FOODS

DR. EVA KUDLOVA

1 Food of vegetable origin

1.1 Cereals

Cereals are the staple food in most diets, and in the developing countries provide about two thirds of the ***energy and protein intake***. As countries become more affluent, the importance of cereals, and plant food in general, declines. However, cereal foods provide approximately 30 % of the energy, 50 % of the available carbohydrate, and 25 % of protein in European countries and North America. The major cereal grains are wheat, rice and corn. Barley, sorghum, millet, oat and rye are minor grains worldwide but are significant in some regions.

Cereal grains are also an important source of ***minerals*** and some ***vitamins***. A major factor influencing the nutritional value of flour is the milling process, in which the bran and germ are separated from the starchy endosperm and the starchy endosperm is ground to flour. Aleurone is removed during milling together with the pericarp and the testa as bran. Milling not only reduces the protein content of flours, but also changes the amino acids composition. Because vitamins and minerals are largely present in wheat fractions removed during milling, refined flours are much lower in vitamins and minerals than coarser flours.

In addition whole grains are excellent sources of dietary ***fibre*** important in prevention of several civilization diseases. A very high intake of unrefined cereal products rich in fibre and ***phytate*** has been associated with impaired utilization of zinc and other minerals. The adverse effects of phytate and/or fibre on mineral utilization have been extensively studied, but conflicting results have been reported.

Wheat is a major contributor to the food supply in the world. The wheat kernel generally consists of endosperm (81-84%), aleurone (6-7%), pericarp and testa (7-8%) and germ (3%). The pericarp surrounds the entire seed and acts as a protective covering. The pericarp and testa are largely

composed of cellulose, hemicellulose and lignin (all these are fibre). Their content of nutrients is low. The germ is rich in ***vitamins B***. ***Starch*** is the principal constituent of the endosperm and the endosperm contains virtually all the starch of the kernel. The starchy endosperm is the source of flour. Its cells are packed with starch granules, which lie embedded in a matrix that is largely protein. Wheat typically contains approximately 70% available carbohydrates, 14% protein, 2% fat and 1.8% ash. The ***limiting amino acids*** in the wheat protein ***are lysine and threonine;*** the ***major amino acids are glutamic acid and proline***.

In general, the concentration of minerals and trace elements in **maize** is lower than in other cereals. ***Pellagra*** (niacin deficiency) is found in areas, which heavily depend on maize as a staple food even when it is consumed as wholemeal. Among cereals, maize is particularly ***low in niacin***, and the niacin present is in a bound form. In addition, maize is ***low in tryptophan***, which may be converted into niacin in the body. Yellow maize is the only grain that contains useful quantities of carotenes. They are easily destroyed and are reduced during prolonged storage. Maize also contains some or all the B vitamins with the exception of vitamin B12. Maize is a good source of vitamin E.

Rice is the staple food of east, southeast and south Asia where 90% of the world's crop is produced and consumed. In brown rice only the hull has been removed. Undermilled rice or unpolished milled rice is rice from which the hulls and all or part of the germ and pericarp have been removed; little of the aleurone layer is removed. Regular milled rice, marketed as polished or white rice, is rice from which the hulls, practically all of the germ and pericarp, and most of the aleurone have been removed. Protein, fat, vitamins and minerals are present in greater quantities in the bran removed than in the remaining endosperm, which is composed mostly of starch. ***Beri beri*** (vitamin B1 deficiency) develops if polished rice is the predominant source of food. Among cereals, rice has a ***comparatively high content of essential amino acids*** and a fairly low content of glutamic acid and other non-essential amino acids. However, ***lysine is the first limiting amino acid*** followed by threonine.

1.2 LEGUMES

Dry or common beans are legume seeds largely consumed by the human population in most of the world. Peas, lentils beans (Phaseolus vulgaris), soy bean (Glycine max) and groundnuts (Arachis hypogea) are the most widely consumed species.

