



# Food Safety Tips



## Sous Vide Cooking: Time and Temperature for Food Safety

by Dr Brian A Nummer, PhD Extension Food Safety Specialist | August 2017

Sous vide cooking was made popular by several well-known French Chefs in the 1960s. Today, it is considered a cutting-edge cooking technique for celebrity chefs and home chefs alike. Newly designed equipment has made this technique accessible to all.

The term “sous vide” is French for cooking under a vacuum. It is essentially placing foods in a bag, vacuum sealing, followed by cooking submerged in a hot water bath. The cooked foods can be eaten immediately or chilled and refrigerated for later use.

**Time and temperature** is the key to both the art and science of sous vide cooking. On the culinary side, low temperatures cook food retaining moisture and texture. It is hard to overcook a food at low temperature. Delicate foods cook in less than an hour (think thin fish fillets). Meats and poultry can cook at low temperatures for hours to days. High temperature sous vide cooking can be used to soften tough meats and melt fat.

Here are a few culinary examples of sous vide cooking.

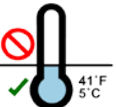

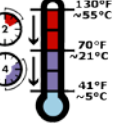
- ◇ **72 hour ribs.** Ribs are cooked at  $> 170^{\circ}\text{F}$  for 1-3 days. The rib collagen (white stuff near bones) melts into gelatin. The meat will literally fall off the bones after cooking.
- ◇ **Crispy duck.** Duck pieces are cooked at high temperature to melt the duck fat and cook the meat. After sous vide cooking, the duck is deep fried crispy. The fat is gone and the skin is crispy inside and out.
- ◇ **Beef** of any kind can be slow cooked at  $\geq 130^{\circ}\text{F}$  for several hours. The meat will retain its raw tenderness and raw red color, yet be fully cooked.
- ◇ **Spices and inclusions** can be vacuum sealed along with the main food item.
- ◇ **Low temperature** sous vide can be used to cook and hot hold foods for many hours without overcooking most foods.

Keep in mind that sous vide is cooking in water. Foods cooked using this method will not have a grilled or browned surface. Red meats may cook to be gray. White meats will remain white. Chefs can “finish” sous vide cooked foods using a grill or surface pan fry. More culinary creations can be found in the many articles, books, and websites on sous vide.

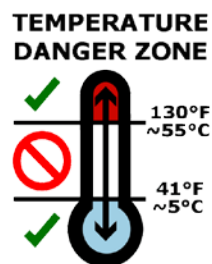
## FOOD SAFETY

### SOUS VIDE TIME-TEMPERATURE

On the science side, both **time and temperature** are the keys to maintaining food safety. This fact sheet will discuss three key **time and temperature** controls for sous vide:

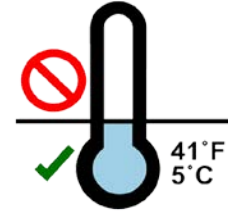
|   |   |
|---|---|
| <p><b>REFRIGERATION</b></p>  <p>41°F<br/>5°C</p>                                     | <ul style="list-style-type: none"> <li>• Refrigerate all perishable foods at <math>\leq 41^{\circ}\text{F}</math> or freeze.</li> <li>• Refrigerate sous vide cooked foods at <math>\leq 41^{\circ}\text{F} \leq 7</math> days (no time limit on frozen storage).</li> </ul>  |
| <p><b>COOKING</b></p>    | <ul style="list-style-type: none"> <li>• Cook at <math>\geq 130^{\circ}\text{F}</math> or</li> <li>• Under-cook <math>\leq 130^{\circ}\text{F}</math> for <math>\leq 1</math> h.</li> <li>• Ensure cold foods reach cooking temperature in <math>\leq 2</math> h.</li> </ul>  |
| <p><b>COOLING</b></p>  <p>130°F<br/>~55°C<br/>70°F<br/>~21°C<br/>41°F<br/>~5°C</p> | <ul style="list-style-type: none"> <li>• Always rapidly chill cooked foods. Use ice.</li> <li>• Ensure sous vide cooked foods chill from <math>&gt; 130^{\circ}\text{F}</math> to <math>70^{\circ}\text{F}</math> in <math>\leq 2</math> h; and</li> <li>• Ensure sous vide cooked foods chill from <math>70^{\circ}\text{F}</math> to <math>41^{\circ}\text{F}</math> in <math>\leq 4</math> h.</li> </ul> |

