Beneficial Aspects of Food Processing

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The most important identified points for further study are information on processed foods to be considered in epidemiological work, databases to estimate the intake of compounds from processed foods, translation of in vitro results to in vivo relevance for human health, and optimisation of thermal and non-thermal processes using kinetic principles. The positive impacts of processing have gotten less attention than the negative ones, despite the fact that they are crucial to any discussion of the risks and benefits of thermal or heat-treated food. The prior study concentrated more on the dangers of (thermal) food processing than its advantages. After a brainstorming session, the ILSI Europe Process-Related Compounds and Natural Toxins Task Force resolved to do research on the advantages of thermal food processing.

Thermal procedures must be used to modulate food raw materials during food processing at the industrial and residential levels in order to address concerns related to food safety and palatability. Foods that have been thermally treated undergo a number of biological, physical, and chemical changes that affect their texture, flavour, and nutritional value. Foods that have been thermally treated typically have higher food safety and quality.

While some unwanted reactions that result in nutritional content loss and the creation of potentially mutagenic and carcinogenic chemicals are known to happen, the positive changes that happen during food processing will be the main emphasis of this review. These include the production of helpful and bioactive components, the improvement of nutritional quality, and the elimination of harmful (anti-nutritional) compounds that arise from heat treating food in homes and businesses.

This exercise aims to recapitulate the advantages of food processing and cooking. Beneficial should be seen as preferable in terms of sustainability, food safety, shelf life, food attractiveness, and health. This calls for a wholistic approach and seeks to provide a thorough explanation of the health benefits of cooking and the beneficial substances that are involved. It will discuss what is now known about potentially health-promoting chemicals that can occur while cooking. Research lacunae will be noted. It's noteworthy to notice that the majority of knowledge about the health effects of heat-processed foods focuses on goods where the Maillard reaction is crucial, such coffee, cocoa, and barley.

Food safety and palatability issues require the use of thermal processes for modulation of food raw materials during food processing at industrial and household levels. Thermal treatment of foodstuffs induces several biological, physical and chemical modifications, leading to sensory, nutritional and textural changes. In general, the thermal treatment of foods results in enhanced food safety and quality.

Historical and anthropological facets of cooking and the evolution of food processing

Since our ancestors discovered how to use fire for cooking approximately 700,000 years ago, food has been heat-treated for many centuries to alter and retain the nutritional and organoleptic qualities of food. The field of modern anthropology generally agrees that the evolution of thermal food treatment from its inception has had a significant, if not dominant, influence on human phenotypic, intellectual, sociological, and economic advancement. Home cooking has been less popular since the late 19th century in favour of more industrialised methods. Preservation was first prioritised, followed by quality (particularly nutritional quality difficulties following World War II) and safety (particularly microbiological safety) in the 1920s and 1930s.

In the interim, new technologies emerged, including the use of microwaves and steam and radiation therapies. Because of this and the widespread availability and use of semifinished processed goods in daily cookery, home cooking has undergone a revolutionary change. The availability of contemporary technology makes it feasible to focus more on the gourmet aspects of food. Since 80–90% of the foods used in home cooking are thought to be semi-processed, it makes sense to take processing's positive effects on food safety and quality into account.

As Appert and Pasteur pioneered heating in bottles and cans, current sterilisation techniques, including ultra-high temperature and other non-thermal procedures, followed. These techniques will be covered in the next section. Due to food processing, people spend less time cooking at home, which has changed people's lifestyles and improved population health (higher life expectancy) due to the availability of consistently high-quality, safe, and nutritious food. Foods that have undergone thermal processing may contain substances that should be carefully examined in terms of their potential health effects.

Food processing, both in homes and businesses

Heat is applied in a number of ways while cooking food at home, including boiling, frying, steaming, baking, stewing, and roasting in conventional, microwave, and steam ovens. Many of the procedures mentioned for home cooking are also used in the industrial thermal treatment of food products. Heat has also been utilised in conventional transformation processes other than cooking, like extrusion cooking, smoking, kilning, roasting coffee, canning, pasteurisation, and related technologies (ultra-high temperature treatment). It is significant to remember that industrial scale control over these processes is far superior to home level control.

From farm to fork, there are several factors that affect food quality, such as raw material quality, processing methods, packaging, and cooking, in addition to sensory and nutritional elements. Providing safe and high-quality food in response to consumer demands is the primary goal of industrial food processing.

Factors in processing that impact food

The most important beneficial aspects can be summarized as follows:

1. Food safety (pathogens): Inactivating food-borne pathogens, as mandated by most food safety laws, is the primary advantage of food processing.
2. Additional areas of food safety: extending the shelf life, deactivating natural poisons and enzymes.
3. Nutritional value: increased nutrient bioavailability and digestion.
4. Texture, flavour, and taste are sensory qualities.
5. Advantages for functional health, such as probiotics, prebiotics, flavonoids, MRPs (Maillard reaction products), and other food ingredients and their reaction products.
6. Convenience: the availability of foods that are partially or fully prepared, such as frozen meals that can be microwaved.
7. Cost: Scale economies.
8. Diversity: the introduction of a worldwide food supply chain and freedom from the seasonality of food availability.
9. Life quality is enhanced since preparing and supplying meals takes less time.

Using the foods listed at the beginning of this section as an example, the first five benefits are the subject of this study. The elimination of undesirable substances and microbes is the primary positive outcome of food processing. Pasteurisation is the least amount of heat treatment required in this case: This method uses a combination of time and temperature to kill dangerous microorganisms such Mycobacterium TB, Salmonellae, and Staphylococcus aureus. Pasteurised food is widely safe from a microbiological perspective, as long as it is properly packed (i.e., no recontamination after processing) and chilled. Sterilisation is a severe heat treatment that inactivates spores in addition to vegetative cells. From a microbiological perspective, these items are entirely safe and can be stored indefinitely if packaged appropriately and recontamination is avoided.

