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Campden BRI
food and drink innovation

Food Reheating Instructions – a Key Element in the Delivery of Safe, High Quality Foods

In New Product Development there are many stages that need to be considered. It is not possible to simply produce a great quality food from the finest ingredients in a home kitchen and up scale to full production without considering issues such as:

- Formulation
- Ingredient supply
- Product processing
- Packaging
- Storage temperatures (chilled/frozen)
- Shelf life
- Nutritional content (fat/salt/sugar)
- Quality

Often many of the above factors are interlinked, such as packaging and shelf-life (for example: modified atmosphere packaging can be used to keep the product fresher for longer). Often one key consideration which is excluded from list is how the product will be cooked or re-heated. The selection of re-heating instructions using appropriate appliances can have a huge impact on the nutritional content and organoleptic quality of the food. Furthermore, the intended mode of reheating needs to be carefully considered during the design stages of the product. For example, a product heated in a microwave will heat in a different manner compared to heating in a conventional oven. The microwave product may need different formulation and packaging to the conventionally heated product. Considering the re-heating of products during the design stages is far simpler than having to re-formulate and re-package a product after full scale production.

Key drivers in New Product Development are health issues, quality and green issues including energy use. The careful consideration of re-heating can have positive benefits for all three. Careful design of the product with the re-heating instructions in mind can lead to shorter heating times, giving less time for nutrient destruction, less energy required during the re-heating process and a better quality product, as overheated areas will be less likely. Re-heating is an area often overlooked, but is a key element in the delivery of safe, high quality foods.

Most products will require either cooking or reheating by the consumer. Effective consumer instructions are vital to achieve optimum product quality and safety. This article explores some of the background to and key issues around this area.

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What is re-heating?

A very good question and one that is only answered by an in-depth understanding of the specific food products in question. One simple definition might be that re-heating is the act of warming up a ready cooked or processed food. However, the requirements of re-heating in terms of the temperature required to give both an assurance of food safety and palatability in the food depend very much on the food itself, the storage conditions and any previous processing the food has undergone, together with the packaging used to hold and protect the food.

The target temperature aimed for at the end of the re-heating process depends on whether the food can be classed as safe to eat without further thermal treatment (such as some bakery goods, or canned foods) or whether the food requires reheating to kill any possible food poisoning bacteria that may have re-contaminated or grown on the food prior to the re-heating process. With the former two types of product, reheating is purely a matter of supplying sufficient heat energy to the product to make it palatable and taste sufficiently hot. Therefore the temperature to which the product is re-heated depends on several factors, such as personal taste (some people like their food hotter than others!) and the ability of the food to hold and conduct heat (for example soup is best served hotter than Christmas pudding). This article focuses on foods falling into the latter category, where the re-heating process is a necessary step to safeguard the food from possible food poisoning issues. It is difficult to produce a food where once it has been cooked, cooled and stored there is no doubt that bacterial recontamination or growth has not occurred. For example, almost all retailers require that raw food and food that has been pre-cooked prior to selling to customers (lasagne for example) achieve sufficient temperature on re-heating to kill any pathogenic (food poisoning) bacteria that may have contaminated or grown on the food during the production and chilled storage (by the retailer or consumer) process. Foods that require chilling to maintain their microbiological integrity are by definition not sterile.

Why is it important?

The re-heating of food is primarily to kill pathogenic bacteria, so making the food safe to eat as well as increasing the temperature sufficiently to make the food palatable. One of the most temperature tolerant pathogenic organisms able to grow at low temperatures (even at fridge temperatures of 5 ^oC) is *Listeria monocyogenes*. The destruction of this bacteria requires a sufficient thermal process – meaning a combination of time at a temperature - is needed to kill it. The higher the temperature the bacteria is subjected to, the greater the killing effect and the longer the time at a temperature the greater the killing effect. For food safety, the generally accepted thermal process is that the slowest heating location within the food (cold spot) must achieve an equivalent process to two minutes at a temperature of 70 ^oC. This has been proven to reduce *Listeria monocyogenes* numbers one million-fold. Since the original loading of bacteria is highly unlikely to be above a level of one million, this thermal process has been considered acceptable to render the food safe to eat, even if it has been contaminated with *Listeria monocyogenes* and conditions within the food have been such that growth of the bacteria has occurred. This process has also been shown to be able to eliminate or reduce levels of other food poisoning bacteria such as *E.coli* and *Salmonella* adequately.