Legume seeds are a good source of ***protein and energy***. Energy comes mainly from carbohydrate, starch being the main component. From the various studies protein averages 23.6% and carbohydrate 62.8% with an estimated total energy of 1500 kJ/100 g of dry legume seeds. The protein content of the beans is influenced by various factors, like nitrogen fertilization of the soil, yield of seeds per unit area and to a lesser extent by genotypes. Beans protein digestibility is considered lower than good quality animal proteins. The nutritive value of the bean ***protein*** is strictly related to its limiting amounts and low bioavailability of the sulphur containing amino acids, particularly methionine. The content of ***fats*** is generally low but shows a considerable variation among varieties (0.4-4%). The concentration of fats in dry seed legumes is varies from 1 to 4 % with the exception of soy bean (19% of fat) and groundnuts (40%). The dietary ***fibre*** may represent from 10 to 20% of the whole dry seed legume. Dry beans (Phaseolus vulgaris) are a fairly ***good source of some essential minerals***, namely Ca, Fe, Cu, Zn, P, K and Mg. On the other hand, phytic acid present in beans is a chelating agent, which may interfere with bioavailability of minerals, mainly with Zn, Mn, Cu and Fe. This has been fairly well studied in soybean. Beans constitute a poor source of fat-soluble vitamins and vitamin C. They are a good source of vitamin B1, B6 and folacin and a fairly good source of niacin. Here again the main problem may be related to the bioavailability of vitamins of cooked beans and their interaction with other food components. Fibre and phenolics are capable of reacting with vitamins interfering with bioavailability.

1.3 Vegetables

1.3.1 Tubers

The underground organs of many plants are widely consumed. These vegetables were particularly important before the development of refrigerated storage because they can be stored under simple conditions for quite long periods, and together with cereals, provided a staple supply of food energy throughout the winter.

Potato. The plant is native to the high Andes and the tubers were imported into Europe by the early explorers of the Americas, where they became established as a food crop in the late 17th and early

18th century. Potato provides about 300 kJ of **energy** per 100g. The biological value of potato ***protein*** (2 g/100g) is quite high, it contains significant amounts of ***vitamin C*** (10-16 mg/100g) and the amounts consumed in the Czech Republic and some other countries make is a major source of this vitamin providing about one quarter of the total intake. It is also an important source of thiamine, iron and fibre. The potato contains alkaloids of the ***solanidine*** group, the level of which varies between varieties, but which are higher in the skin and sprouts. Greening of the potato on exposure to the sunlight leads to increased concentration as does physical damage. These glycoalkaloids make potato bitter and at high intakes are toxic.

When potatoes are boiled, the cooking water leaches out water-soluble vitamins and this loss adds to the thermal losses of vitamin C. Mashing boiled potatoes disrupts the cell walls and increases the absorption of water by the starch. Frying of potatoes causes loss of water as steam and the potato absorbs fat from frying medium. The fat content of the final chip can vary over a wide range, higher frying temperature usually leading to less uptake, but in commercially prepared chips a range of 7-15 g/100g can be found.

Sweet potato and yam are also important and widely cultivated across the tropical world. **Sweet potato** (Ipomoea batatas) produces tubers similar to the potato in composition but have higher dry matter, and therefore higher starch content. The tubers contain little protein and the vitamin C content is a little higher. The flesh of the sweet potato may be white or yellow; the latter varieties provide a source of carotene. The **yam** (Discorea spp.) contains mainly starch, with little protein, and yellow flesh varieties provide carotene.

1.3.2 Root crops

The major root crops are members of two plant families: the Cruciferae, which includes **turnips**, and the Umbelliferea, including **carrots** and **parsnips**. Typically they are rather high in water, with low protein contents. The carbohydrates include free sugars and some starch in the more mature roots. They contain relatively low amounts of dietary fibre and most other nutrients, carrots being the exception, being very rich in carotenoids. Beetroots are very rich in anthocyanin pigments, but contain virtually no carotenoids.

Cassava (Manihot utilissima, manioc). The tree was native to South America but is now widely cultivated in tropical Africa and Asia. The fresh root contains mainly water (50-75 g/100g) with about 1 g/100g protein, the remainder being starch. The root also contains cyanogenic glycoside ***linamarin***, which is highly toxic, and the roots are traditionally ground, washed and dried to hydrolyse the major part of this toxin. Cassava is the staple food of many people in the tropics, despite the need to prepare it very carefully to prevent toxicity. It is however a ***low protein*** food and communities relying on cassava as a staple often have a high incidence of protein energy malnutrition. ***Tapioca*** is a starch product prepared from cassava.

Sugar beet (Beta vulgaris subsp. cicla). Although not consumed as a vegetable, the sugar beet is one of the most important root crops cultivated in northern Europe. It is processed to produce ***sucrose*** - the familiar table sugar. Sugar beet syrup is also important food ingredient in many products. A small fraction of the pulp is processed to produce a dietary fibre fraction for use in human foodstuffs.

