



This Food Science Fact Sheet is one of a series compiled by Institute of Food Science and Technology, providing clear, concise and scientifically reliable information on key food science topics for consumers.

Safe Heating of Food

Saving energy and staying safe

Why do we heat food?

Millions of years ago, early humans were adapted for eating meat and plants without cooking. Through harnessing fire, the invention of cooking allowed us to gain more energy from meat, which fuelled the dramatic evolution of the human brain. This major evolutionary step ensured methods of heating food became a permanent feature for human existence. Today we heat food for many reasons such as:

Food safety - applied correctly, heat kills food poisoning organisms such as *Escherichia coli*, *Salmonella* and *Listeria monocytogenes*, making food safe to eat.

Digestibility - heat breaks down complex molecules (protein, carbohydrate etc.) making it easier for the body to absorb the nutrients from food. For tomatoes, for example, heating helps release antioxidants from cell walls.

Preservation - drying removes moisture from food, makes it difficult for microorganisms to grow, and increases shelf life.

Texture - when starch is heated with water, the granules swell and burst (gelatinise) and it can be used to thicken soups, sauces, puddings etc. Cooking meat makes it softer and more appealing.

Flavour and colour - heating enables the development of palatable flavours and enhances the appearance of foods. On heating, sugar starts to caramelise giving off a desirable aroma and characteristic brown colour in some desserts and confectionery (e.g. toffee, fudge).



What are the disadvantages of heating food?

Nutrient loss - vitamin levels are reduced, proteins are denatured and lose moisture in the presence of heat, resulting in reduced nutritional value. Hence it is important to apply the correct amount of heat to destroy pathogens whilst retaining as many of the nutrients as possible.

Over-cooking - foods can become difficult to metabolise due to dryness caused by over-cooking. When cooked until charred on the outside, certain foods can form dangerous carcinogenic substances.

Risk from contaminants - at high temperatures, starchy foods such as potatoes and bread can form acrylamide which can be unhealthy at high levels. This process contaminant can be controlled by careful selection of food type and good cooking practices.

Food poisoning - there are certain food poisoning organisms, such as *Clostridium perfringens*, which cause issues if food is not heated thoroughly and cooled quickly. Spores from these organisms germinate in the right conditions and cause illness.

What are the the key considerations?

Temperature and time - cooking is a physical process resulting in chemical changes in food and varies depending on the type of food and the desired outcome. Food must be cooked, or reheated, until it is piping hot – normally over 70°C. Cooling should be rapid to avoid having food in the temperature danger zone (8 to 60°C) for too long, as bacteria love lukewarm food.

Nutrition - not overcooking food, and using a minimal amount of water for boiling, can improve nutrient retention.



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Cost of energy - heat energy used to cook, or reheat food, is generated from electricity, gas and oil, in most households. The energy demand should be a major consideration in the selection of kitchen appliances and types of food preparation.

How does the cost of energy affect food safety behaviours?

With the current soaring prices, attention to energy use has become more relevant. Recent surveys show increasing trends in consumer behaviour that may affect food safety. These include occasionally switching off domestic refrigerators and freezers which has serious implications and is not recommended; reducing cooking times; avoiding heating/reheating food. Practices such as thawing frozen food in a refrigerator before cooking, managing heat loss by covering pots or keeping oven doors shut, planned cooking (e.g. batch/bulk) and using energy efficient appliances are helpful for managing energy bills. Some options include:

Hob - although the unit cost of gas is cheaper than electricity, electric hobs are more energy efficient because there is less energy loss to the environment. One can further improve energy savings by using the correct burner and saucepan size, adequate pot coverage and heat settings. Halogen hobs are even more efficient because of their particular method of heating.



Electric kettle - it is proven that boiling water in an electric kettle and then using it for cooking on a hob decreases energy use. It is also better to use the volume display on a kettle and only boil the volume of water needed as it is costly to boil a full kettle for just one mug of tea. Also storing boiled water in vacuum flasks for later use can be helpful.



Convection oven - use a fan or exhaust system to circulate hot air around the oven, as opposed to conventional ovens. Air circulation allows more even heating, and browning, and reduces the required cooking temperature and time. Bigger



ovens are better suited for cooking larger items e.g. roasting joints of meat and are effective for baking cakes and biscuits.

Microwave oven - these are effective for defrosting and reheating food, but are less suitable for baking bread, cakes, cookies and delicate pastries. To manage energy use, they should be unplugged when not in use.



Air fryer - these are popular appliances due to their lower energy consumption, reduced cooking time, requirement for less oil, convenient for small volumes and giving crispier products, compared to conventional frying methods. They have a similar operating system to fan ovens and are popular for cooking chips, potatoes, chicken, fish, sausages, vegetables, beef burgers and bacon.



Slow cooker - use minimal electricity to cook food over a long period (over 3 hours), at low and consistent temperatures. Arranging meat and vegetables evenly in the pot can increase efficiency. They can be used for casseroles, soups and even baking.



Practices affecting food safety and dispelling myths:

How important are cooking instructions?

They are safe temperature-time guides that have been validated by experts to ensure food is safe to eat. The main point is that food should always be cooked until piping hot.



What is the food safety risk of using an air fryer without cooking instructions?

Many food products that require cooking have instructions for using a hob, conventional oven or a microwave oven, but only a few have instructions for cooking using an air fryer. This leaves consumers to guess an appropriate temperature and time to use. Air fryers have a smaller cooking space and good air circulation, so cooking times are estimated to be reduced by about 30%. However, approximations may pose a safety risk from food poisoning from

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undercooking or nutrient loss from overcooking food. A temperature probe can be used to ensure that adequate cooking is achieved; checking that food is hotter than 70°C.



Which foods can be eaten without cooking or reheating?

Ready-to-eat (RTE) foods have been safely precleaned, precooked and packaged for consumption. Examples include cooked meat (e.g. ham, chicken, beef), smoked fish, and processed desserts and fruits. Some may be stored in ambient conditions, and others need chilled storage to keep them safe. Under the correct storage conditions, and before the use-by (expiry) date, they are safe to consume without heating. Heat-preserved foods undergo commercial sterilisation, pasteurisation or aseptic processing treatments, to destroy pathogenic organisms and extend their shelf life. Examples include canned foods such as baked beans, creamed rice pudding, carrots, butter beans, sweetcorn, pasta in tomato sauce and custard, which do not have to be reheated before consumption. They can be eaten cold, or warm, depending on individual preference and circumstance.



Is it safe to reduce cooking times?

High-risk foods such as raw meat, seafood, eggs and rice, carry a higher risk of causing food poisoning if not cooked thoroughly. It is important to ensure that safe heating is achieved by using a temperature probe, or checking the item is piping hot and any meat juices are running clear. Also, keeping a pan covered or oven closed will help it retain heat that can brown or dry the food further, if required.

Reducing the cooking time of RTE foods, such as prebaked quiches, sausage rolls and fully cooked ready meals, so that they achieve a palatable temperature does not pose a food safety risk. Energy efficient breakfast ideas such as soaking rolled oats overnight in milk, as opposed to cooking porridge, and eating baked beans cold can save energy.



References

[FSA Consumer Insights Tracker Report: Key Findings from December 2021 to March 2022](#)

[FSA Cooking Safely in Your Business](#)

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