Equivalent process

'Equivalent process' is an important term to understand when it comes to determining what temperature (and time at that temperature) is required when re-heating foods. As already explained, the usual thermal process required when re-heating foods is to attain and hold a temperature of 70 ^{o}C for two minutes. However, an equivalent process to this can be achieved by higher temperature and shorter times or by lower temperatures and longer times. There is a method to calculate this and the table below outlines the different time and temperature combinations calculated to achieve the same (equivalent) thermal process to two minutes at a temperature of 70 ^{o}C:

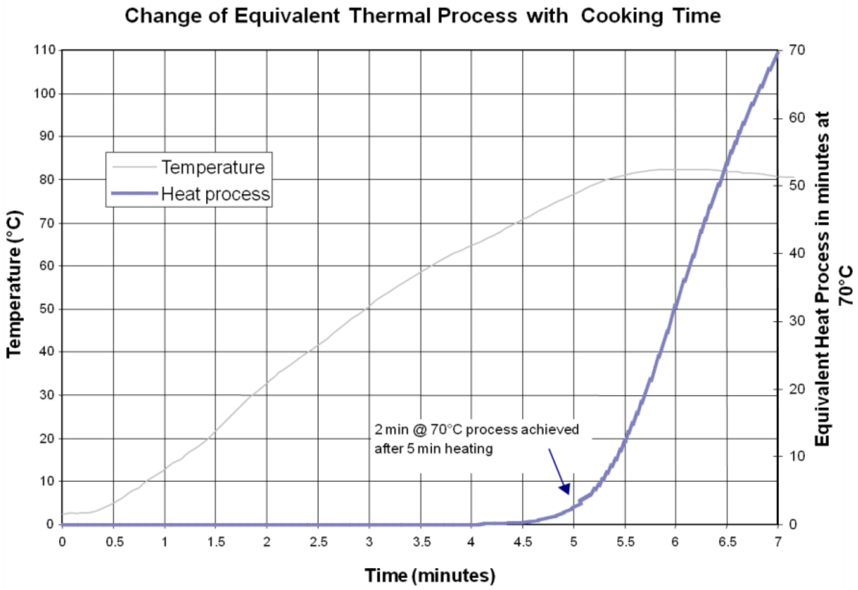
Temperature °C	Time (minutes :seconds)
80	00:06
78	00:10
76	00:18
75	00:26
74	00:36
73	00:48
72	01:06
71	01:30
70	02:00
69	02:42
68	03:42
67	05:00
66	06:42
65	09:10
64	13:18
62	23:19
60	43:05

This table shows that if a temperature of 80 ^{o}C is achieved in the product and this is held for six seconds, this would be equivalent to holding at 70 ^{o}C for two minutes. The table demonstrates that just because a product is hot, does not necessarily mean it would be safe to consume. For example a food at 60 ^{o}C would still be considered hot to eat, but the food would need to be held for over 43 minutes to achieve the same level of bacterial destruction as achieved at 70 ^{o}C for two minutes!

This 'equivalent process' emphasises the need to measure both the temperature achieved by the food during re-heating and the time at that temperature, to ensure that the food is safe to consume.

How is it measured?

The measurement of the 'equivalent thermal process' is important to assure the safety of any re-heated foods. When developing instructions, to give consumer guidance on the safe re-heating of foods, techniques need to be employed that can record both the temperature of a product and the time at that temperature. Suitable temperature measurement probes can be inserted into the food and an electronic data logger used to monitor and measure the temperature of the food at the probe tips at given time intervals, so producing a graph of temperature against time of the food during the re-heating process. This data can be analysed and the 'equivalent thermal process' calculated (to ensure that the instructions allow the product to achieve an equivalent process to two minutes at a temperature of 70 ^{o}C). The graph below shows the time/temperature trace of a heated food and the equivalent thermal process achieved during the re-heating process. The vertical scale on the left shows the temperature at the cold spot and the vertical scale on the right shows the equivalent thermal process (to minutes at a temperature of 70 ^{o}C):



The product was heated for 5 minutes and a two minute stand time was permitted. Points of interest include:

- After 4½ minutes heating the minimum temperature was above 70 ^{o}C, but the product had not achieved the required thermal process equivalent to 2 minutes at 70 ^{o}C.
- After approximately 5 minutes heating a thermal process equivalent to 2 minutes at 70 ^{o}C was achieved (with a product temperature of 76 ^{o}C).
- The product cold spot temperature continued to increase after removal from the heat source after 5 minutes (due to conducted heat energy from hotter areas of the product).
- Removing from the heat source and allowing a two minute stand time allowed a large increase in the thermal process – equivalent to 70 minutes at 70 ^{o}C.