The inactivation of anti-nutritional factors, such as natural toxins and protease inhibitors (e.g., trypsin inhibitors in soy), is another advantageous impact. However, because of chemical changes occurring in the food, the quality of sterilised food will deteriorate with time. The extension of shelf life, which is mostly brought about by microbiological, biochemical, chemical, and physical changes, is the second consequence.

The benefits of food processing are exemplified by these five impacts, some of which will be further discussed below. Processing, however, can also lower the quality of food, which might have unfavourable effects like:

1. The loss of some (necessary) nutrients as a result of chemical reactions (available lysine, vitamin C, etc.)
2. The creation of undesirable substances (acrylamide, acrylamide, acrylein chloropropane diols and -esters, heterocyclic amines, etc.).
3. Occasionally the development of substances that impair the perception of flavour (such as sulphur compounds produced while heating milk).
4. Loss of texture, discolouration, etc.

Process optimisation is therefore necessary to maximise the expected positive impacts and minimise the undesirable ones. The technological methods to achieve such optimisation are covered in this section.

Optimization through reaction kinetics

Food quality alterations, whether resulting from heat processing or not, are caused by modifications at the molecular, chemical, biological, and physical levels. For instance, oxidation of a vitamin can alter a product's nutritional value (chemical reaction); enzymatic conversion of polyphenols can alter a food's colour (biochemical reaction); food can undergo phase changes (physical reaction); and bacteria or moulds can cause food to spoil (microbial reaction). There are two things we need to be aware of in order to direct these reactions in the appropriate direction:

Two factors are (i) comprehension of the reaction occurring and (ii) reaction rate. From a thermodynamic perspective, food is unstable, meaning that spoiling cannot be avoided in theory. What is controllable, though, is the rate at which spoiling occurs. At least two relations are required: one describes how a quality attribute changes over time, and the other examines how that change is affected by external factors like pressure and temperature. It is necessary to understand the temperature dependency of applying heat, the pressure dependence of a reaction when using high-pressure technology, the dependence of an application on the strength of an electric field, etc. This is the kinetics domain. van Boekel has written a great deal about this subject; for more information, see this reference.

Types of processes

Thermal processes

Thermal methods have historically been widely employed in the field of food technology. Other technologies have appeared only recently (see below). Based on the degree of heat treatment, thermal procedures can be categorised as follows: pasteurisation (between 70 and 80 °C), sterilisation (between range 110–120 °C), as well as extremely high temperature treatment (between 140 and 160 °C). Temperature-induced increases in reaction speed account for the effectiveness of thermal treatment. Temperature always causes an increase in chemical reactions, as well as biochemical and microbiological processes. However, enzymes and microbes inactivate above a particular temperature. Radical and physical responses typically don't depend as much on temperature.

We can take use of the fact that different reactions that are significant for food quality have varying temperature sensitivity. One can create a graphic of this type by utilising the kinetic equations found, for example, in. Because the x-axis does not indicate the inverse of absolute temperature, it should be noted that this figure is not an Arrhenius one. Food technologists have the ability to control two crucial process variables: temperature and time, which together yield the highest-quality food conceivable. These graphs, which can be created with the help of reaction kinetics, quickly display which time-temperature combinations provide the desired result. Essentially, this idea can be used for any quality modification that is deemed significant; nevertheless, experimental parameters must be determined.

A single example from the work of De Vleeschouwer et al. (2008) illustrates the potential of this strategy; it concerns the reduction of acrylamide while maintaining the required brown colour quality feature. The potential of this method is demonstrated by a single example from the work of De Vleeschouwer et al. 2008; it concerns the reduction of acrylamide while preserving the necessary brown colour quality attribute. To 10 mM melanoidins (brown pigments; melanoidins are usually desired substances). Acrylamide formation is marginally more temperature-dependent than colour formation, as illustrates. This suggests that lowering the temperature will have a greater effect on reducing acrylamide formation than colour formation. Therefore, acrylamide synthesis can be decreased while keeping the same colour by heating for a longer period of time and at a lower temperature.

Non-thermal processes

A number of the non-thermal processing methods are still in the experimental stage of development. The ones we take into consideration here are those that are commercially used in the food sector, including dehydration, freezing, membrane processing, high pressure, and pulsed electric fields. The benefits and drawbacks of various non-thermal processes in relation to thermal processes are compiled in. It should be mentioned that spores cannot be inactivated by high pressure alone; nevertheless, a combination of pressure and a light heat treatment—which again qualifies as a heat treatment—may be useful; Studies are being conducted. Specialised high pressure–low temperature applications result from the pressure-dependent freezing point depression of water to about 20 °C at 200 MPa and the development of several ice crystal forms under pressure. Pressure causes individual starch granules and denaturation of proteins, which can also result in gelatinization, depending on the temperature and pressure. It should be emphasised that pressure-induced gels have different physico-chemical properties from heat-induced ones, which enables a large range of alternative gel structures to be created using T and p combinations. In addition, new food textures have been produced as a result of pressure-supported protein-polysaccharide interactions. Less research has been done on the inactivation kinetics and response mechanisms of nutrients, poisons, allergens, bacteria, and viruses in non-thermal processes than in thermal processing. Further information is required regarding the processes involved in spore and enzyme inactivation. It would be ideal to have shelf-life studies done on items that are not heated.

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