

COOKING AND ITS EFFECT ON NUTRITION

Lesson Aim

Describe appropriate food preparation for different foods - in relation to value for human health.

THE NUTRITIVE VALUE OF FOOD AFTER COOKING

The nutritive value of food depends not only upon what and how much is consumed but also how it is prepared. Given that food is unlikely to be eaten unless it is appetising, its preparation is very important to maintaining good nutrition. However the process of preparing and cooking food changes, not only its appearance and texture, but also its nutrient content and the availability of those nutrients. In this course we will assess the way in which nutrients are affected by the variety of processes that occur during the growth of foods, harvest, processing, storage, preparation and cooking. This will be followed by an examination of diet planning and assessment and the nutrient requirements of special needs groups.

Cooking involves the application of heat using moist or dry methods cooking might (in the process) increase palatability and appearance of food by:

- Enhancing and conserving natural flavours
- Blending flavours (e.g. in cakes, casseroles etc.)
- Producing the most suitable colour, form and texture
- Improve digestibility - For example tough meat should be more tender and easier to chew after cooking.
- Add variety to the diet - In terms of taste, appearance, aroma and texture and so encourage foods to be eaten.

Cooking can also improve the safety of food this is achieved by destroying pathogenic microorganisms.

It can also bring about changes in the nutrient value of food for example:

- Some fat is absorbed when foods are fried increasing their energy value.
- In grilling some fat may be lost.
- Nutrients may be lost by chemical breakdown or by being leached into cooking waters.
- Cooking may enhance or degrade the availability of different nutrients.

Cooking may therefore affect the nutrient value of food either beneficially, or negatively.

Meat and Poultry

Most foods of animal origin could be digested raw by man, but raw meats and fish are usually particularly unpalatable. Cooking makes it easier to chew so the digestive juices gain more rapid access to protein. At the same time, particularly with meat, an appetising aroma develops.

Meat is important in the diet for its good quality protein, iron and B group vitamins. On heating, the muscle tissue protein coagulates and is denatured, but only at high temperatures it will be destroyed. If carbohydrates are also included with the meat, an additional loss of nutritive value in the food occurs at high temperatures due to non-enzymatic browning. Some loss of the amino acid, lysine occurs in this way during the roasting of meat, but the amount is small. Non-enzymatic browning also accounts for the development of flavour, colour and aroma. This non-enzymatic browning process is called 'Maillard Reaction'. It is a chemical reaction that occurs between amino acids and reducing sugars when exposed to heat, affecting the bioavailability of some amino acids.

The protein of connective tissue, i.e. collagen, is not denatured on heating but moist cooking methods softens and starts to convert collagen to gelatine. During cooking of meat shrinkage occurs, causing extrusion of meat

juices. These form the 'drip' during the roasting of meat and if this is not used in making gravy, extractives such as iron and thiamine may be lost as well as fat soluble vitamins.

During moist methods of cooking these go into the cooking liquid and as the meat is generally eaten with the liquid of stews, casseroles etc., there is no loss. Fat melts during cooking; the higher the cooking temperature, the greater the loss of fat into the roasting tin or cooking liquid.

The loss of B group vitamins during cooking meat is significant especially as meat supplies about 20% of thiamine in the diet. The loss is proportional to the cooking temperature, and about 30-60% may be lost during roasting.

Preparation prior to cooking may also have an effect. A good example of this is vitamin D, which is a fat-soluble vitamin. This means that trimming the fat from a cut of meat will reduce the vitamin D content in the food. This does not mean all fat should be left on meat, but rather that excessive trimming of fat results in the loss of vitamin D in the food. This is important in assessing the nutritional value of a food.

Fish

Fresh fish does not generally require cooking; however, many people find the thought of raw fish unpalatable and care must be taken with handling and preparation to ensure contamination does not occur. In place of heat, fish may be 'cooked' with acids such as vinegar, or juices of citrus fruits. However, raw fish consumption can cause thiamine deficiency because of the presence of thiaminase which is destroyed with cooking.