It is an absolute imperative that the slowest heating location (or cold spot) is identified and a probe used to monitor the temperature at this location. If the cold spot is missed and this slowest heating location does not achieve the required minimum thermal process, then there is a possibility that any food poisoning bacteria present will not be sufficiently killed and so pose a risk of infection to consumers on eating the product.

There are three types of temperature measurement probes used in the food industry: thermocouples, thermistors and platinum resistance thermometers. The most common type of used for developing re-heating instructions are thermocouples.

Thermocouples operate on a voltage generation principle and consist of two dissimilar metal or alloy wires joined at two ends. Any difference in temperature between the two ends generates a voltage and the greater the difference in temperature the greater the voltage. This voltage can then be calibrated to represent a temperature difference. For example, if one end of the thermocouple wire is effectively held at a steady temperature of 25 ^{o}C inside a handheld box, then inserting the other end (the probe tip) into hot food will generate a voltage which can be read as a temperature.

Thermocouples are used for temperature measurement in many areas of industry and for measuring temperatures from way below freezing to several thousand degrees Celsius. For each temperature range and application the metals used to manufacture the thermocouples are selected to give the optimum performance. For re-heating trials the best types to use are either type T or type K.

In order for any probe to give an accurate reading of the temperature to which the probe tip is subjected , the measurement device (the probe and the unit into which it is plugged) must be calibrated as one. Calibration is defined as establishing the relationship between the temperature measured by the device and the actual temperature. When calibrated, temperature measurement devices will come with an 'offset' temperature. This must be added to the temperature measured by the device to give an accurate temperature measurement. Sending a thermometer away for calibration and assuming it reads exactly the correct temperature on its return is a common mistake as most thermometers cannot be adjusted. The 'offset' determined during the calibration process has to be added to the thermometer display reading in order to give an accurate temperature measurement.

Calibration must also be performed in the range in which temperatures are going to be measured, as the calibration offset can vary with the temperature. For re-heating the most important temperature is likely to be in the region of 70 ^{o}C and so its makes sense to have temperature measurement devices calibrated at this temperature.

The scientific complexity involved with selecting the correct type of probe and location of the probe(s) in the food can be daunting. Some of the factors that need to be considered are identified below:

- Cold Spot – must be identified and monitored
- Probe Size – too big and it will affect the accuracy of the temperature reading (the probes may conduct heat to the tip), too small and breakage can occur during insertion into the food
- Calibration – all temperature measuring equipment needs to be calibrated and any correction factors taken into account (an un-calibrated probe could read 3 ^{o}C too high – thus indicating a safe thermal process had been achieved when it may have not)
- Number of probes – the more probes inserted into the product the more likely the coldest heating location (cold spot) will be monitored, too many probes become difficult to manage experimentally and may allow unwanted internal heating by conducting heat down the probes.

The techniques used to measure the time and temperature combination depend on the re-heating process used. Monitoring the time and temperature of foods reheated using domestic gas, electric and fan-assisted ovens is very different to the methods used for microwave ovens as metallic thermocouple probes cannot be used in microwave ovens where the large electrical field strengths will induce high voltages and arcing in the probes. For monitoring food temperatures during microwave heating optical fibres need to be used and their fragile nature (and large cost) causes problems (for example a rotating turntable can twist and break the probes).

What effect is there on quality?

The quality of a re-heated food depends on many factors, but it is imperative that during re-heating the required minimum thermal process can be achieved. New product development is time consuming. Often ideas and formulations never reach full production, and the ideas that do get through should be comprehensively screened to ensure the maximum nutritional value and optimal organoleptic quality.

The final link in ensuring the quality and safety of food products designed for consumer re-heating is the consumer heating instructions. Inadequate cooking instructions may leave the product under or overheated. Underheating could lead to the product being insufficiently warm to be palatable or worse, cause possible food poisoning issues. Overheating may result in the product quality being deemed unacceptable by the consumer or cause possible issues with chemical contamination of the food (migration) caused by the breakdown of the packaging if the temperature limit (of the packaging) is exceeded. Exceeding the temperature limit of the packaging is more common than expected with microwave foods.

Instructions that cause under or overheating of foods may result in the consumer being unhappy with the product, complaining to the manufacturer or losing confidence in the product or even the brand. Therefore, pack re-heating instructions are the final opportunity that product developers have to ensure that the desired product quality is maintained. There is a legal requirement for cooking or reheating instructions to be supplied if they are needed in order for the consumer to correctly use the product. The manufacturer must be able to show that every reasonable step has been taken to ensure that the cooking instructions are adequate to deliver safe food, otherwise the manufacturer may be held legally responsible should the consumer suffer from the results of inappropriate instructions, possibly resulting in food poisoning or thermal injury.