1.3.3 Other vegetables

Leafy vegetables include a wide range of leaves and stems of the food plants. As a group the leafy vegetables are relatively low in dry matter and therefore energy; the leaves contain proteins, sugars and cell wall material, although on weight basis the levels are relatively low. Their major importance lies in the contribution of vitamins, as they contain ***carotenoids, vitamin C, and folates*** in particular, together with ***minor amounts of B-vitamins. Potassium*** and ***magnesium*** are present at significant levels and the vegetables contain a range of ***trace elements*** absorbed from the soil. Many of the leafy vegetables are cooked before consumption, and cooking in water can lead to leaching and thermal losses of vitamin C, especially if the vegetables are left standing when cooked, prior to consumption. The use of pressure cookers and microwave cooking reduces vitamin losses. The freezing of vegetables involves minor losses of the labile vitamins. Canning produces slightly greater losses and drying may result in total loss of vitamin C and folates.

Onions (Allium spp) is a group of vegetables that are widely consumed because of the flavours they contribute. They are formed from the fleshy bases of the leaves (bulbs). A number of species are used as foods: **Allium cepa** is the main one, **chives, garlic,** and **leeks**. The nutritional composition is similar to that of leafy vegetables.

Vegetables consumed as their fruits. Some foods commonly considered as vegetables are botanically fruits. The family cucurbitaceae includes the **cucumbers, courgettes, marrows, pumpkins** and **squashes**. These foods are characterized by being very high in water content and provide minor amounts of sugars and dietary fibre. The vitamin C contents are low. The nutritional value of these vegetables lies principally in their ***provision of variety of taste and texture to meals***. Capsicums include sweet peppers, chilli and black pepper. The **sweet peppers** have a high vitamin C content. **Tomatoes** are also a significant source of vitamin C.

1.4 Fruits

Fruits are characterized by being ***high in water content***; which increases the bulk of food. They contain a ***mixture of glucose, sucrose and fructose*** with the proportion varying according to the fruit. The non-starch polysaccharides are present to the extent of 2-4 g/100g in all and are typically rich in water-soluble ***pectic substances***. The fruits as well as vegetables are primarily seen as a source of vitamins, especially ***vitamin C***, although the concentrations in different fruits show wide variations. Green and yellow-coloured fruits are also important sources of carotenoids, which are believed to have protective roles other than acting as pro-vitamin A.

2 Food of animal origin

2.1 Meat

Major carcase meats are produced from **cattle, sheep** and **pigs** in Europe and the USA, whereas in the Middle East, Africa and the Indian subcontinent goat, **camels, water buffalo** are more important. One of the major changes in diets in many countries, is the growth in importance of ***poultry meat***, especially from chicken and turkey. Meat is not an essential component of the diet and societies that have adopted vegetarian diet do not show evidence of malnutrition when the supply of total food is adequate.

The composition of all meats is dependent of the ratio of fat to lean, which determines the energy value and the concentrations of virtually all nutrients, because the nutrients are present in different concentrations in the fat and the lean. It is consequently difficult to give a mean or typical values for meats as a whole without specifying the fat : lean ratio. The water content declines as the

fat increases, the protein contents are around 20% in most fresh meats, and the fat content of wild animals is usually lower than comparable domesticated species. Domesticated species have been selected for growth rate, and until recently the ideal animal was a fat one. The composition of the organs, which are collectively called offal shows much smaller variations.

Meats are conventionally seen as ***protein*** foods and this is true for the lean, which contains substantial amounts of high biological value protein. The amino acid composition shows that when compared with the amino acid requirements of man, and the ideal reference protein, the balance of amino acids is very close to the reference. The major proteins of connective tissue, collagen and elastin, have imbalanced and inadequate amino acid compositions.

Meats as a whole are important sources of ***fat*** in the diet. A range of different classes of lipid is present in animal tissues: triglycerides, which form the fat stores in adipose tissues in subcutaneous fat; the abdominal fats surrounding kidney and the intestines, and the marbling fats between the muscle blocks; phospholipids within cell membranes and nervous tissues; glycolipids in brain and other neural tissues; and lipoproteins in many tissues. In lean tissues the major lipids are phospholipids, but in adipose tissue the triglycerides are the most abundant and the fat in meat is principally triglyceride. The fatty acid composition of the fat principally depends on whether or not the species is a ruminant. The fat in non-ruminants is dependent on the composition of the fats in the animal's diet, whereas that of the ruminant is affected by the activities of the microflora in the rumen, which hydrogenate much of the ingested fat, so that the fats of ruminant animals are usually highly saturated.

