it acquires a characteristic sticky consistency due to the presence of gliadin. Gliadin, glutelin and water form 'gluten', which is responsible for the plasticity of the dough.

Examination of Wheat Flour

Mix a little wheat flour with water, and knead it thoroughly. Allow the dough so formed to stand for 15 minutes. Take a 100 ml beaker, and fill it three-fourths with water. Wrap a small piece of the dough in a muslin cloth, immerse it in the water in the beaker, and squeeze it hard. Starch comes out into the water, and an opalescent solution is formed. Keep squeezing the dough until starch ceases to come out. Examine the suspension in the beaker and the firm, sticky gluten left in the muslin cloth separately.

Tests with the Suspension

1. Iodine test: Boil 5 ml of the suspension until it becomes clear. Cool and perform iodine test. A positive test shows the presence of starch.
2. Half saturation test: Starch is precipitated by half saturation with ammonium sulphate. Filter and perform iodine test with the filtrate. A negative test shows that dextrin is absent.
3. Benedict's test: A negative test indicates the absence of reducing carbohydrates.

Tests with Gluten

Tests for gliadin: Take a small piece of gluten in a test tube. Add 15 ml of 70% ethyl alcohol. Boil for 2 minutes over a small flame. Cool and perform the following tests:

1. Biuret test: A positive test shows the presence of gliadin as this is the only protein soluble in 70% alcohol.
2. Xanthoproteic test
3. Millon-Nasse test
4. Aldehyde test
5. Sakaguchi's test
6. Lead sulphide test

The tests 2–6 are positive and show the presence of various amino acids in gliadin.

Tests for glutelin: Take a small piece of gluten in a test tube. Add 15 ml of 10% sodium hydroxide. Boil for 2 minutes over a small flame. Cool and perform the following tests:

1. Biuret test: A positive test shows the presence of 3 glutelin as it dissolves in dilute acids and alkalis.
2. Xanthoproteic test
3. Millon-Nasse test
4. Aldehyde test
5. Sakaguchi's test
6. Lead sulphide test

The tests 2–6 are positive and show the presence of various amino acids in glutelin.

BREAD

Bread is prepared from wheat flour to make it easily digestible. Dough is prepared by mixing wheat flour with water, a little salt and baker's yeast. It is thoroughly and kept a little above the room temperature for a few hours. The yeast cells multiply, and their amylolytic enzymes act upon starch converting it partially into dextrin, maltose and glucose. An amylolytic enzyme present in flour also becomes activated, and aids in the breakdown of starch. Some of the glucose is fermented by the yeast enzymes to form alcohol and carbon dioxide. The evolution of carbon dioxide causes expansion of

the dough. The dough is cut into loaves and baked in an oven at 235°C for 90 minutes. At this temperature, the yeast cells are killed and their enzymes destroyed. Most of the alcohol evaporates. The carbon dioxide expands causing the loaves to swell further, and also makes them spongy. In the outer layer of the loaves, which are subjected to the highest temperature, the proteins are denatured, starch is converted into dextrin, and dextrin is decomposed into a brown product, caramel.

Examination of Bread

Take the central portion of a slice of bread in a porcelain dish. Break it into small pieces. Immerse them in water for some time, and then rub the pieces between fingers. Strain through a muslin cloth. Squeeze the mass left in the muslin cloth until no more fluid comes out. Examine the suspension and the gluten left in the muslin cloth separately.

Tests with the Suspension

1. *Iodine test*: Boil 5 ml of the suspension until it becomes clear. Cool and perform iodine test. The first drop of iodine may produce blue colour indicating the presence of starch. Further addition of iodine produces a violet colour indicating the presence of dextrin.
2. *Half saturation test*: Starch is precipitated by half saturation with ammonium sulphate. Filter and perform iodine test with the filtrate. A violet colour indicates the presence of dextrin.
3. *Benedict's test*: A positive test shows the presence of reducing carbohydrates.
4. *Barfoed's test*: A positive test shows the presence of monosaccharides.
5. *Seliwanoff's test*: A negative test shows the absence of ketohexoses.

Tests with Gluten

Perform the tests for gliadin, glutelin and their constituent amino acids as in the case of wheat flour.

POTATO

Potatoes belong to the group of tubers. Quantitatively, they are an important constituent of an ordinary diet. Their carbohydrate content is high, protein content poor and fat content negligible. The carbohydrate is present almost entirely in the form of starch. Its concentration is nearly 20%. The chief protein is a globulin. Its concentration is about 1.5%. Some free amino acids are also present. Potatoes contain vitamin C and iron in very small amount but considering the bulk of potatoes in an ordinary diet, they constitute an important source of these two nutrients. The vitamin C content of potatoes declines on storage.

Examination of Potato

Take a sliced potato, and scrape its raw surface with a knife. Collect the scrappings in a beaker, and pour some water over them. Mix thoroughly. Boil for a few minutes and cool. Collect the supernatant fluid and perform the following tests with it.

1. Iodine test: A positive test shows the presence of starch.
2. Half saturation test: Starch is precipitated by half saturation with ammonium sulphate. Filter and perform iodine test with the filtrate. A negative test shows the absence of dextrin.
3. Biuret test: A positive test shows the presence of proteins. However, the test may be only faintly positive as the concentration of proteins is rather low.
4. Xanthoproteic test
5. Millon-Nasse test
6. Aldehyde test
7. Sakaguchi's test
8. Lead sulphide test

The tests 4–8 are faintly positive showing that the various amino acids are present in low concentrations.