Once produced, the greatest effect on the product quality will be the implementation of the cooking instructions supplied on pack, and it is in the interests of the food producer to ensure that their re-heating guidelines give the best possible quality of the food. Such instructions can only be achieved using a thorough approach to their development. Campden BRI has a well established Instruction Development and Verification service that was implemented over twenty years ago and based on scientific research. The service now offers the Development and Verification of all types of instructions including microwave, hob, grill, conventional gas and electric oven, fan-assisted oven, shallow and deep frying, toasting and steaming.

The first stage in any instruction development schedule (once the product has been fully developed) is the performance assessment of the appliances to be used for re-heating the food. This is sometimes termed the ‘calibration’ of the appliance. This is a key area in the process of instruction development for any product, regardless of whether it is to be heated in a conventional oven, microwave oven, or grilled, fried or boiled. It is important that the cooking environment temperature of the heating appliance is known and operated consistently. This then allows continuity in the developed cooking instructions. Problems can arise, for example, on a gas hob or grill where the dial has no markings to indicate the size of the gas flame. If for example a ‘medium’ heat setting is required, the operator may not be confident or be able to prove that they are able to use the same heat setting in the future. It is also necessary to have confidence that the appliance setting used to develop the instructions is representative of those used by consumers.

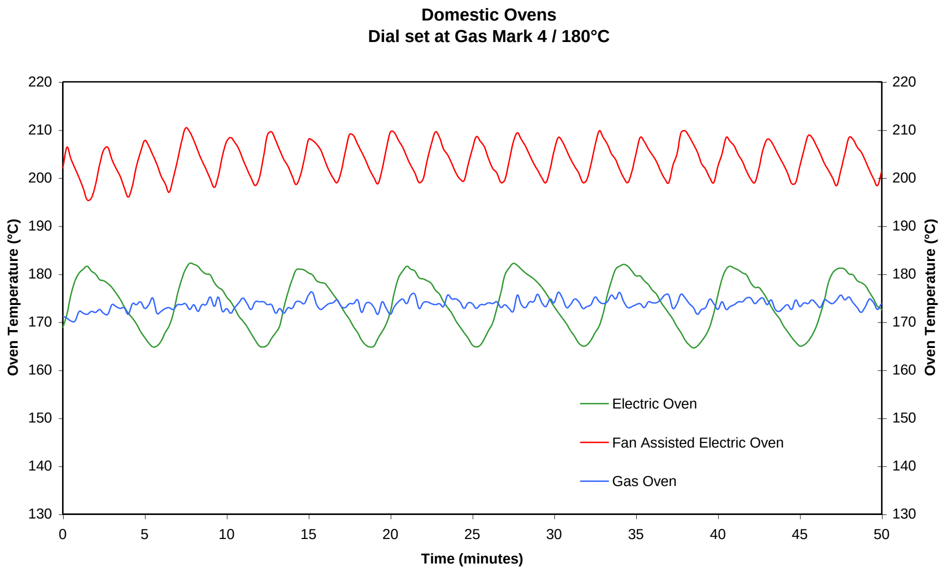
Performance assessment – hobs & grills

At Campden BRI, a performance assessment method for both hobs and grills was developed at the request of the food industry membership. Appliances were tested to determine their average performance. The methods were based on heating a known volume of water over a set period of time on a hob, and heating a ‘model’ sausage under grills. The temperature rise found over the time period denotes a low, medium or high heat setting. This standard procedure then allows both the grills and hobs to be set up in the same way each time the appliances are used or allows for objective assessment if the setting is adjusted.

Performance assessment – hot air ovens

There are three main types of domestic hot air ovens used by consumers: gas, electric and fan assisted electric ovens. Each has a different heating mechanism, so can heat foods at different rates. It is surprising how often the temperature dials on the cooker bear little resemblance to the actual air temperature in the oven, a basic factor that can have a significant effect on product safety and quality. It is therefore essential to know the temperatures more precisely that the oven is achieving when developing reheating instructions.