Meats also contain a range of inorganic constituents; they are relatively low in sodium and calcium, and high in ***potassium, phosphorus*** and ***magnesium. Iron*** levels are high in meats that have not been bled out at slaughter, and in blood products; ***zinc, copper*** and ***several trace*** elements are present in meat. The ***inorganic constituents are mostly found in the lean portion***. Very important nutritional characteristic is high bioavailability of the inorganic nutrients they contain. Meats contain most of the ***B vitamins*** and they are especially important as a source of ***vitamin B_{12}***. The ***fat soluble vitamins are present in the fat***, the concentration being highly dependent on the diet eaten by the animal.

2.2 Fish and seafood

Fish and a wide variety of seafood have always been important in the diet of the communities living close to the sea, rivers and lakes. The importance of fish grew with the development first of refrigerated transport and then of on-board refrigeration on the fishing vessels. Fish are unstable commodity, and among the early products of spoilage are ***trimethylamine*** and ***ammonia***, which reduce consumer acceptability.

Fish are seen as important sources of good-quality ***protein***. The protein is accompanied by very low amounts of ***fat*** in white fish, crustaceans and molluscs, and the fat from fish as a whole, is characterized by the ***high proportion of long-chain polyunsaturated fatty acids***.

The concentrations of the inorganic nutrients in fish are not particularly unusual when compared with meats, with the exception of ***calcium*** in fish with fine bones, ***where the bones are eaten together with flesh***. Shellfish tend to accumulate trace elements, so that oysters are one of the richest sources of zinc eaten. Fish are a major source of ***iodine***, again being accumulated from their environment.

2.3 Eggs

The hens' eggs are the most important, with minor usage of duck, goose, and quail eggs. The protein of egg contains the amino acid essential for the development of the embryo, and for this reason egg protein ***was the reference protein for biological evaluation and assessing amino acid pattern*** for a considerable period. It is now recognized that it is perfect for the chicken but not necessarily for other species, and other ***amino acid compositions are now seen as ideal for humans***. The ***lipids*** in eggs are rich in phospholipids and the fatty acid composition shows quite a ***high polyunsaturated : saturated ratio***. ***Cholesterol*** content of one average egg is about 280 mg. Although the opinion regarding the effects of dietary cholesterol on blood levels has changed, the cholesterol content of eggs is still perceived negatively by many consumers. The eggs contain the ***range of vitamins and minerals necessary for the development of the chick, and thus eggs are a valuable food***. The ***iron*** in eggs ***has a low bioavailability***, possibly because it is bound to the egg proteins. Egg white contains the protein ***avidin***, which binds to biotin and makes it unavailable to man. Cooking the egg denaturises the avidin and abolishes the effect.

2.4 Milk and milk products

Milk and milk products became part of the diet of adult humans when the hunter-gatherer developed into pastoralist. A land "flowing with milk and honey" was clearly very attractive to the biblical tribes as well as to the great forefather Czech. Liquid milk is a very unstable commodity and many products that evolved were fermented foods that could be stored and transported and thus extending their value. Milk in our context implies milk from the cow with a minor contribution from sheep and goat. In the Middle East, goat and camels are the milk animals and in the Far East water buffalo are important, the Lapps consume reindeer milk.

Milk and its products are excellent sources of many nutrients. The major ***protein*** in milk is ***casein***, which in cow's milk is around 80% of the total 3.2 g/100ml. The other major proteins are ***lactalbumin*** and a range of ***immunoglobulins***. The milk proteins are of high biological value, and their high lysine content means that when consumed with cereals, there is a substantial supplementation between the two sources of protein. The heat processing of milk leads to some loss of biological value, and this often correlates well with the proportion of lysine that has become unavailable because of interaction with carbohydrates. ***Allergic reaction to milk proteins*** are one of the most common forms of food intolerance. The production of cheese leads to the release of free amino acids into the product and the conversion of some of these to amines. The presence of ***tyramine*** can stimulate the sympathetic nervous system and is believed to be associated with migraine in susceptible people.

The amount of fat in milk varies between different species. Cow's milk ***fat*** content is 3.9 g/100ml with a significant proportion of ***short chain, volatile fatty acids***, and only ***low levels of unsaturated fatty acids***.