The changes which occur during cooking of fish are similar to those in meat. Shrinkage is less and fish is not an important source of thiamine in the diet. Fatty fish contain vitamins A and D in the fat, these are heat stable, but may be lost in any fat lost during the cooking process. Fatty fish are also an important source of omega-3 fatty acid. Fish are an important source of iodine in the diet but only small amounts of iodine will be lost with cooking or acid preparation.

A major concern for people consuming fish is the mercury content. As a general rule, older, larger, faster swimming fish will have the highest levels of mercury. When catching your own fish to eat, cooking is particularly important as it is not always possible to tell what pollutants are in the water the fish lived in. While some pollutants can be reduced by trimming fat off the fish before cooking, mercury is found throughout the muscle tissue. Frying is a common cooking method for fish; however, deep frying serves to quickly seal the fish trapping any pollutants in. Cooking **will not** reduce the mercury content of fish.

Plant Foods

Most plant cells are surrounded by a tough wall of cellulose which is little disrupted by chewing. Digestive juice will also not penetrate this cellulose wall. Cellulose is softened by moist methods of cooking (steaming, broiling, boiling, stewing) so enabling digestive juices to penetrate the cell wall and reach the cell contents.

Fruits and green vegetables may be eaten raw in limited amounts, but cereals, roots and pulses (legumes, seeds) containing a greater amount of starch is not easily digested unless cooked. When starch granules are heated in the presence of water, water passes through the walls of the granules causing swelling. The cell walls surrounding the starch granules are softened, and the starch gelatinised. In this form the starch is easier to digest.

Fruits and vegetables are of importance in the diet because of their mineral element and vitamin content. A great deal of these, however, may be lost due to them being heat labile, water soluble, or sensitive to alkaline cooking liquids. Losses of Vitamin C, in particular, occur in these ways. Wastage of the outer darker green leaves of vegetables can also cause losses of vitamins and minerals in the diet. Apart from these losses of nutrients during the preparation and cooking of vegetables, cooking may also result in the loss of colour, especially in green vegetables. The rate at which colour change takes place depends on the pH, cooking temperature and cooking time. Sodium bicarbonate added to water increases the pH and improves the colour but has a detrimental effect on vitamin C; hence, it is not recommended.

Grains lose many nutrients during processing (this is discussed in the following lesson). However, during cooking, nutrient losses can also be great as most grain products i.e. rice, pasta, barley etc. are boiled and the

cooking water discarded. Using absorption cooking methods - where water is added and absorbed by the grains or is constantly added and absorbed during the cooking process, (e.g. as when cooking risotto) are the best options to retain nutrients.

THE EFFECT OF COOKING AND PROCESSING METHODS ON NUTRIENTS

The method of processing often affects vitamin content and availability. Water soluble vitamins can be affected by heat, acid, and other cooking methods, regardless of the type of the dish.

Water soluble vitamins can leach into cooking water. This means some vitamin content is often lost through evaporation. Degradation will depend on the amount of heat applied. Cooking can also make these vitamins more bioavailable. Conversely, it can also degrade these vitamins, ultimately reducing the overall content. It is difficult to consume too much of a water-soluble vitamin, because excess is excreted. This group includes the B vitamins and vitamin C.

Fat soluble vitamins are also affected by cooking. They will not leach into cooking water, but can leach into fats such as olive oil or butter. These vitamins can degrade with cooking, but not as easily as water soluble vitamins do.

When consumed in excess, fat soluble vitamins can be stored in the body's fat deposits. Over time, this accumulation can be dangerous. This groups includes vitamins A, D, E, and K.

Vitamins that are the most unstable when cooked/processed and stored:

- Ascorbic Acid (vitamin C)
- Folic Acid (vitamin B9)
- Thiamine (vitamin B1)

Vitamins that are more stable when cooked, processed or stored:

- Niacin (vitamin B3)
- Pantothenic acid (vitamin B5)
- Biotin (vitamin B7)
- Vitamin D
- Vitamin K

The nutrient content in food is influenced and changed through many processes including growing methods, harvesting methods, storage methods and food preparation methods. In this lesson we will concentrate on food preparation and cooking.