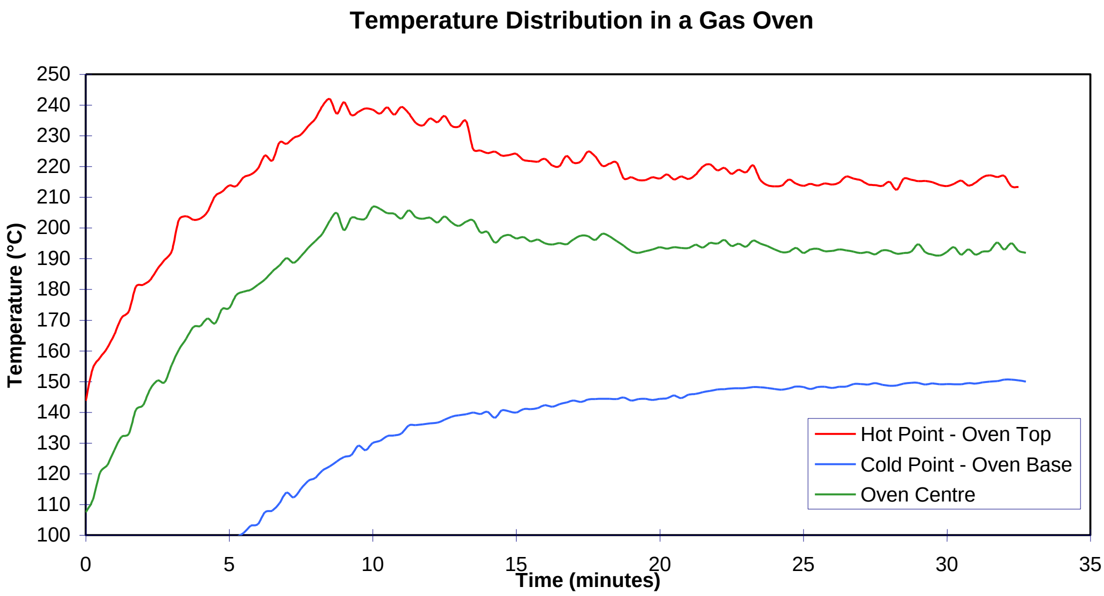
The graph below shows the centre temperature of three different oven types, a gas, electric and fan assisted electric oven, all of which had the dial set at 180 °C or gas mark 4. It is a very clear example of the differences that can occur between oven types and why it is important to know the temperature of the oven used to develop cooking instructions.



The gas oven temperature profile in the graph above has a range of temperature from approximately 172 °C to 176 °C, giving an average temperature of approximately 174 °C; this is lower than the set temperature, but the temperature is reasonably stable. Both the electric and fan assisted ovens show a much wider temperature range as the thermostat switches on and off, ranging as much as 30 degrees from the target temperature. The electric oven has an average temperature of approximately 175 °C and the fan assisted electric oven has an approximate average temperature of 205 °C, some 25 °C higher than the dial setting. If this dial setting on the fan oven had been used for instruction development, the resulting heating time required for the product to be microbiologically safe may be insufficient when used in an oven with a correct temperature setting. This could have implications for the safety and quality of the food product.

For this reason, a single measurement of mean temperature taken after pre-warming the oven is not sufficient, as it may have been taken anywhere along the cyclic temperature profile. The temperatures of the oven should be logged over a period of time once the oven has reached its steady state operating temperature, and the average oven air temperature taken as the true reading.

The non-uniformity of temperature within the oven cavity influences the quality and safety of products that result when reheating instructions are followed. The graph shows that there can be a large temperature difference between the top and bottom of the oven cavity.



This should be considered when deciding where to position the product in the oven when developing the reheating instructions and how these are communicated to the consumer. This large variance in temperature between the top and bottom of a gas oven are not seen with fan-assisted electric ovens, where the difference would only be expected to be a few degrees. Hence specifying re-heating in the top of a gas oven set at 190 ^{o}C would actually deliver (according to the graph) a temperature of approximately 220 ^{o}C, whereas re-heating in the top of the a fan-assisted oven set at 190 ^{o}C would deliver a temperature much closer to the set temperature.

This large degree of variation in oven temperatures can also play an important role in deciding the suitability of packaging for the food product. A specific example would be the melting point of plastic containers.

Performance assessment – microwave ovens

The performance assessment of microwave ovens is complex and would be worthy of a dedicated article. The focus of this section is to demonstrate the likely variability between microwave ovens and to highlight some of the factors that contribute to this variability.