Milk contains disaccharide ***lactose*** and is the only known source of this sugar in the diet. When milk sours, the lactose changes its form and separates out in the liquid whey from the solid curd. The curd then may be processed for cheese. Thus, although milk has a relatively high carbohydrate content in the form of lactose, cheese has very little or none.

The ***sodium*** levels in milks vary over a narrow range, with that of mature human milk being substantially lower than that of cow's milk. Human milk also contains lower levels of ***K, Ca, Mg*** and especially ***phosphorus***. Milk contains both ***fat-soluble and water soluble vitamins***. The concentration of fat-soluble vitamins depends on the type of feeding and is usually higher in the summer months. The levels are broadly proportional to the fat content in both milk and milk products, because these vitamins are usually stable during the processing of milk. Skimmed milks are consequently low in the fat soluble vitamins and many proprietary products are fortified with a vitamin mix. Milks are a ***good source of B-vitamins***, but riboflavin levels decline on storage if the milk is exposed to sunlight. Some losses of thiamine occur on pasteurisation. Raw milk contains significant amounts of ***vitamin C*** but substantial losses occur on storage and following heat processing.

3 Fats and oils

A range of separated fats and oils are consumed as foods. Fats and oils are distinguished by their physical characteristic, ***oils being fluid at ambient temperatures and fats being solid***. The lipids from animal products tend to be solid fats whereas those from plants are usually oils, but the distinction lies in their fatty acid and triglycerol composition, not in the origin of fat. Chemically ***they are predominantly triacylglycerols***. During use some hydrolysis takes place, with the formation of free fatty acids but the level in fresh products is very low. Free fatty acids produce an unacceptable flavour and lead to rancidity.

Fats, with their energy value of 36 kJ/g are the ***richest source of energy***. Fats also ***provide the essential fatty acids and contribute to the absorption of the fat-soluble vitamins***. Fats are also important in connection with the palatability of foods. This has profound nutritional implications because it acts as a constraint on the compliance with nutritional advice to reduce total fat intake.

4 Beverages

Water is an essential component in the human diet, required to maintain the hydration of tissues and the composition of the extracellular fluid compartments of the body. In many societies the offering of a beverage is an integral part of welcoming a guest, and beverages often have a central role in their food cultures, so that the consumption of a beverage also has a symbolic role.

The consumption of water alone is not particularly attractive to people, and in the production of virtually all beverages great importance is attached to organoleptic quality of the finished product, because this is a major factor in the acceptability of the beverage.

Soft drinks range from products consisting of water with added sugar and flavouring to those containing some fruit juice or fruit homogenates. The nutritional role of soft drinks is essentially limited to making the consumption of water attractive, while the sugar they contain contributes energy. Typically they contain about 10 g/100ml of sugar and therefore provide around 167 kJ/100 ml, so the consumption may provide a significant ***contribution to energy intake***.

Fruit juices are produced by expression from the fruits. The fruit juices are very similar in composition to the fruits from which they are derived, with the exception of fibre; their major role therefore lies in the ***provision of vitamin C***. The consumption of fruit juice as part of a meal results in a substantial ***improvement in the availability of iron in the meal*** as a whole.

Tea, coffee and cocoa, although derived from different plants, they contain alkaloids of the methyl xanthene group - ***caffeine, theobromine and theophylline***, - of which the caffeine is the most active and acts as a stimulant.

Mineral waters from natural springs, particularly those with pronounced flavours, have been ascribed health-giving properties by many cultures during human development. Many of these natural waters are rich in mineral salts, and others contain sulphurous compounds.

Alcoholic beverages appear to have been part of the human diet from very early times. **Beers, ales** and **stout** are produced by the fermentation of a cereal, usually barley, with yeast. The alcohol content usually ranges between 3 and 7 g/100ml. Beers contain low concentrations of riboflavin and nicotinic acid, and may provide a good source of available iron whose absorption is enhanced by alcohol. The name **"wine"** is considered to apply only to the liquid produced by the fermentation of grape juice. Wine contains 10-17% alcohol, 0.4 – 1% organic acids,

small amounts of sugars, peptins, polyphenols, and traces of other substances. The **spirits** are produced from virtually all carbohydrates that can be fermented, and the carbohydrate source largely determines the flavour and aroma of different spirits. Nutritionally, spirits must solely be regarded as a source of energy from alcohol, as they contain virtually no other nutrients.