Before discussing the key time-temperature concerns, it is important to point out the temperature danger zone for the rapid growth of bacteria in foods. If perishable foods are left in the temperature danger zone for more than a few hours, bacteria have the chance to grow. The key then is to keep perishable foods safely refrigerated until ready to cook. Then, ensure that the time it takes to get cold foods up to the cooking temperature above  $130^{\circ}\text{F}$  is no more than 1-2 hours. Do not sous vide for extended time below  $130^{\circ}\text{F}$ . This is called “incubation”, not



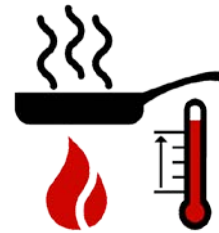
“cooking”. Later, higher temperature cooking of these foods may not make the food safe.

### REFRIGERATION



All perishable foods should be refrigerated at or below  $41^{\circ}\text{F}$  ( $5^{\circ}\text{C}$ ). This includes all raw foods that are ingredients for sous vide cooking. Poor quality ingredients make poor quality product.

### COOKING



The term “fully cooked” implies that a food is cooked sufficiently to destroy all of the foodborne illness bacteria such as *E. coli* O157:H7 and *Salmonella*. The US FDA model Food Code specifies that cooking vegetables to  $\geq 135^{\circ}\text{F}$ , intact meat to  $\geq 145^{\circ}\text{F}$ , ground meats to  $\geq 155^{\circ}\text{F}$  and poultry to  $\geq 165^{\circ}\text{F}$  is considered “fully cooked” and safe. Therefore any sous vide process that achieves those food temperatures is safe.

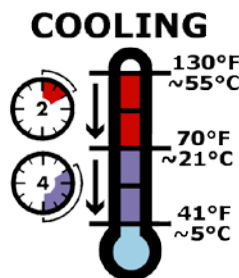
However, the sous vide process often uses low cooking temperatures over long time periods. The FDA and USDA both have established safe processes for cooking temperatures between  $130$ - $165^{\circ}\text{F}$ . The following time at temperature chart has been created using USDA established safe cooking times. P = poultry and M = meat (pork or beef). Ground meats and poultry are safe under these same cooking times (Goodfellow and Brown, 1978). An example use of this chart would be sous vide cooking a beef steak. The vacuum packaged steak is placed into the sous vide hot water. Once the steak is at  $130^{\circ}\text{F}$ , then it will

take 121 minutes at 130°F to be fully cooked. Anything less is “under-cooked”. Since most chefs will not pierce the bag to check temperature, most sous vide times are over estimated by at least an hour.

| Safe Sous Vide Cooking            |                 |     |       |    |    |
|-----------------------------------|-----------------|-----|-------|----|----|
| Minimum time (min) at temperature |                 |     |       |    |    |
| °F                                | P               | M   | °F    | P  | M  |
| 130                               |                 | 121 | 141   | 29 | 10 |
| 131                               |                 | 97  | 142   | 24 | 8  |
| 132                               |                 | 77  | 143   | 20 | 6  |
| 133                               |                 | 62  | 144   | 17 | 5  |
| 134                               |                 | 47  | 145   | 14 | 4  |
| 135                               |                 | 37  | 146   | 12 | 3  |
| 136                               | 82 <sup>a</sup> | 32  | 147   | 10 | 4  |
| 137                               | 66 <sup>a</sup> | 24  | 148   | 8  | 2  |
| 138                               | 53 <sup>a</sup> | 19  | 149   | 7  | 2  |
| 139                               | 43 <sup>a</sup> | 15  | 150   | 5  | 2  |
| 140                               | 35 <sup>a</sup> | 12  | > 150 | 5  | 2  |

<sup>a</sup>Cooking poultry ≤ 140°F leaves a rubbery texture.  
Meat = M (USDA, 1999) and Poultry = P (Juneja, et al. 2001).

Sous vide is an exceptional cooking technique for delicate foods like fish. Fish cooked at 145-165°F can overcook to be hard and bitter. Many Chefs cook delicate fish fillets from 110-130°F in sous vide processes. It is important that the full time of the process is under 1 hour. These foods are undercooked. They should not be chilled and refrigerated for later use.