Developing re-heating instructions for products using just one or two microwaves seems to be common in industry, but studies have suggested that results from a much wider number should actually be sought. In order to address the issue of uniformity of heating in microwave ovens, ovens should be selected that are known to give different heating patterns. Campden BRI instruction development procedures test products in a minimum of six disparate ovens; the ovens are selected to encompass different design features such as:

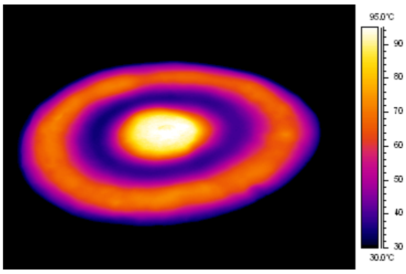
- Power output and Heating Category
- Internal cavity size and shape
- Cavity material (stainless steel, painted steel)
- Turntable type (metal, glass or none)
- Microwave delivery method and location (e.g. waveguide entry into top/side/base of cavity)

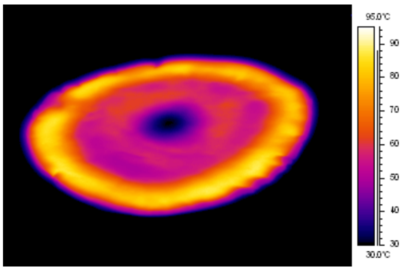
The power output of microwave ovens can be affected by:

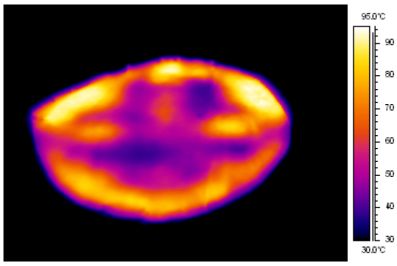
- Power supply voltage
- Food load size (generally the larger the load the more efficient the oven)
- Magnetron warming (as the magnetron warms, it becomes less efficient, so producing less microwave power)

In microwave ovens the heating patterns can be very different because of differences in the design. Even microwaves with the same power output can give different results. If you want to test a product and its packaging in real conditions, it is vital that you select enough ovens to give a range of heating patterns. It is also suggested that tests are performed with food products placed in different locations inside the oven - for example at the centre of the turntable and at the edge of the turntable.

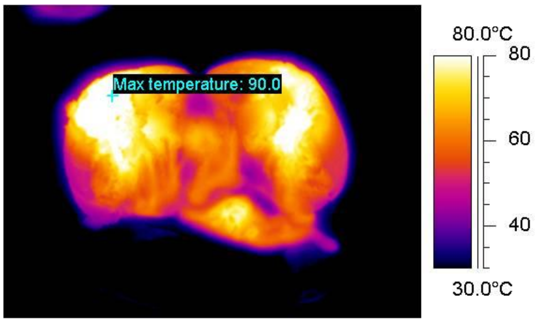
The thermal images (temperature pictures) below show the very different heating patterns of a flat pastry product using the domestic ovens. The temperature scale on the right shows the temperature of the pastry, with lower temperatures (30 ^{o}C) being black to higher temperature (90 ^{o}C) being white. The images show thermal profiles from two turntable ovens, one demonstrating greater turntable centre heating (left image), one demonstrating greater turntable edge heating effects (centre image) and one non-turntable oven (right image):



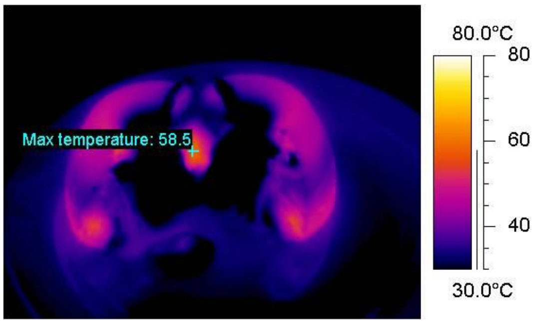




It is important to note that the heating pattern can depend on the size, shape, and thermal and physical properties of the food being heated as well as the performance of the oven. However, the images below clearly show that a product heated at the edge of the turntable heats much less intensely than when heated at the centre of that same oven. The same heating time was used for the two comparisons and the product was heated in the oven showing a greater turntable centre heating effect (above left image).



Dessert heated on the centre of the turntable in an oven with strong centre heating characteristics



Dessert heated on the edge of the turntable in an oven with strong centre heating characteristics

If instructions were developed without testing the product in both locations, then there is a good possibility that the product could be over or under heated when microwave heated in consumers' ovens.

By ensuring that the instructions for a product are thoroughly tested in a wide range of microwave ovens before it hits the shelves, manufacturers can help avoid costly complaints or even product recalls.

Instruction development techniques

Each product should be carefully assessed and the required methods of re-heating considered. This is not a simple task and considerations such as product quality and convenience should be taken into account. For example, a product may heat much more quickly using microwave energy, but be of better quality if heated using gas, electric and fan-assisted ovens – is quality or convenience the most important consideration?