Baking

Baking is a commonly used cooking technique that applies dry heat to a food along with an air flow. It avoids the problems of nutrient loss due to leeching and is effective at breaking down starches. However, heat labile nutrients will be destroyed and the long cooking time will negatively affect nutrient value. Baked goods lose moisture and leech fats, tending to be dry. Loss of these fluids will invariably result in some loss of both water soluble and fat soluble vitamins. The pH of the food may be altered by adding acidic cooking ingredients or, in cakes, by adding baking soda (an alkaline ingredient).

Blanching

Blanching is the plunging of a food item into boiling water for a very short time period before removing it and transferring it to cold or icy water. The cold water stops the cooking process. Blanching can remove the bitter taste from some vegetables and can also enhance their colour, making them more appealing. The application of very high heat will kill many microorganisms and will also soften the tough fibres in vegetables.

The water soluble vitamins, including Vitamin C and B-complex vitamins, are heat sensitive (heat-labile) and easily destroyed by blanching so care must be taken not to blanch foods for too long and to quickly refresh foods in cold water to prevent heat labile nutrients from being destroyed.

Braising

A method of cooking that is similar to baking, however a liquid is placed beneath the food or the food placed in a liquid. The liquid, at high temperatures, will convert to steam and so the food will be partially baked and partially steamed. It is used primarily in the preparation of meat dishes, where the tough collagen fibres (in connective tissue) require high heat and time to become softened and palatable. This, of course, impacts on the level of heat-labile nutrients in the food and leeching may also be a problem in the early stages of cooking. High temperatures will seal foods quickly, helping to trap juices and the nutrients within them to some extent. Other terms for braising include stewing or pot-roasting. Casserole and stews are braised dishes. When the meat is kept in the fluid, or the fluid returned to the meat, nutrient losses will be lessened. Calcium and other essential trace minerals including magnesium, zinc and iron are unaffected by braising.

Grilling

Grilling, like baking, is a dry cooking method, the difference being that grilling is the direct application of heat to the food as opposed to hot air. Food is generally cooked very quickly, which is good for limiting nutrient degradation, but at very high heat, which causes loss of the heat-labile nutrients. Barbecuing, cooking over hot coals or charcoals are all considered variations of grilling. With larger cuts of meat cooking time is lengthened, resulting in additional nutrient loss. However, grilling tends to impart a pleasing flavour to foods, in some cases partially smoking them. Fat tends to drain away from foods, reducing calorie content as well as fat soluble vitamin content.

Poaching and Boiling

Poaching, as opposed to boiling, is the gentle heating of a food in water. Typically an acid is also added to the water (wine, vinegar, citrus juice) and this can impact on acid/pH sensitive vitamins such as vitamin K. Leaching is of course a major source of nutrient loss but as the heat is lower - B group vitamins should remain intact as the temperature is below 100°C. Mineral content is not dramatically altered with poaching or boiling more than with other cooking methods.

Pressure Cooking

Pressure cooking uses pressure to increase the temperature and decrease cooking time for example - at 100°C, and in normal pressure, water boils but in standard pressure cooking, water will not boil until it reaches closer to 125°C. The advantages of pressure cooking are that cooking time is reduced, leaching is reduced as fluids remain in the pot and food remains hydrated as steam does not all escape. However, the higher temperatures will affect heat-labile vitamins.

Roasting

Like baking, this is the application of conducted dry heat to a food. Typically a roasted dish comprises meat or vegetables, whilst baking infers the cooking of a grain or flour based product such as bread or cake. The methods are essentially the same although, usually, roasting may suggest the use of higher temperatures compared to baking. Roasted foods are generally basted with a fatty substance (lard, butter, oil, ghee etc.) to prevent leeching of juices. However, juices are lost (as with baking) and heat-labile (easily destroyed by heat) vitamins are, of course, destroyed in large amounts. Minerals remain intact with roasting.