Often sous vide foods are consumed directly after cooking. However, it is possible to chill and refrigerate fully cooked foods for later use. Proper sous vide cooking (*time-temperature*) will destroy all of the foodborne illness bacteria except for three

(*Clostridium botulinum*, *Clostridium perfringens*, and *Bacillus cereus*). These bacteria can produce spores that survive the cooking process. Spores do not cause illness. However, if spores return to growing bacteria, they can produce toxins making people ill. To prevent these spores from any possibility of growth, rapid cooling is required.

Professional Chef's will use an ice-water bath. Fill a container with ice. Place the vacuum packaged sous vide cooked foods into the ice bath. Don't remove the food from the package. Add just a little water (maybe 10% of the volume). Stir or rotate the bag(s) every 15-30 minutes. Add more ice if the ice melts significantly. Use a calibrated thermometer to check the temperature by folding the bag over the thermometer (if possible). The goal is to chill from 130 to 70°F within 2 hours and from 70-41°F within another 4 hours. A good ice bath should chill the food from 130-41°F within 2 hours total.

After chilling, place the packaged, fully cooked sous vide food in the refrigerator or freezer. Since bacterial spores may still be present, fully cooked and chilled sous vide foods can safely be refrigerated for up to 7 days. Or, these foods can be frozen without a shelf life. Be sure and label the foods so that the safety “use by” date is known. Refrigerated sous vide cooked foods may no longer be safe after 7 days and should be discarded.



## Sous Vide Equipment

For sous vide, part of the science lies in the equipment. At the culinary level, sous vide implies a precise control of the water temperature. Yet there are a few equipment factors important to maintain a safe process.

*Accuracy:* Accuracy is a concern for food safety when cooking at or near 130°F. The actual cooking temperature must be at or above 130°F in all parts of the water bath. Cooking temperatures must also be accurate so that sufficient cooking time is used to destroy foodborne illness bacteria. This means no cold spots or cooking vessels too large for the immersion heater. An accuracy of ± 1°F is common and professional units may have an accuracy of ± 0.1°F.

**Heating capacity:** Generally, immersion heater elements are rated in watts. A standard 15 Amp electrical breaker can handle up to approximately 1800 watts. Most home immersion sous vide units are close to 1000 watts and thus similar to a home microwave. The greater the watts, the more heat can be created and come-up times will be shorter. The volume of water to heat will also impact the come-up time. Keep in mind that it may not be possible to sous vide cook from frozen using some equipment.

**Gadgetry and Price:** Add-on gadgetry and price will have no effect on food safety. Wireless networking, Alexa or Google Home connections, Bluetooth, sounds, bells, and whistles are all add-ons. If the equipment has heating capacity with accuracy, the safety will rely on the operator. There is one exception. If the power supply is interrupted during a very long cook, the food temperature could drop into the temperature danger zone. One brand of immersion cooker changes the color of its display to indicate a power interruption. The thought of cooking three day ribs for one day at 145°F followed by incubating two days at room temperature is disconcerting.

#### Photo Credits

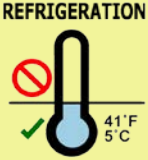

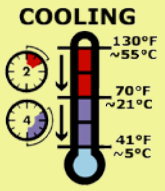
The header photo left is courtesy of Chef Tim Franks. All other photos were created by the author modified from food safety icons that are copyrighted by the International Association for Food Protection (IAFP). Permission from IAFP is granted for educational use.

#### References

Goodfellow, S. J. and Brown, W.L. 1978. Fate of *Salmonella* Inoculated into Beef for Cooking. *Journal of Food Protection*. 41:598-605.

Juneja, V.K., Eblen, B.S. and Marks, H.M. 2001. Modeling non-linear survival curves to calculate thermal inactivation of *Salmonella* in poultry of different fat levels. *International J of Food Microbiology* 70:37-51.

USDA Appendix A. 1999. Available online at: [https://www.fsis.usda.gov/OPPDE/rdad/FRPubs/95-033F/95-033F\\_Appendix\\_A.htm](https://www.fsis.usda.gov/OPPDE/rdad/FRPubs/95-033F/95-033F_Appendix_A.htm).

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