Once suitable appliance performance assessment has been completed, the re-heating of a product can be performed to give consistent quality, then the instructions need to be developed, remembering the need to achieve a safe minimum thermal process appropriate for the product. For each re-heating method the choice of setting (grill, hob or microwave) or temperature (gas, electric or fan-assisted oven) and cooking time will have an impact on the quality.

In developing instructions there are a range of ‘tools’ available to modify the quality of the foods. These include:

- Heating Covered – can reduce moisture loss, but will decrease surface dehydration (reduce browning and crisping effects)
- Standing – removal from the heat source and allowing to stand can allow evening out of the product temperature and allows a continuation of the thermal process (increasing the level of bacterial destruction)

- Stirring – Helps remove cold spots and can reduce the required heating time
- Turning – Help remove cold spots and is usually necessary for grilled/fried products

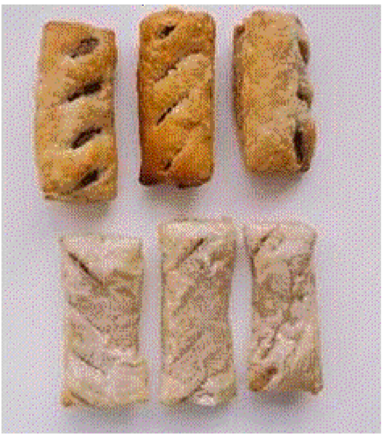
It is also necessary to devise a scientifically acceptable protocol; for example, the following should be considered:

- Number of replicate trials
- Initial weight of the samples.
- Sample dimensions (especially thickness) and shape
- Initial temperature of the samples
- Sample production, e.g. from a test kitchen, pre-production or production products

Some example case studies on the development and impact of re-heating instructions are given below:

Oven heated product – case study

A consumer could have any of the three main types of domestic oven (gas, electric and fan assisted electric). Using one instruction for a pastry product (such as a sausage roll) in a fan oven, the required centre temperature is achieved and the pastry quality is considered acceptable only if it has risen and turned golden brown. However, the same instruction in a gas oven may well produce completely different results, see the image below (fan-assisted electric oven - top and a gas oven - bottom).



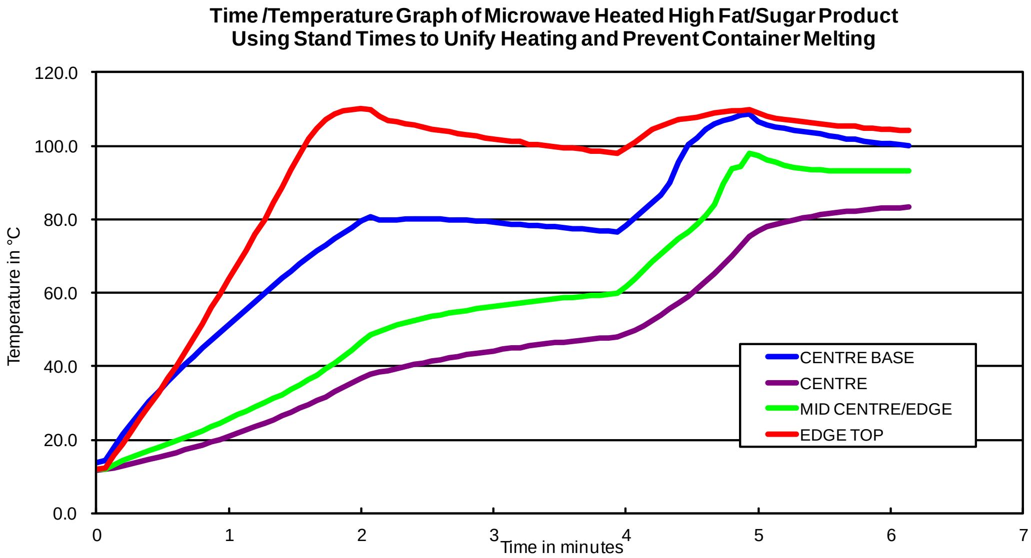
The product may be safe to eat within the same heating time, but with less efficient heat transfer due to the natural convection of heat in the gas oven (as opposed to forced convection in a fan assisted oven) the pastry quality is substantially reduced, with poor colour and lift. It may be necessary, therefore, to extend the heating time of such products to ensure an acceptable quality. If this is done, however, the new extended heating time must be confirmed in each oven type to check the quality of the pastry - it may well have become overheated and appear unacceptable. Often the pressure is on the development technicians to produce a simple, single cooking instruction that will cover all oven types and eventualities as well as being as short a time as possible. However, a better quality product may be achieved if different instructions are followed for the different oven types.