Sautéing

This may also be referred to as shallow frying. Foods are cooked rapidly in a shallow pan coated with a small amount of fat (butter, oil, ghee or a combination). The rapid cooking and high temperature seals in nutrients but heat-labile vitamins will still begin to degrade. Technically to sauté foods - you flip or toss them about in the pan. Stir-frying is a similar fast-cooking method used in the Asian cuisine, as opposed to the European sautéing. Mineral contents are not affected by such cooking method.

Steaming

Steaming is an increasingly popular method of cooking because it requires no addition of fats or oils. Flavour is generally better retained as well as colour; leeching is not a concern. When the steaming time is short, palatability can be improved without too much loss of B-group vitamins and Vitamin C. Steaming protein foods such as fish, meat and poultry limits nutrient loss, which is, otherwise, caused by the excessive cooking time required for roasting. Steaming is a good alternative for cooking grains, as they contain niacin (a water soluble and heat-stable vitamin), that is lost to cooking water when grains are boiled.

FOOD PREPARATION AND COOKING TIPS

Preparing Vegetables, Cooking Vegetables and Nutrient Loss

When you trim or peel vegetables it is worth remembering that most vitamins and minerals are situated close to the skin surface or outer leaves of most vegetables. If vegetables are thickly peeled you can lose a large proportion of the food's nutrient value; folate and vitamin C, for example, can be lost by up to 25%, trace elements (microminerals) are also lost by thick peeling but in smaller proportions. Fibre can be lost in quite large proportions and protein can be reduced by 10%.

The effect is amplified when you consider the amount of nutrient content that is also lost if vegetables are subsequently boiled – for example: up to 90% of vitamin C is lost during boiling, calcium levels are reduced by around 50% along with folate and fibre, trace elements are also lost during boiling and depending on the element this loss can be from 10-20%. Some foods, e.g. tomatoes, lose 100% of folate and vitamin C during cooking.

When you boil vegetables, vitamins within them dissolve (solubilise) to the water. If you want to avoid this, to an extent, then you should consider steaming, grilling, roasting, stir-frying or micro-waving because these methods do generally tend to preserve vitamins and other nutrients far more efficiently than boiling does.

Temperature can also affect nutrient loss - by keeping the cooking temperature below 100°C you can considerably improve the retention of the vitamin B group.

Cooked Food - The Benefits

There are advantages to cooked food. It does not always lower the nutrient value.

Benefits of cooking food:

- It destroys bacteria and other harmful organisms that can contaminate food.
- It breaks down toxins in some foods that may be harmful in the raw food but not when cooked.
- It removes environmental pollutants.
- It makes phytochemicals that are unavailable in some raw food more available (e.g. in tomatoes).
- The food is tastier.
- It makes indigestible vegetables digestible (by breaking them down).

How to Preserve the Nutrient Value of Food

It sounds like common sense but preserving nutrient value is often the most overlooked when preparing and cooking foods. Here are some suggestions on how to retain the maximum nutrition in cooked foods:

- Use fresh food – food loses nutrients as it ages.
- Cook for the shortest time possible – food also loses nutrients during long cooking.
- Scrub and wash vegetables thoroughly and don't peel them.
- Always try to use the outer leaves of leafy vegetables if they are in good condition.
- Use vegetable cooking water for stock or sauces (but avoid boiling if possible and steam, grill, roast or microwave instead).

- Store food in airtight containers and keep it in the refrigerator; store vegetables in the fridge crisper.

SUMMARY OF KEY POINTS TO REMEMBER

In general, the content of minerals in a food is not significantly reduced by most cooking methods, although they may leech in small quantity into cooking fluids. Fat content can be reduced when cooking temperatures cause it to become liquid and flow out of foods. However, this requires adequate drainage, away from the food, to avoid frying. Carbohydrates may be leached into cooking fluids or begin to breakdown at higher temperatures. Complex proteins will denature (change their configuration and perhaps begin to break down into simpler units) with heat and long cooking times.