Microwave Heated Product - Case Study

The type of instruction selected for a product can have a dramatic effect on the final quality. There are several development tools that can be used to modify the heating profiles of food and any combination of these can turn an unevenly heated product, perhaps suffering with edge overheating effects, into a uniformly heated food. These tools are:

- Stirring
- Turning (for both turntable and non-turntable ovens
- Stand time (during or after microwave heating)
- Heating covered (and pierced)
- Use of different power levels (power levels other than full are pulsed)
- Transfer to different packaging

The graph below shows the heating profile for a high fat/sugar product. The product was packaged in a polypropylene container. Using a single stage full power instruction the container began to melt after a heating time of 2½ minutes (with an unsafe minimum centre temperature of 40°C). Using a 2 minute stand time after heating for 2 minutes allowed the hotter edges to conduct heat to the cooler centre. As a result the edges dropped in temperature sufficiently to allow further heating of 1 minute without risk of melting the container and the centre increased in temperature sufficiently to be safe.



What effect is there on nutritional composition?

The nutritional composition of foods can be measured in many ways, e.g. fat, sugar, vitamin and mineral content and the change in the nutritional value of the food during re-heating will depend on many factors. If water is used to boil vegetables, then the level of water soluble nutritional components such as vitamin C will be reduced due to loss into the water. The destruction of vitamins and other nutritional chemicals can also occur with the increased temperature (and time at that temperature) experienced by the food during heating.

Studies comparing cooking re-heating methods have been performed, but the results are very specific to the sample preparation and cooking methods used for the studies. The cooking times, environment temperature, size and shape of the foods, heating patterns of the appliances, amount of water or oil used can all have an impact on the nutritional content of the foods. Additionally, the nutritional marker used to 'measure' the nutritional content of the cooked or re-heated food can impact on the 'measured' effect of the heating process on the nutritional content. For example, using Vitamin C (water soluble) as a method of nutritional content measurement will give relatively high loss compared to say Vitamin A (fat soluble) when boiling in water, compared to the reverse being true if the food were fried in fat.

Trials can be 'engineered' to give a particular result. For example with microwave heating of foods, lower nutrient (e.g. Vitamin C) loss compared to boiling of foods can be obtained by using short microwave heating times and boiling with large volumes of water. The reverse result could be obtained using a long microwave cooking time and a short boiling time using a small volume of water. Hence the food preparation and heating methods used in specific studies need to be analysed in depth before conclusions are drawn regarding the trial results.

Nutritional Quality - Factors to Consider

The most important factors in reducing the nutritional content loss of foods include the following:

- Even heating – This allows all areas of the food to attain a similar temperature during the heating process; hence all areas should achieve the required thermal process within a short time interval. This reduces nutrient destruction as in unevenly foods some areas overheat whilst waiting for the slowest heating location to achieve the required thermal process.
- Do not overheat – Heating the food to a higher minimum temperature than required will increase the destruction of nutrients through oxidation.
- Boiling or Frying - Use the smallest amounts of water and oil possible as this reduces leaching of water and fat soluble nutrients.

To Conclude

The aim of this article was to highlight the importance of re-heating as in intrinsic part of product development and to discuss the key issues of re-heating of foods.

The development of instructions using appropriate appliances and considering re-heating prior to or during the development of a food product can have huge advantages compared to just applying re-heating instructions as an afterthought. Product quality, shorter re-heating times and less energy required during the heating process are all benefits of better re-heating design, planning and development.

Food re-heating must be designed to allow the attainment of a safe level of destruction of viable vegetative food poisoning bacteria. This is usually achieved by attaining a thermal process equal to or greater than two minutes at a temperature of 70 ^{o}C. Cooking appliances used to develop re-heating schedules must be set up ('calibrated') to give a known temperature or heat power output and a range of appliances used (especially microwave ovens, if they are selected for re-heating the food product).

Thought should go into the design of the food, to ensure faster heating (e.g. by reducing the food thickness). The instructions should be chosen to give minimum nutrient loss (for example by using the smallest amounts of water and not over heating the product).

Careful consideration of the design of a food, its packaging and its reheating instructions can make the difference between failure and success of a product.

Campden BRI has a well established Instruction Development and Verification service that was implemented over twenty years ago and based on scientific research. The service now offers the Development and Verification of all types of instructions including microwave, hob, grill, conventional gas and electric oven, fan-assisted oven, shallow and deep frying, toasting and steaming.

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