Generally, water soluble vitamins (B-group, and C) will leach into cooking water and are less heat stable than their fat-soluble counterparts (vitamins A, D, E, K). Degradation by air or light is generally a very slow process and should not be a concern when preparing foods for cooking but is more of a problem during storage.

The longer you cook a food the more you will degrade the nutrients in it. Calorie content of food is not altered by cooking, unless you are draining liquid fats or skimming solid fats during cooking. Proteins will be degraded by extremes of pH and temperature, but component amino acids should still be available and will be more easily digestible than a complex protein.

While cooking can degrade the nutrient value of foods it also:

- Destroys disease causing micro-organisms

- Enhances the availability and digestibility of some nutrients

- Can at least partially destroy the toxins and chemicals that plants may have been exposed to and animals may have ingested.

Nutrient loss can be alleviated by:

- Selecting appropriate cooking methods

- Re-using cooking water

- Reducing the amount of time a food is cooked particularly vegetables.

Some vitamins are heat-sensitive and will be destroyed by cooking. Others are affected by light or air exposure. The following table is a good guide to keep this lesson in mind:

Vitamin	Leaches into water?	Degraded by air?	Degraded by light?	Heat sensitive?	Additional information
Vitamin A	No	Slightly	Slightly	Slightly	
Vitamin B1 (Thiamine)	Yes	No	Unclear	<100°C No >100°C Yes	
Vitamin B2 (Riboflavin)	Slightly	No	If in liquids	No	Loss through leeching is significant for long cooking time or solution/food is alkaline
Vitamin B3 (Niacin)	Yes	No	No	No	Cooking can improve availability of niacin
Vitamin B6 (Pyridoxine)	Yes	Unclear	Yes	Yes, content remains the same, but available B6 is reduced	Can be destroyed by microwaving, more stable in plant foods than animal
Vitamin B12 (Cobalamin)	Yes	Unclear	Yes	No	Loss occurs if cooked in copper pots or acids
Vitamin B9 (Folate)	Yes	Unclear	Slightly	Only at very high temperatures	Degrades with storage
Vitamin C (Ascorbate)	Slightly	Yes	Yes	Yes	Affected by alkalinity and long cooking, one of the most fragile vitamins
Vitamin D	No	No	No	No	Improves availability of calcium
Vitamin E	No	Yes will make foods go rancid	Yes	No	Loss occurs if cooked in copper pots or for long periods or if cooked from frozen
Vitamin K	No	No	Yes	No	Very sensitive to extremes of pH

SET TASK

1. Investigate, by contacting your local government or council or via the internet or library, whether there are any laws in your area regarding the commercial preparation and cooking of foods. Take notes and obtain pamphlets, etc., if you are able.
2. Obtain a piece of chicken and a vegetable of your choice (if you do not eat chicken, substitute it for fish or for a second vegetable that is very different from the first; alternatively, you may use egg). You will need five small portions. Cook each using a different method. Try to use methods that are quite different to each other. Take notes or photographs, if possible, of the food before and immediately after cooking (remember to include the juices, or cooking water which contain or are a part of the original food!). Make notes on the changes in the food, the juices/cooking water, etc. Taste the foods and comment on the texture, taste and palatability as a result of your different cooking methods. For the vegetable, taste the raw product as well.

Assignment 1

Question 1

Cooking is the application of one of two types of heat. Name them and then classify all the methods of cooking (baking, blanching etc.) listed in your course according to which type of heat they use.

Question 2

How does cooking improve the safety of foods? Discuss in 1 paragraph maximum.

Question 3

Describe in 2-3 sentences each how cooking affects the following:

- B group vitamins in meats
- Connective tissues
- Fats
- Mercury in fish
- Mineral content of braised foods

Question 4

What is the best way to cook food to retain B group vitamins? Explain in approximately 100 words.

Question 5

Suggest how a serve of potato could be made more nutritious. Present your answer by ordering the steps of preparation and adding 2-3 sentences on how your preparation and cooking methods are better at retaining nutrients than the methods used to prepare mashed potato.

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